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Facing Reciprocity: How Photos and Avatars Promote Interaction in Micro-communities

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Abstract

Online platforms facilitate the formation of micro-communities on the Internet by enabling exchange between locally dispersed individuals. Since all interactions are mediated through the online platform, user representation plays a critical role for such communities. Grounded in Social Exchange Theory, we report results of a behavioral experiment on the role of user profile photos and avatars for the emergence of network structures over time. While overall network value increases slightly, the underlying structures of exchange shift systematically from many weak ties to fewer but significantly stronger reciprocal exchange relations. Interestingly, despite representing users in a highly abstracted way, avatars yield outcomes comparable to those when using actual photographs. We discuss theoretical and practical implications of how online platforms can leverage social cues such as profile photos and avatars to manage and support micro-communities.

Keywords Laboratory experiment · Micro-communities · Reciprocity · Social cues · Social exchange theory

Mathematics Subject Classification C9 · D61 · D85 · D91

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1 Introduction

Online platforms facilitate the formation of micro-communities by enabling social exchange between locally dispersed individuals with mutual interests or goals (Lasfer and Vaast 2018; Preece 2000). Examples include communities for knowledge exchange (Buendía et al. 2018; Pedersen and Lupton 2018), resource sharing (e.g., Nextdoor), as well as social and professional networking sites (Grissa 2016). Value created in these communities stems from different forms of exchange between members where typical interactions include the provision of advice, answers, hints to job or accommodation vacancies, endorsements, testimonials, or simply the sharing of photos, links, or otherwise relevant content. In a more abstract sense, one user creates value for another user at some cost (e.g., time and effort), where the cost is typically smaller than the value created (Berninghaus et al. 2008). Thereby, the creation of value is often motivated by expectations about reciprocity, where helping someone else today is associated with the prospect of own benefits in the future (Güth et al. 2010).

Importantly, in such micro-communities, members do not come together for once-off interactions but multiple times over the course of days, moths, or even years, establishing transactional histories and knowing with whom they have interacted in the past (i.e., whom they helped and who helped them). As this creates path dependencies, it is hence important to take into account (at least the recent) history of interactions when seeking to understand individual behavior at any given point in time. Moreover, this also warrants a deeper investigation into how behavior and outcomes develop over time—both on the individual and group level.

Considering all interactions are mediated by the online platform, *user representation* plays a pivotal role in this environment. A crucial design decision thus pertains to *how* users should be represented in the micro-community. On most platforms, they can upload a photograph of themselves as their digital representation (Hesse et al. 2020; Lee et al. 2014), typically in the form of portrait-like profile pictures (Teubner et al. 2021). Thereby, the platform employs a key feature of virtually all forms of social exchange in the real world: the processing of visual appearance in face-to-face encounters. After all, what automatically comes to mind when thinking about other people is their faces (Tamir and Ward 2015). Hence, it does not come as a surprise that online communities leverage visual representations.

The increasing blending of online platforms, virtual worlds, and potential future metaverse applications also introduces other forms of user representation, specifically avatars. Avatars refer to stylized graphical user representations that capture characteristic human features (Bailenson and Blascovich 2004). As photos have raised various concerns, mainly around privacy and discrimination, avatars are becoming more and more popular with users (Micallef and Misra 2018; Wolverton 2018). This trend is also evidenced in the popularity of applications such as Bitmoji, Zepeto, or the Codec Avatar project (Apple 2022; Facebook 2019; Gaus 2018; Nusca 2017; Tech at Meta 2022). Vivid user representations

have been found to facilitate exchange relations in various contexts (Bente et al. 2014), and avatars may serve as a viable extension, or even alternative, to photographs—in particular when privacy is a concern.

This gives rise to questions in view of expectations about reciprocity, the facilitation of individual transactions, and the emergence of community value when different forms of representation are being used (Hesse et al. 2020; Lee et al. 2014; Tamir and Ward 2015). While user photographs and avatars have been studied for online social networks (Steinbrück et al. 2002; Wang et al. 2010), the sharing economy (Ert et al. 2016; Fagerstrøm et al. 2017), public good experiments (Teubner et al. 2013), electronic commerce (Karimi and Wang 2017), and e-learning (Kear et al. 2014), little is known about the specific differences between photos and avatars as well as the role of such cues for facilitating *multilateral relations over time* (i.e., such as seen in micro-communities). Prior research has mostly investigated the role of user representation for *static* (i.e., snapshot) and bilateral community interactions. In contrast, the role of user representation in *dynamic* scenarios as well as for multiple exchange relations has remainded largely unexplored. Moreover, only few studies have deliberately considered how and under which conditions photos and avatars differ in terms of outcomes—and when they do not. Against this backdrop, this paper addresses the following overarching research question: **To what extent does the availability of profile images (photographs/ avatars) affect the process of network formation and value creation in online micro-communities, and how do outcomes depend on the employed type of profile imagery?** To address this question, we present behavioral evidence from a controlled, multi-period laboratory experiment.

We find that while overall network value increases slightly over time, the underlying network structures of exchange shift systematically from many weak ties to fewer but significantly stronger reciprocal exchange relations. Interestingly, despite representing users in a highly abstracted way, avatars yield results similar to those of using actual photographs. This study hence contributes to Social Exchange Theory (SET) by empirically demonstrating two mechanisms that govern *how* specifically reciprocal relations—as posited by SET—develop over time and what this means on a network-level. In addition, results extend the literature on avatars' influence on user behavior by illustrating similarities and differences in the effects of avatars and photos in the absence of other forms of communication.

The remainder of this paper is organized as follows. Section 2 sketches out the study's theoretical background and develops our hypotheses. Section 3 then presents method and the experimental design. Next, Sect. 4 reports the results which we discuss in view of theoretical and practical implications as well as limitations and future work in Sect. 5. Last, Sect. 6 concludes the manuscript.

2 Theoretical Background and Hypotheses

2.1 Social Exchange Theory

Social Exchange Theory (SET) posits that human relationships are formed based on subjective cost–benefit analysis (Blau 1967). Originating from the nexus of

economics, psychology, and sociology, SET conceptualizes interpersonal interactions as a form of social trade, where individuals' actions are contingent on the benefits they (expect to) receive from others (Homans 1961; Kelley and Thibaut 1978; Uehara 1990). Summarized across all actors of a network, this net benefit can be thought of as *value creation*. Exchanges are prompted by resources' value and their dispersion across different individuals (Levine and White 1961). The value of those resources is materialized through exchanges (e.g., the transfer of ideas, knowledge, objects, goods, or services). As such, (social) network analysis lends itself well to study how resources are exchanged within a micro-community. Specifically, network analysis allows to assess key characteristics of the formation of social exchange in a network through measures such as *network density* (Mitchell 1969) and *reciprocity* (i.e., "a user strategy to return received favors in a similar way"; Lee et al. 2010, p. 136).

2.2 Reciprocity in Social Exchange

The notion of reciprocity plays a major role in how social exchange unfolds. It refers to bi- and multilateral relations of exchange between individuals where one actor creates value for another that is expected to be returned in good faith, entailing some agreed-upon standard of equivalence (Berninghaus et al. 2008; Gouldner 1960). As such, the concept of reciprocity is widely used in Social Network Analysis where it is referred as the "degree to which individuals report the same (or similar) intensities with each other" (Scott et al. 2008, p. 203). Here, intensity refers to the "strength of the relation as indicated by the degree to which individuals honor obligations or forego personal costs to carry out obligations" (Mitchell 1969; Tichy et al. 1979, p. 509).

Reciprocity represents a core success factor for social exchange relations in the long run (Cook and Rice 2003; Emerson 1972). Reciprocal exchanges do not involve explicit bargaining; they are contigent on each party's actions and thus, often emerge over time (Cropanzano and Mitchell 2005; Molm 2003). Considering a community of actors, tracing exchange relations reveals network structures (Cook and Rice 2003; Surma 2016). Individuals have finite resources (e.g., time) which leads them to be selective in choosing exchange partners (Levine and Kurzban 2006). In this sense, reciprocal exchanges tend to function as a stabilizer within networks. As individual cost–benefit analysis will ultimately define the network structure, reciprocity is essential for network formation (Mitchell 1969; Scott et al. 2008; Tichy et al. 1979).

Reciprocity has been found a critical factor in a range of contexts, including personal relations (Buunk and Schaufeli 1999), online reviews (Bolton et al. 2013), elections (Finan and Schechter 2012), organizations (Settoon et al. 1996), and more abstract economic exchange scenarios (Berg et al. 1995; Berninghaus et al. 2008). One particular finding is that in many cases, factors that may have an impact on the unilateral provision of resources (e.g., frequency of contact, similarity between exchange partners) only play a secondary role: Whether an actor decides to provide

resources or not is contingent on whether they *received* resources before (Plickert et al. 2007), that is, whether a reciprocal relation could be established.

More recently, scholars have explored how reciprocity is manifested in social networking sites. In this context, reciprocity is often applied to the notion of self-disclosure: as individuals receive others' personal information over time, they reciprocate by sharing their own personal information with them (Posey et al. 2010). In the same vein, reacting to content posted by others (e.g., in the form of a "like" or comment) is hoped to elicit reactions when posting own content (Surma 2016). In a way, the process of value creation hence relies on an initial spark of value and then enters a cycle of further contributions. Feelings of indebteness represent drivers of reciprocation in knowledge exchange (Feng and Ye 2016) and gift giving on social network sites (Kim et al. 2018). Chen et al. (2018) find that reciprocity is effective to move users from low to medium motivational states to contribute within Q&A communities. Ye et al. (2018) study reciprocity in an online book barter market, where they find reciprocal relationships to help improving exchanges through "lower rejection rates and faster delivery speeds" (p. 521).

2.3 Photos and Avatars as Carriers of Social Cues

Before exchanges take place, individuals seek social cues to learn that resources are available and that they are worth pursuing (Hobfoll 2002) and to assess the risk of free riding, that is, that the contributions they provide in good faith will not be reciprocated (Das and Teng 2002). Importantly, for micro-communities, all interactions are mediated through the platform which deliberately integrates social cues to support trust-building (Halbesleben et al. 2014; Lasfer and Vaast 2018). A commonly used cue, in this regard, are prospective exchange partners' photographs (Dai et al. 2018; Teubner et al. 2022; Zhang et al. 2018).

The importance of facial imagery as carriers of social cues can be understood based on evolutionary psychology. To facilitate positive human interactions and survival, humans have developed the ability to process the cues embedded in facial imagery and to make assessments of trustworthiness thereupon (Bente et al. 2012; Riedl et al. 2014). In this sense, the availability of a photograph represents a subtle form of visual communication. Individuals can utilize profile photos to create positive self-presentations, for instance, to appear happy, friendly, successful, or self-conscious to others (Wang et al. 2010; Wu et al. 2015). Smiling facial expressions have been found to increase inferred trustworthiness (Ert and Fleischer 2017). For the selection of profile images, users tend to choose posed images (Hum et al. 2011; Wu et al. 2015) and attempt to appear genuine and authentic (Whitty et al. 2014).

As such, photographs may render interactions more personal (Stephenson et al. 1976). Since trust in online environments is not formed solely based on calculative processes but also relies on "soft" signals, profile photos may serve as an effective component towards this end (Qiu and Benbasat 2010; Steinbrück et al. 2002). Profile photos can be assumed to be particularly powerful because the human brain is "hardwired" to intuitively process faces (Anzellotti and Caramazza 2014), involving a brain area referred to as the *fusiform face area* in the extrastriate cortex (Kanwisher

et al. 1997). This is exemplified by the fact that infants react to faces within the first minutes after birth (Goren et al. 1975). In addition, detecting facial expressions happens unconsciously and fast (Willis and Todorov 2006). Representing an inherently social signal, human faces foster trust in a variety of online environments (Cyr et al. 2009; Gefen and Straub 2003, 2004; Hassanein and Head 2007; Ou et al. 2014; Qiu and Benbasat 2010; Steinbrück et al. 2002). Based on such photos' trust effect and its implications for social exchange behavior, we hypothesize that.

H_1 Within micro-communities, the availability of profile photos yields higher network (a) value, (b) density, and (c) reciprocity as compared to default images.

Similarly, an individual's representation in the form of an avatar can also be considered as a social cue that allows to make inferences about them (Burgoon et al. 2008; Isbister et al. 2000; Morrison et al. 2012). Avatars do not display a photo-realistic but a stylized depiction of the represented person. However, by depicting human features (e.g., hair style, clothing, accessories), avatars also induce social presence (Bailenson and Blascovich 2004), in particular for immersive virtual environments (Lee et al. 2009; Nowak and Biocca 2003; Qiu and Benbasat 2005). Past research on the use of avatars (see Table 1 for summary of studies) suggests that evaluations of avatars' characteristics such as attractiveness, empathy, and perceived social support influence positively the development of satisfying social interactions (Banakou et al. 2009; Guadagno et al. 2011), intentions to shop online (Chattaraman et al. 2012; Mull et al. 2015), compliance with favors (Waddell and Ivory 2015), and improved task performance (Ratan et al. 2016; Ratan and Sah 2015). In fact, Tong et al. (2000) showed that the fusiform face area is activated not only for photos of *human* faces, but also for animal and cartoon faces and concluded that "cartoons are readily perceived as animate faces" (p. 264). In addition to humans, even other primates (such as macaques) exhibit comparable brain activation for cartoon and real faces, but not for non-face objects (Freiwald et al. 2009). In other words, whatever appears to be a face is processed as such by the brain. This is reasonable from an evolutionary point of view, as for most of human history—without artificial images—everything that looked like a face—in fact—was a face, and needed to be recognized rapidly to assess sentiment and intentions. We hence suggest that the above arguments extend to avatars:

H_2 Within micro-communities, the availability of avatars yields higher network (a) value, (b) density, and (c) reciprocity as compared to default images.

2.4 Avatars Versus Photos

When thinking about the potential differences between photos and avatars in view of outcomes, it is important to note that avatars may differ greatly in terms of abstraction/detail, emotional expressiveness, realism, and likability (i.e., "cuteness"). Any hypothesing on an avatar's effect will have to be conducted in view of the specific avatar design at hand—as avatar design may range from highly abstract "stickman"

Table 1 Related Literature on avatars and human behavior

Study (Authors, Year)	Focus	Method	Context	Sample (size, origin)	Theory/constructs
Banakou et al. (2009)	Effect of avatar appearance on users' sociability	Virtual ethnography	Virtual world	9, Not indicated	Number of social encounters (private and public)
von der Pütten et al. (2010)	Differences in reaction to interacting with agents (i.e., controlled by artificial intelligence) and avatars (i.e., controlled by humans)	Lab experiment	Self-disclosure tasks	83, US	Threshold model of social influence, Ethopoeia concept
Saunders et al. (2011)	Exploring the notions of space, place, and presence	Lab experiment	Virtual world: Second Life; (brainstorm tool, organizer tool, voting tool)	150, Alpine Executive Center, Second Life	Theory of virtual space and place, Social Presence, Perceived Ease of Use, Perceived Enjoyment, Focused Immersion
Guadagno et al. (2011)	Effect of smile behavior on social evaluations (e.g., perceived empathy) of virtual peer counsellors	Lab experiment	Peer counselling	38, US	empathy, general positivity, supportiveness, likeability, comfort with the interaction, interaction satisfaction, and interaction enjoyableness Social presence, trust
Chattaraman et al. (2012)	Evaluation of a virtual agent that offers search, navigational and procedural support to older adults	Lab experiment	Online shopping	60, US	social presence, perceived social support, trust, perceived risk, patronage intention
Ang et al. (2013)	Effects of gesture-based avatar-mediated communication vs video-mediated communication	Lab experiment	Brainstorming and negotiation	64, UK	Perceived satisfaction, likeability, trust, and intelligence; number of ideas, quality of ideas

Table 1 (continued)

Study (Authors, Year)	Focus	Method	Context	Sample (size, origin)	Theory/constructs
Pinto et al. (2013)	Efficacy of avatar-based depression self-management intervention among young adults	Randomized controlled trial	Depression self-management	28, US	Depressive symptoms
Teubner et al. (2014)	Effects of avatar *humanization* on sharing behavior	Lab experiment	Sharing Economy	216, Germany	Social Presence, Privacy Calculus
Mull et al. (2015)	Examining consumers' perceptions (e.g., credibility, homophily) of using 3D avatars as salespeople	Survey	Online shopping	120, US	Credibility, homophily, attractiveness, and intention to interact
Ratan and Sah (2015)	Effect of avatar customization (i.e., designing an avatar) and avatar embodiment (i.e., perceiving avatar is incorporated in body schema) and gender on post-game behavior	Lab experiment	Online game	64, US	Stereotype threat theory, avatar embodiment
Waddell and Ivory (2015)	Effect of interaction of avatar's and user's features on favor responses	Field experiment	Online game	2300, North American World, World of Warcraft	Avatar attractiveness, avatar sex, user sex, magnitude of request (i.e., small vs large favor), compliance (i.e., agreeing to the favor)

Table 1 (continued)

Study (Authors, Year)	Focus	Method	Context	Sample (size, origin)	Theory/constructs
Ratan et al. (2016)	Examining how avatars can be integrated to students' communication to improve their performance motivation	Field experiment	Education	229, US	Avatar type (i.e., actual-self, ideal-self, superhero-student), average number of topics discussed
Canidate and Hart (2017)	To identify preferences for health information provider avatars and how such avatars compare to seekers' own characteristics	Online survey	Informational website	1119, US	Age, gender, and ethnicity origin
Gordon et al. (2017)	A pilot proof-of-concept feasibility study for avatar-assisted therapy in a virtual environment	Pilot study, interviews before and after the treatment	Outpatient substance abuse treatment	58, US	Avatar features: hair, skin, eye color, facial features, body type and size, and clothing Treatment completion, urine drug-screen positive samples, re-arrest information
Heyselaar et al. (2017)	Examining differences between human–computer language interaction (e.g., with a human-like avatar) and human–human language interaction (i.e., with a human partner) in a priming syntactic activity	Lab experiment	Virtual reality	Experiment 1: 48; The Netherlands Experiment 2: 48; The Netherlands	Relationship questionnaire (opinions of partners), conflict questionnaire (how participants managed conflict), target responses (active, passive)

Table 1 (continued)

Study (Authors, Year)	Focus	Method	Context	Sample (size, origin)	Theory/constructs
Joo and Kim (2017)	Effect of an online game avatar's body shape (obese vs. normal weight) and health behavior (healthy vs. unhealthy) on user's health behavior (using exercise machine or eating high-sugar cookies)	Lab experiment	Online game	124, South Korea	Exercise behavior, eating behavior, Body Mass Index (control)
Teng (2017)	Extent to which regarding an avatar as oneself (i.e., avatar identification) impacts gamers' continued intention to play (i.e., gamer loyalty)	Online survey	Online game	1384, Not indicated	Social identity theory, social capital theory / avatar identification (four factors: feeling during play, absorption during play, positive attitude toward the avatar, importance to identity), participation in gaming communities, social presence, loyalty
Wu and Kraemer (2017)	Examining how emotion in language (i.e., positive or negative) affects avatars' judgment (e.g., likeability) and preferences (e.g., avatar as an interacting partner)	Online survey	Virtual environment	189, US and Amazon Mechanical Turk (Amazon MTurk)	Choices between a pair of avatars: (i) avatar they would prefer to interact with; (ii) avatar they would prefer to use for self-representation; and (iii) the avatar they attributed to human control Variables: likeability

Table 1 (continued)

Study (Authors, Year)	Focus	Method	Context	Sample (size, origin)	Theory/constructs
Messinger et al. (2019)	Analyzing how a person's avatar differs from the individual the avatar represents and how in-world behavioral traits are affected by the relative attractiveness of the avatar compared with the real person		Virtual environment	Study 1: 167, US 97, Second Life Study 2: 38, US	Self-enhancement theory, self-verification theory / Variables: attractiveness (avatar vs. real person), behavioral traits
Yu et al. (2021)	To compare a point cloud reconstruction-based avatar with a virtual character-based (3DVC) avatar in a 3D telepresence system	Lab experiment	VR/AR teleconsultation system	24, Germany	Performance at task, co-presence, telepresence, social presence, self-location, uncanniness and eeriness perceptions, behavior impression (natural, realistic, synchronous), system usability scale, fast motion sickness scale

figures to (near) photo-realistic representations (e.g., Meta's Codec Avatars; Clark 2021; Skarredghost 2022). In addition to that, there exist several further aspects that should be taken into account:

- First, avatars may fall into what has been labeled as the "uncanny valley" (Cheong 2022; University of Cambridge 2019). This concept refers to a negative relation between an avatar's resemblance to a human being and a user's emotional response to it, specifically when the avatar comes very eerily close to human appearance but can still be identified as artificial. In this range, avatars evoke feelings of uneasiness, and revulsion. Beyond avatars within digital applications, examples of the uncanny valley can be found in movies, robotics, and lifelike dolls.
- Second, not only may an avatar affect the behavior of others that encounter it, but also the user being represented by and/or controling the avatar. Being represented by an avatar of a certain style or appearance is known to create a back-coupling, referred to as the *Proteus effect* (Yee et al. 2009; Yee and Bailenson 2007). The effect refers to people's tendency to be affected by their digital representations (e.g., in video games, on dating sites, or social networks), in a way that their behavior conforms to common expectations towards the digital representation (TechTarget 2014; Yee and Bailenson 2007). Research suggests that the effect extends into users' real life with small but fairly consistent effect sizes (Clark 2020; Ratan et al. 2020). A recent review study indicates that three main components drive the Proteus effect, namely similarity (i.e., self-identification), desirability (i.e., wishful identification), and perceived embodiment (Praetorius and Görlich 2020).
- Third, as another boundary condition, it is important to understand not only how avatars look, but also how and under which restrictions they were created and assigned to users. Will, for instance, avatars depict the actual user or are they free to chose any ever so phantasmal identity? How is a potential matching ensured? In this regard, research indicates that when users select (or are assigned to) avatars that reflect their appearance well, they are less likely to engage in deception (Galanxhi and Nah 2007; Hooi and Cho 2013). As we will describe in the next section, the present study makes use of *certified avatars*, where an independent third party (i.e., the research team) creates and assigns the avatars based on participants' photographs (as taken right before the experiment). This establishes that (1) the avatars indeed reflect participants' appearance and (2) that this link is reliable and trustworthy.

The avatars used in this study fall into the middle range of a) having a rich set of features (i.e., hair style and color, head shape, skin tone, accessory, etc.) but b) being clearly cartoonish and far away from photoreaslism (proportions, no texture, not even a nose, etc.)—see Figures A1 and A2 in the Appendix. While the photos provide a clear and realistic view on the person behind the online identity, the avatars also strip away quirky features and they appear particularly neat and cute—keeping a safe distance to "uncanny" representations. We hence leave it as an open-ended question here how (these specific) avatars will affect outcomes compared to

photographs. Given the study's specific setup with high (presumed) avatar likabiltiy and a credible reflection of user appearance, we believe that avatars may be as effective as photosgraphs or even surpass them.

3 Method

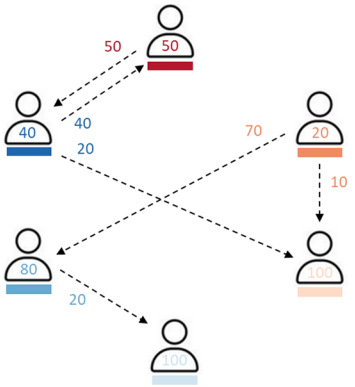
3.1 Experimental Treatments

To evaluate our hypotheses, we emulate an online micro-community by means of a 15-period Gift Exchange Experiment (Berninghaus et al. 2008). Building on the gift exchange model by Akerlof and Yellen (1988), this setting allows to investigate the formation of reciprocity in social exchange (Berninghaus et al. 2008; Güth et al. 2010). Naturally, such experiments cannot simulate or reproduce actual micro-communities; they represent stylized and abstracted models of such communities, capturing the most important structural features.

We employed three different conditions. First, in the *profile photos* treatment, participants were represented by an actual photograph of themselves. Second, in the *avatars* treatment, participants were represented by an avatar a staff member created based on the participant's photo. Third, participants in the *control* group were represented by a default image. Examples for all conditions are provided in Appendix A. Each participant was exposed to only one of the three conditions (between-subjects design). Participants were randomly assigned to the treatments and to gender-balanced cohorts of six (3 males, 3 females) and remained in the same cohort for the entire experiment.

3.2 Experimental Task

Following the design of Berninghaus et al. (2008), in each period, all six participants $i \in \{1, 2, \ldots, 6\}$ of a cohort were endowed with $E = 100$ units of one out of six unique resource types. Participants were then able to make transfers to other participants of their cohort. Thereby, each participant decided (simultaneously) how many units of their own resource to transfer to each other participant (non-negative integer values only). The total number of units transferred could not exceed the initial endowment of $E = 100$ units. A transfer from participant i to j in period t is denoted by $x_{ij,t}$. Every transaction $x_{ij,t} > 0$ yielded transaction costs of $c = 1$ monetary unit (MU) for the sender (i), representing the (small but positive) effort associate with the transfer. Therefore, participants could face transaction costs varying between 0 MU ($x_{ij,t} = 0$, $\forall j \neq i$) and 5 MU ($x_{ij,t} > 0$, $\forall j \neq i$). After each period, participants thus held between 0 and 100 units of the six resource types. These were then converted into monetary units. In order to reflect decreasing marginal utility for each resource, amounts were converted into monetary units by means of the square root function (Berninghaus et al. 2008). Participant i's payoff for period t is hence given as:



	Participants					
Endowment	100	100	100	100	100	100
Transferred	-50	-(70+10)			-20	-(40+20)
Received	40		20+10	20	70	50
	$\sqrt{50}$ $+\sqrt{40}$	$\sqrt{20}$	$\sqrt{100}$ $+\sqrt{20}$ $+\sqrt{10}$	$\sqrt{100}$ $+\sqrt{20}$	$\sqrt{80}$ $+\sqrt{70}$	$\sqrt{40}$ $+\sqrt{50}$
Value	13.40	4.47	17.63	14.47	17.31	13.40
Transaction Cost	-1	-2	0	0	-1	-2
Result	**12.40**	**2.47**	**17.63**	**14.47**	**16.31**	**11.40**

Fig. 1 Exemplary illustration of a period outcome

$$p_{i,t} = \sqrt{E - \sum_{j \neq i} x_{ij,t}} + \sum_{j \neq i} \sqrt{x_{ji,t}} - c \sum_{j \neq i} 1_{x_{ij,t}>0}$$

Given the concave nature of the square root function and the transaction costs, the overall (i.e., social) optimum corresponds to an even distribution of all resources among all participants. Since only integer numbers were possible, an allocation of 17, 17, 17, 17, 16, and 16 represented the optimal approximation, yielding an average outcome of 19.49 MU per participant and period. Note that the scenario represents a social dilemma with a unique Nash equilibrium in not transferring any resources at all. Participants may choose to follow this strategy, yielding a certain payoff of (at least) 10 MU (from their own resource type). Overall, capturing the nature of online micro-communities, mutually exchanging resources with others yields the potential for better outcomes while it also involves 1) the inherent risk of realizing a loss and 2) the temptation of free riding. Figure 1 illustrates this by an example.

3.3 Procedure

Altogether, 216 subjects participated (108 females, 108 males, average age = 22.1 years) across the three conditions. Each condition comprised twelve cohorts with 6 participants per cohort ($216 = 3 \times 12 \times 6$). Sessions took about 50–60 min. Participants were recruited from a pool of university students using ORSEE (Greiner 2015). The experimental interface was implemented using zTree (Fischbacher 2007). In order to incentivize behavior (Smith 1976), each participant's payoffs from ten randomly selected periods were paid out in cash (1 MU = 0.14 USD; average payoff of 26.2 USD).

After arriving at the lab, participants gave written consent for the use and processing of their photograph. Specifically, this included the photos' use within the experiment (shown to the five other respective participants in their cohort),

processing for scientific purposes, and use in presentations and publications. The experimental design and execution adhered to the ethical and procedural guidelines of the economic lab the study was conducted at.

A research assistant then took each participant's photo. Appendix A provides examples for the profile images used in the three conditions. In the *avatars* treatment, a staff member created the avatar based on the photo by using a proprietary tool with the aim of matching characteristic features (e.g., clothing, eye color, hairstyle and color, head shape). This process was conducted while participants were settling into the lab (i.e., within a few minutes) so that the participant-specific avatars were available upon the start of the actual experiment. A pre-recorded audio version of the experiment instructions was played, and a written version was handed out (Appendix B). Participants then answered twelve quiz questions testing their comprehension of procedure and payoff rules. After every participant had successfully completed the quiz, the actual experiment started.

3.4 Measures

Participants repeatedly decided whether, how much, and with whom to share their resources. At the *network level*, we analyze the emerging graph of connections for each cohort in terms of network value, density, and reciprocity. At the *individual level*, we investigate each transfer $x_{ij,t}$ from participant i to another participant j in a given period t. Further, we consider each participant's total volume of transfers, as well as the number of recipients they sent resources to. As *control variables*, we use participants' gender and risk attitude (Holt and Laury 2002). Appendix C provides an overview of definitions and summary statistics for all measures.

Importantly, it is a well-established result in the behavioral sciences that strategic interaction with a fixed time horizon (here: 15 periods) yields so-called "endgame effects" (Berninghaus et al. 2008; Bolton et al. 2004). Thereby, the final few periods usually exhibit a markedly different pattern of behavior (e.g., collapse of collaboration). Hence, we follow the common practice of excluding the last three periods from analysis and focus on the first twelve periods.[1]

4 Results

4.1 Hypotheses Testing

To evaluate our hypotheses, we consider (1) realized overall value (as compared to the theoretical upper and lower bounds, normalized to the interval [0, 1]), (2) the underlying network's density, and (3) overall reciprocity within the network. Figure 2 summarizes these measures by treatment (left) and over time (right). To assess

[1] Hence, our dataset includes 432 observations at the cohort level (3 treatments × 12 cohorts × 12 periods), 2,592 observations at the participant level (3 treatments × 12 cohorts × 12 periods × 6 participants), and 12,960 observations at the transfer level (3 treatments × 12 cohorts × 12 periods × 6 participants × 5 respective other participants).

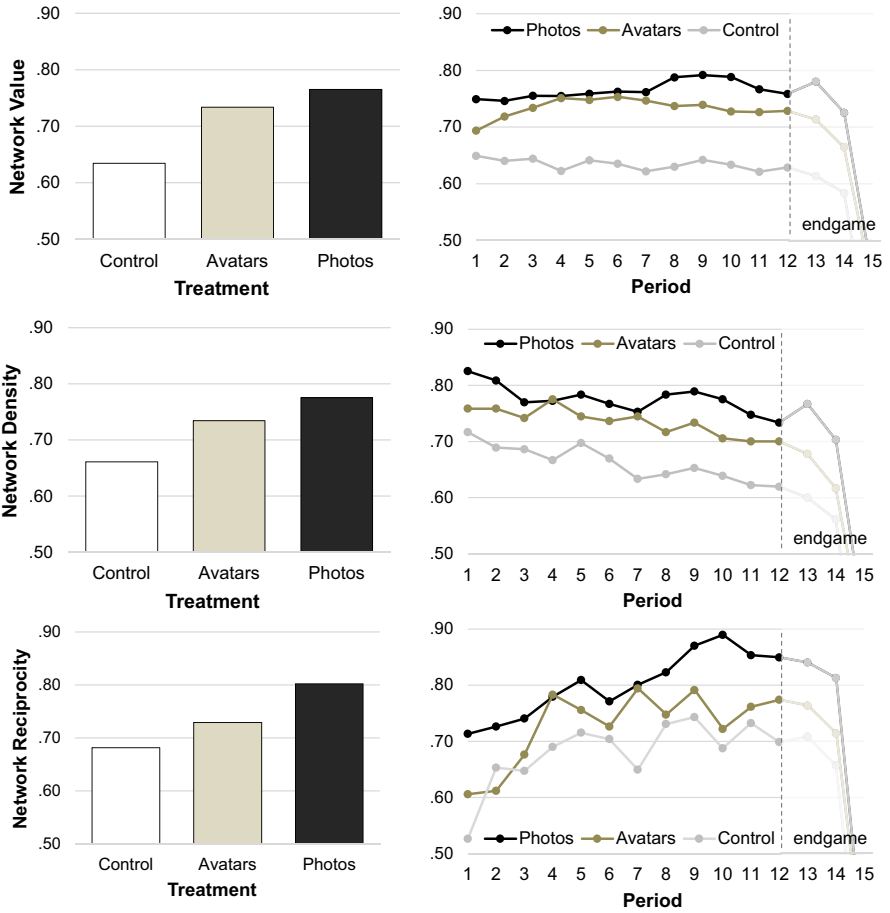


Fig. 2 Network value creation, density, and reciprocity across treatments and over the course of the experiment

the displayed treatment differences and time trends statistically, we use a set of panel regressions that consider the dependent variables at the cohort level (see Table 2). The regression models account for the dynamics of network formation over time by controlling for period effects (coded from 0 to 11) and treatment-period interactions.

As hypothesized, photos ($b = 0.131$, $p < .05$; H_{1a} supported) and avatars ($b = 0.099$, $p < .10$; H_{2a} supported) have a positive overall effect on network value.[2] Value also increases over time for photos but not for avatars or the control condition (photos: $b = 0.004$, $p < .05$; avatars: $b = 0.003$, $p = .169$; control: $b = -0.001$, $p = .262$). The results on network density and reciprocity provide further insight into how specifically value is created within the network. Overall, the availability

[2] Note that the treatment effect for avatars is only marginally significant ($p < .10$). However, the analysis reported in Table 2 is conducted at the cohort level and hence relatively conservative.

Table 2 Panel regression models for network value, density, and reciprocity (random effects; cohort level)

	(a) Network value		(b) Network density		(c) Network reciprocity	
Treatment: Photos (H_1)	**.131*** (.052)	**.108*** (.053)	**.114*** (.056)	**.099** (.058)$^{+}$	**.120*** (.053)	**.100**$^{+}$ (.059)
Treatment: Avatars (H_2)	**.099**$^{+}$ (.052)	.085 (.053)	.073 (.056)	.062 (.058)	.048 (.053)	.039 (.059)
Period (0–11)	.001 (.001)	− .001 (.001)	− **.006***** (.001)	− **.008***** (.002)	**.013***** (.002)	**.011**** (.003)
Photos × Period		**.004*** (.002)		.003 (.003)		.004 (.005)
Avatars × Period		.003 (.002)		.002 (.003)		.002 (.005)
Constant	.630*** (.037)	.642*** (.038)	.696*** (.040)	.705*** (.041)	.611*** (.039)	.621*** (.042)
N	432	432	432	432	432	432
R^2	.018	.030	.084	.086	.104	.105

Standard errors in parentheses. ***$p < .001$; **$p < .01$; *$p < .05$; $^{+}p < .10$; Significant coefficients highlighted in bold face

of photos has positive effects on network density ($b = 0.114$, $p < .05$; H_{1b} supported) and reciprocity ($b = 0.120$, $p < .05$; H_{1c} supported). In contrast, the effects of avatars on network density ($b = 0.073$, $p = .192$; H_{2b} not supported) and reciprocity ($b = 0.048$, $p = .368$; H_{2c} not supported) are positive but insignificant.

Result 1a The availability of profile photos yields higher network value (H_{1a}), higher density (H_{1b}), and higher reciprocity (H_{1c}) in the micro-community than the control condition with default images. By contrast, the availability of avatars only yields marginally higher network value (H_{2a}), while density (H_{2b}) and reciprocity (H_{2c}) are not significantly different than in the control condition.

Moreover, we do not observe any statistical differences between photos and avatars on network level (i.e., with regard to network value, density, or reciprocity).

Result 1b Photos and avatars yield similar results in terms of network value, density, and reciprocity.

Interestingly, in the first periods, there emerge relatively dense networks (i.e., high number of ties). Then, however—and irrespective of treatment condition—density *decreases* and reciprocity *increases* over time, that is, the network structure shifts towards fewer but stronger links.

Result 1c While network value in the micro-community is stable over time, network density decreases and reciprocity increases over time in all three conditions (photos, avatars, control).

These results illustrate how participants form transfer relations within their micro-community. Starting out from a broader "shotgun" approach (i.e., transferring small(er) amounts to many others), they adapt their behavior towards larger transfers to fewer recipients over time, where the enduring relations are also more likely to be mutual. As can be seen from the treatment-time interaction coefficients in Table 2 and Fig. 2, this dynamic is consistent across treatment conditions.

4.2 Transfer Strategies

Next, to shed more light on the underlying behavior of network formation, we investigate participants' transfers in more detail. Specifically, we consider (1) total transfer volumes, (2) number of recipients, and (3) average amounts transferred per recipient. This analysis allows us to discern strategies (e.g., "shotgun" approaches vs. targeted transfers to specific recipients). Table 3 shows the results from a set of panel regressions for these measures, considering models with and without treatment-period interactions.

First, photos ($b = 15.688$, $p < .001$) and avatars ($b = 13.128$, $p < .001$) exhibit higher overall transfer volumes than the control condition. There also exists an increase over time ($b = 0.495$, $p < .001$). However, as can be seen in the second model

Table 3 Panel regression models for individual transfers (random effects; participant level)

	Total transfer volume		Number of recipients		Average transfer / recipient	
Treatment: Photos	**15.688*** **	**12.117** **	**.568** **	**.489** *	**2.822*** **	**2.740** **
	(3.561)	(3.698)	(.185)	(.197)	(.792)	(.849)
Treatment: Avatars	**13.128*** **	**11.501** **	**.371** *	.317	**3.023*** **	**2.855*** **
	(3.562)	(3.699)	(.185)	(.197)	(.792)	(.849)
Period (0–11)	**.495*** **	**.180**	**− .032*** **	**− .040*** **	**.231*** **	**.216*** **
	(.074)	(.128)	(.005)	(.009)	(.023)	(.039)
Photos × Period		**.649*** **		.014		.015
		(.181)		(.012)		(.055)
Avatars × Period		.296		.010		.031
		(.181)		(.012)		(.055)
Risk Aversion	− 1.931^{+}	− 1.931^{+}	− .035	− .035	− .517*	− .517*
	(1.042)	(1.042)	(.054)	(.054)	(.232)	(.232)
Gender: Female	− 7.679**	− 7.679**	− .371*	− .371*	− .270	− .270
	(2.920)	(2.920)	(.152)	(.152)	(.649)	(.649)
Constant	55.859***	42.406***	3.870***	3.524***	14.029***	10.939***
	(6.662)	(2.667)	(.347)	(.140)	(1.484)	(.604)
N	2592	2592	2592	2592	2592	2592
R^2	.029	.032	.022	.020	.047	.047

Standard errors in parentheses.***$p < .001$; **$p < .01$; *$< .05$; $^{+}p < .10$; significant coefficients highlighted in bold face

specification, this is primarily driven by the photo treatment (slope = 0.180 + 0.649, $p < .001$). Second, compared to the control condition, participants transfer resources to a higher number of recipients in the photo condition ($b = 0.568$, $p < .01$) and in the avatar condition ($b = 0.371$, $p < .05$). Further, irrespective of treatment condition, this number decreases over time ($b = –0.032$, $p < .001$). Finally, the interplay of these findings (*increasing* overall transfer volume and *decreasing* number of recipients) is then also reflected in the average amount sent per recipient. Here, both treatments (as compared to the control condition) yield higher amounts, and there is a marked positive time effect ($b = 0.231$, $p < .001$).

These results indicate that profile images (either photos or avatars) were indeed utilized as a cue to develop an impression of potential exchange partners that, in turn, contributed to facilitate resource transfers.[3] Moreover, we considered risk aversion as a control variable and found it to be associated with lower overall transfer

[3] To confirm that reciprocity in fact acts as a driver and sustainer of exchange relations, we conducted a complementary analysis on the individual transfers at a peer-to-peer level (Appendix D). Indeed, the amount that was received from the respective other participant in the previous period (t–1) predicts one's transfer in the current period (t). This analysis also shows that female participants tend to transfer less (b = -1.142, $p < .001$) while neither male nor female subjects receive systematically higher transfers in general when accounting for reciprocity (b = -.053, $p = .616$). Sender-receiver gender interactions and gender identity/difference do not reveal any further effects.

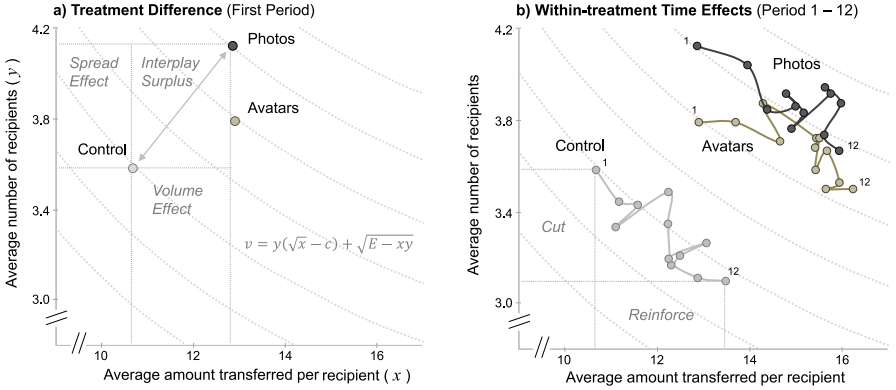


Fig. 3 Effect decomposition with **a** treatment differences (first period) and **b** within-treatment time effects. Curved lines represent iso-value levels (v) where cost c = 1 MU and endowment E = 100 MU. Note that the iso-value levels assume identical transfers for each subject as well as infinitesimal division while the plotted data is based on actual (integer) numbers of recipients and transferred amounts

volumes ($b = -1.931$, $p < .10$), an effect that is primarily driven by the fact that risk averse subjects tend to make lower average transfers per recipient ($b = -0.517$, $p < .05$), rather than to fewer recipients ($b = -0.035$, $p = .518$). Additionally, female participants also tend to transfer less overall ($b = -7.679$, $p < .01$) where this effect is primarily driven by the lower number of recipients ($b = -0.371$, $p < .05$) rather than by lower average transfers ($b = -0.270$, $p = .678$).

Result 2a The availability of profile images (photos, avatars) yields higher total transfer volumes, higher number of recipients, and higher transfers per recipient than the control condition.

Result 2b Over time, the number of recipients decreases while the average transfer per recipient increases—regardless of the treatment condition.

4.3 Effect Decomposition and Network Value

To better understand how profile images affect network formation and value over time, we now differentiate between cross-treatment differences (in the first period) and time effects (within a fixed treatment condition). As main dependent variables, we focus on the average number of recipients participants engage with and the average amounts transferred to those recipients (x- and y-axis in Fig. 3a, b). The total transfer volumes can be approximated by the product of the two factors (i.e., area of the resulting rectangle). This allows attributing and hence decomposing the overall differences into the two underlying partial effects. Figure 3a, b illustrate this and include levels of equal network value (dotted grey lines).

Treatment effects (first period) Focusing on the first period, Fig. 3a allows to discern an immediate *volume effect* ("transfer more resources to the same people") and a *spread effect* ("transfer resources to more people") of profile images

regarding transfer volumes and how these translate into network value. Further, there is an *interplay surplus* (emerging from the interaction of the two). Compared to the control condition, participants in the photo treatment both shared resources with a higher number of other participants (spread effect) *and* transferred more to each of them (volume effect). Considering the difference between the photo and avatar conditions, it becomes evident that the photos' entire surplus is grounded in the spread effect. In other words, while the amounts transferred per person are virtually identical, using photographs (rather than avatars) increases the number of initial recipients—and hence the overall volume of resources transferred down the line. Again, these results corroborate the usefulness of profile images as visual cues to engender initial trust towards potential interaction partners and to engage in exchanges with them. Table 4 summarizes all partial and overall relative effects for the three treatment contrasts (photos vs. control, avatars vs. control, and photos vs. avatars).

Result 3 While the average transfer per recipient is comparable between photos and avatars, photos yield a higher number of recipients (spread effect) and hence a higher level of value in the first period.

Time effects (within-treatment) Building on the treatment effects in the first period, Fig. 3b illustrates the dynamics of network formation that occur over the course of the twelve periods. We can discern marked time-effects in how participants adapt their behavior. When comparing the first period to the following values, notice that over time, participants transfer resources to *fewer people* but with *higher amounts* per recipient. This transition can be described as a "cut and reinforce" strategy, where participants cut off non-functioning (i.e., low reciprocity) relations and reinforce flourishing relations. Importantly, this behavior can be observed in all three treatment conditions—with varying effect sizes.

Considering the described two-fold alteration of the rectangles allows attributing the relative changes of transfer volumes to the "cut" and "reinforce" portions. As can be seen in Table 5, the surplus due to reinforcing generally outweighs the decline due to cutting (reinforce $>|$cut$|$). Moreover, the overall relative increase in transfers is highest for the avatars condition (with only little cutting and much reinforcing), while behavior in the control condition is more governed by cutting, resulting in a lower overall effect. Also, in comparison to the treatment differences in the first period (i.e., an area increase of up to 38.7% compared to control; see Table 4), the within-treatment time effects from first to last period are smaller (photos: 10.2%, avatars: 16.2%; see Table 5). Importantly, the transition of the two transfer components (number of recipients, average transfer per recipient) takes place *along the iso-value lines* over time. Hence, the overall value levels remain stable by and large (even though overall transfer volumes increase slightly).

Result 4 Over time, participants interact with fewer participants ("cut") and transfer higher amounts in reciprocal relations ("reinforce").

Table 4 Treatment effect decomposition of total transfers (approximated by the product of average amount transferred and number of recipients; corresponds to rectangle areas in Fig. 3a

Treatment Comparison	Volume effect (Δ avg. transfer)		Spread effect (Δ avg. recipients)		Interplay surplus	Total effect (Δ area)		ΔValue (%)
Control vs. Photo	10.67⟶12.86	+20.5%	3.58⟶4.13	+15.1%	+3.1%	38.25⟶53.04	+38.7%	+20.6
Control vs. Avatar	10.67⟶12.91	+20.9%	3.58⟶3.79	+5.8%	+1.2%	38.25⟶48.94	+27.9%	+15.7
Avatar vs. Photo	12.91⟶12.86	− 0.4%	3.79⟶4.13	+8.8%	<0.1%	48.94⟶53.04	+8.4%	+4.3

Table 5 Time effect decomposition of total transfers (approximated by rectangle areas in Fig. 3b

Treatment	Period		Cut effect (Δ area)		Reinforce effect (Δ area)		Total effect (Δ area)		ΔValue (%)
	1	12							
Control	38.3	41.8	− 5.19	− 13.6%	+8.72	+22.8%	+3.53	+9.2%	− 3.2
Avatar	48.9	56.9	− 3.76	− 7.7%	+11.72	+23.9%	+7.95	+16.2%	+5.0
Photo	53.0	58.5	− 5.89	− 11.1%	+11.30	+21.3%	+5.41	+10.2%	+1.2

5 Discussion

The emergence of exchange relations in networks is complex in nature. In this study, we employed a multi-period experiment to study the role of photos and avatars for dynamic network formation in micro-communities. We observe systematic use of cut-and-reinforce strategies, where people shift towards fewer but stronger (and more reciprocal) relations. While this behavior is not contingent of user representation, the availability of photos/avatars leads to higher network value, density, and reciprocity as it induces more and higher transfers right from the get-go—and this effect persists over time. Note that there only occur smaller differences between photos and avatars, suggesting that the effectiveness of photos in conveying social cues can, in principle, also be achieved by avatars (taking into the account the specific boundary conditions and design).

5.1 Theoretical Contributions

Micro-communities facilitate value creation through technology-mediated social exchange. Our study sheds light on the formation of reciprocal relations over time, and how these relations contribute to network formation and value creation. As posited by SET, the prospect of net benefits plays a pivotal role for users to engage in social exchange relations (Blau 1967). Moreover, SET assumes the existence of relationships in the long run as opposed to one-off interactions (Kim et al. 2018; Molm 1997). By considering the dynamics of such exchanges over time, the present study contributes to SET by empirically illustrating and differentiating two inherent mechanisms for how such relations unfold. Specifically, we illustrate how users (1) engage in a higher number of reciprocal exchange relations and (2) are willing to contribute more strongly to those relations when profile images (photos or avatars) are available. We demonstrate that the decision to "reach out" to others is taken early on and affects exchanges from there on. This demonstrates that user representation is a crucial factor for online network formation that needs to be taken into account.

But why is that? We argue that the facilitating role of profile images links back to extant literature on affective information processing. Evolutionary, the ability to process social cues in human faces has been vital for humans to engage in rewarding social interactions. As such, the human brain has evolved to readily process human faces and these facial processing abilities are innate, involuntary, and

fast (Kanwisher et al. 1997). Because online communities lack actual face-to-face encounters, profile imagery represents an essential cue for facial processing (Bente et al. 2012; Riedl et al. 2014). Hence, the availability of profile images enables users to draw on their innate capacity to process human faces and, based on this, form impressions and engender trust (Ert et al. 2016; Riedl et al. 2014). While previous research has shown that this process can facilitate trust in individual one-to-one relations (Bente et al. 2012; Ert et al. 2016), our results provide insights into how these processes emerge when the user can engage in multiple relations and when these relations are carried out over time.

One intriguing result in this regard relates to the similarities and differences in the effects of avatars and photos. The human brain continuously draws significance from random and vague visual stimuli. Known as *pareidolia*, this process allows users to "see faces where actual faces do not exist" (Hong et al. 2014, p. 352). Thereby, the brain area that is dedicated to the processing of faces is also involved in the processing of avatars (Riedl et al. 2014; Tong et al. 2000). Previous research found that avatars can function as a potent social cue in user interface design (Lee et al. 2009; Nowak and Biocca 2003; Qiu and Benbasat 2005). Applied to the context of micro-communities, our results show that photos and avatars yield very similar outcomes. On one hand, this can be seen as surprising as the here-used avatars only convey a highly stylized image of the human behind them. On the other hand, however, avatars in fact trigger the same neurological processes and are interpreted very much like actual faces. With this in mind, it is important to note that all avatars used in our study have a friendly appearance and participants know that they can be relied upon. Hence, some basic requirements for trusting behavior are met (e.g., credibility, perceptions of benevolence). This supports past research that indicates that when an avatar resembles the person behind it closely, it is more likely to elicit neural and behavioral responses similar to those evoked by the person themselves (de Borst and de Gelder 2015; Fysh et al. 2022). Drilling down into the individual transactions allows discerning how these differences come about and play out over time. While the average transferred amounts per recipient are almost identical for photos and avatars, the *number of recipients is smaller* in the avatar conditions. In other words, users in the avatar condition engage in fewer social relations but the strength of those relations is comparable to those of photos. One interpretation of this would be to think of photos as guiding attention towards the micro-community as a whole, whereas with avatars, people will be more likely to focus on fewer individuals. However, other approaches are well-conceivable: Most naturally, artificial images may simply be not perceived as trustworthy as actual photographs. Also, some avatars may convey "veto-features" that are not seen in photographs (although the opposite is actually more likely, as avatars smoothen out a lot of the more striking facial features). Overall, this extends literature analyzing avatars' influence on users' behavior. Previous research has focused mainly on user perceptions of avatar features (e.g., Ang et al. 2013; Heyselaar et al. 2017; Wu and Kraemer 2017; Yu et al. 2021), avatars' behavior and performance (e.g., online worlds, online games; Teng 2017; Waddell and Ivory 2015; Yu et al. 2021), and health behaviors (e.g., Gordon et al. 2017; Joo and Kim 2017; Pinto et al. 2013). Results from our study indicate that avatars can have a positive influence on online behaviors (i.e., exchange

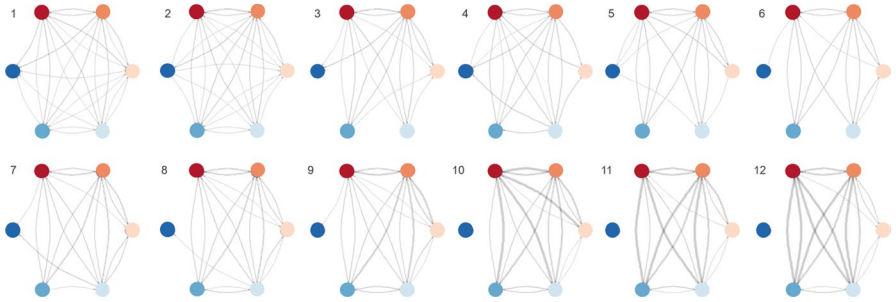


Fig. 4 Example of network formation; edge width shows transfer volume; periods 1 to 12

of resources) in the complete absence of communication between interacting partners (e.g., negotiating or messaging).

Finally, our approach allows for the investigation of community formation over time. Existing research on profile imagery commonly employs snapshot approaches, focusing on the impact of photos (and/or avatars) on one-to-one interactions at a specific point in time (Ert et al. 2016; Qiu et al. 2018). Complementing and extending this work, we provide insights into how participants adapt their behavior over time and how these effects shape network formation. Several interesting patterns appear. First, we observe a consolidation of social exchange relations ("cut and reinforce") which occurs regardless of treatment condition. For exposition, Fig. 4 illustrates this "cut-and-reinforce" graphically for one cohort from the avatars condition.

The role of reciprocity appears to be equally important across all treatment conditions. This consolidation of network relations reflects the formation of dense clusters inside networks for the flow of resources, which has previously been identified in the literature (Levine and Kurzban 2006). In the same vein, reciprocity has a predominant role over other characteristics (e.g., gender) for the consolidation of exchange relations, also in line with previous research (Plickert et al. 2007). Participants developed interdependent relationships with others through the exchange of resources. Their assessment of reciprocity led them to cut those relationships perceived as unbalanced (in terms of resources transferred and received) and to reinforce those with higher perceptions of equity, in line with the theoretical assumptions and claims of SET (Fox and Gambino 2021; Kelley and Thibaut 1978). Ultimately, the importance of reciprocity in this study corresponds to one of the major tenets of SET, positing that such relationships "evolve over time into trusting, loyal, and mutual commitments" (Cropanzano and Mitchell 2005, p. 875).

The evolving relationships evidenced in this study reflect the developmental approach to interpersonal communication supported by Miller (1978). Participants started to exchange resources with others in their cohort in an impersonal and transactional manner, likely assessing others based on cultural and sociological information. Over time, they developed more interpersonal interactions; in such cases, they were likely able to predict, or make attributions about, the behaviors of others. The assessment of others based on their behavior facilitated participants' decision to focus on reciprocal interactions.

5.2 Practical Contributions

The results of our study have direct implications for practitioners. Even though online communities operate in a virtual space, the "rules" of how humans draw meaning from social cues and decide to engage in social exchange readily apply. The availability of profile imagery (either photos or avatars) plays a critical role for network formation. Whenever there are concerns about user privacy or discrimination, avatars may be advantageous.

A second implication relates to the dynamics of network formation. One striking result here is that much of the subsequent behavior is determined already in the very first period. Online communities should hence attempt guide their members early on, for instance, to contact others, complete their profile, upload a photo, and support this by onboarding and scaffolding processes. In the initial stages, we observe "*shotgun"* approaches, that is, transferring smaller amounts to many other people. Over time, as people cut and reinforce, reciprocal relations form. Platform operators may devise strategies to support this process in a way that (1) a higher amount of the initial links is retained (e.g., by emphasizing the importance of reciprocity) and (2) users are supported in sustaining rewarding relations. For instance, the user interface may support transaction partners in "stabilizing" exchange relations by emphasizing the transaction history over time. This may encourage users to maintain and strengthen relations in the long run.

A third implication relates to behaviors in online communities. Results from this study indicate that individuals develop more reciprocal relations over time in contexts with profile imagery available, even in the absence of other forms of communication. This might prove useful not only for online communities attempting to monetize user interactions (e.g., through gift giving), but also for organizational social networking sites where geographical dispersed employees might need to develop collaborative tasks (e.g., co-design of products) and work together in multiple projects over time.

5.3 Limitations and Future Work

Naturally, this study is not without limitations. Generally speaking, users in a given micro-community will not be represented homogenously but will usually have *different* profile image types. Scenarios in which *only some users* pick avatars while others are represented by photos or default images would also allow for a more specific attribution of value. Vivid user representation could be more effective for those users who employ it if only few do so (rather than when everyone does). In this sense, our results may even under-estimate the power of photos and avatars.

Another limitation roots in the experiment design and how avatars are created and assigned. Previous literature indicates that avatars might play the role of an "actual mask", where individuals can hide behind and engage in deceptive behaviors (Galanxhi and Nah 2007; Hooi and Cho 2013). Thus, giving participants the option to choose their own avatars (not necessarily reflecting their appearance) might have

resulted in their engagement in different behaviors (e.g., free riding, tricking others). However, it is worth remembering that the majority of people tends to select avatars that share some similarities with them (e.g., age, height, and weight; Messinger et al. 2019). Future studies may allow the free choice of profile imagery. In addition, a voluntary certification process (on behalft of the platform) may issue a confirmation for the employed avatar—based on a comparison of face, identification document, and the avatar (similar as being used for KYC processes).

A third limitation is related to the low degree of variance explained by the regression models (i.e., low R-squared values). This is not uncommon in experimental studies, where there might be some unobserved situational drivers of behavior (e.g., mood, distractions). To account for other factors that might explain the variance of our outcome variables, future research may explore the influence of specific user perceptions of others' profile images (e.g., in terms of perceived similarity, attractiveness, etc.). Another avenue to pursue is to analyze what occurs in more immersive environments (e.g., virtual worlds, metaverse applications), by incorporating the concept of space (within which users could move) and place (i.e., a bounded space imbued with meaning) (Saunders et al. 2011). Alternatively, the effect of using more realistic and/or dynamic avatars in such environments should be explored, where animated avatars could include facial expressions (e.g., rising eyebrows, smiling) or other human behaviors (e.g., talking, providing non-verbal feedback).

6 Concluding Note

Social cues and reciprocity play fundamental roles for the creation of value in online communities. This study sheds light on how profile images facilitate the formation of individual transactions and the community. Hence, beyond analyzing individual transactions or snapshots in time, we provide insights into how photos and avatars facilitate the formation of online communities over the course of repeated interactions. We demonstrate that users engage in a higher number of reciprocal exchanges and are willing to contribute more strongly to those relations when profile images are available. In view of their potential to foster social exchange, avatars may be considered as a promising alternative to actual photographs, for instance, when user privacy is a concern.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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