Designed to serve

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DESIGNED TO SERVE: SOCIAL ROBOTS IN VALUE NETWORKS

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DESIGNED TO SERVE: SOCIAL ROBOTS IN VALUE NETWORKS

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by

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SDIN

To my parents

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Using a metaphor for the PhD seems to be a way to open one's acknowledgements. In search for inspiration, Google offered me suggestions as shown in the figure. While each suggestion might have been true in certain periods of the process...the first one is the best metaphor to describe my PhD. So where do I see similarities? To become a good dancer, you need to have a strong inner-critic constantly nudging you to keep practicing, even when you hit mental and physical barriers. Dancing involves a lot of self-motivation, self-reflection, and self-improvement. It requires a strong focus on the details and a lot of practice to get in sync with your dancing partner(s). Dancing entails a lot of public performances, story-telling, keeping the rhythm and the tempo. It challenges you...on some days you feel unfocused, exhausted, and you lack confidence. The secret is to keep your eyes on the ultimate goal and keep working hard even when life gets in your way. Just like when doing a PhD!

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CHAPTER 1

Introduction

"Science is but a perversion of itself unless it has as its ultimate goal the betterment of humanity." (Nikola Tesla)

What?

Exploring value co-creation in human–robot collaborative networks

Robotization has gained momentum, due to the proliferation of robots (i.e., embodied technologies capable of sensing, processing, and responding; Singer, 2009) and other artificially intelligent (AI) agents (KPMG, 2016). Robots are moving from industrial settings (e.g., factories) to public (e.g., retail, hospitality, healthcare) and private (e.g., homes), consumer-facing settings (Veruggio and Operto, 2008). Along with that shift, the social (human-like) aspect of automated technology has expanded. Robots are no longer isolated within controlled and structured environments, nor are they programmed exclusively to relieve humans from performing dangerous, repetitive, and tedious tasks (Matarić, 2017). Instead, today's robots are progressively taking complex roles in unstructured customer environments that demand both physical and social dexterity (Huang and Rust, 2018; KPMG, 2016). As a result, roboticists and engineers come under pressure to move state-of-art AI to human-like levels (i.e., strong AI; Deloitte, 2016) by designing robots that can handle chaotic, social, contextually ambiguous service scenarios (Charisi et al., 2017). Imagine, for example, a robotic waiter in a service interaction. To be accepted by customers, it needs to be responsive to their emotional cues (e.g., happiness, sadness, joy, anger) and exhibit socially acceptable behaviors (e.g., politeness, negotiations). As robots coexist more and more with humans and enter highly sensitive service settings (e.g., healthcare, education), they also will be expected to master empathy and social sensitivity—the human characteristics most difficult to automate (Deloitte, 2016).

*For this dissertation, I define **social robots** as automated technologies that co-create value with humans through their social functionalities. Such autonomous systems understand social cues using facial and voice recognition technology and can interact with users in human-like manners.*

According to academics and practitioners alike, we are experiencing the fourth Industrial Revolution, characterized by new technologies (e.g., AI, robots, Internet of Things, machine learning) that radically change the ways in which and with whom consumers co-create value (e.g., KPMG, 2017, Schwab, 2017). The upheaval created by robotic agents also makes the design of future service technologies that resonate with human values and enhance the well-being of humankind a top priority (Ransbotham et al., 2017). However, the concept of

value has remained ambiguous and continues to intrigue researchers from various disciplines. Service literature regards value as 'an improvement in system well-being' (Vargo et al., 2008, p. 149), such that customers are or feel better off than before engaging in a service (Grönroos and Gummerus, 2014). Value thus entails improvements to customers' subjective well-being, which stems from cognitive and affective evaluations of the situation (i.e., what customers think and how they feel; Diener et al., 2003). However, extant literature lacks insights into how socially endowed technologies affect value co-creation (Kaartemo and Helkkula, 2018), which in turn influences technology acceptance (Wirtz et al., 2018). Accordingly, there is a pressing need for service providers to gain a finer-grained understanding of what constitutes a social robot's value proposition and how it affects customer value (Čaić et al., 2019b).

*In this dissertation, I take a **value-centric perspective** on social robots in service, combining users' personal values with dynamic and experiential value co-creation/co-destruction trade-offs.*

Value is not created *for* but rather is collaboratively created *with* customers (Prahalad and Ramaswamy, 2004), through resource integrations of interconnected networks of actors (e.g., service delivery networks, customer networks). Exploring how value is co-created/co-destroyed within collaborative human-robot networks is a prerequisite for steering robotic technologies toward their full transformative potential. Ever-increasing connectedness and digitalization imply that the need to understand how diverse network actors evaluate technology-enhanced services with respect to changes in their value (i.e., value co-creation and co-destruction potential), prior to technology deployment, is particularly timely and societally relevant. Such insights also might preemptively promote positive and mitigate negative outcomes of a new service, for the benefit of entire networks.

*This dissertation defines **value networks** as service beneficiaries' conceptualizations of actor constellations and their value co-creating/co-destroying dynamics for a particular service.*

With this background, I zoom in on an elderly care setting, which involves vulnerable customers and networks of formal and informal caregiving, as well as some reluctance to accept robotic services (Broadbent et al., 2009; IFR, 2015). To overcome initial customer resistance to robotic technologies and assure the smooth integration of robots into these human social structures, we need to leverage network insights (i.e., users' hopes and fears about the future world). Social robots hold strong promise to enhance the well-being of the elderly while easing the caregiving burden for formal (professional) and informal (family and

friends) service providers. Understanding what elements can encourage their adoption can help ensure the overall network's well-being (Čaić et al., 2018).

Why?

Elderly care: who cares?

Robotic technologies already are changing healthcare value networks and assisting healthcare staff in tasks such as surgeries, telepresence, and preventive and chronic care (Ransbotham et al., 2017; Stone et al., 2016). In the universal search for new, technology-enhanced ways to meet existing needs, healthcare deserves particular attention, because it can offer important steps forward for the advancement of human well-being. This complex setting comprises multiple stakeholders, sensitive data, and inert institutions (Black and Gallan, 2015).

*This dissertation zooms in on a critical segment of healthcare—**elderly care**—marked by vulnerable customers with a high propensity to develop potentially harmful technology dependability that could erode their personal agency further.*

Most countries face the challenges of ageing populations (United Nations, 2017). The elderly segment (people 60 years and older) is expected to more than double by 2070 (European Commission, 2018), with serious implications for healthcare, family structures, labor and financial markets, and many other sectors. Robotic technologies are commonly cited as a potential solution for ensuring the well-being of elderly populations through improved customer service, a constant presence, and reliability (e.g., Broadbent et al., 2009; Pineau et al., 2003). Still, the idea of introducing robots to elderly care settings provokes brisk academic and public policy discussions (e.g., Dell Technologies, 2018; Sorell and Draper, 2014; Sparrow, 2016; Stone et al., 2016), with a full range of dystopian (e.g., fear of losing human touch, human obsolescence, privacy concerns) and utopian (e.g., panacea for social problems, unburdening of the overworked care staff, prolonged independent living) projections.

Accordingly, the topic of caring for the elderly without hurting them (i.e., enhancing value co-creation and reducing value co-destruction potential) intrigues researchers from different disciplines. It demands interdisciplinary, hands-on approaches to

achieve meaningful contributions. Therefore, this dissertation harnesses the power of interdisciplinary research in an effort to contribute not only to academia but also to practice.

How?

Leveraging service design for value co-creation

The introduction of quasi-social agents (e.g., social robots) disrupts institutionalized social fabrics (KPMG, 2016). To integrate into human society, which thrives on social interactions, service robots must be endowed with social value propositions (e.g., conversational capabilities, emotional alertness and expressiveness, other human-like traits) (Breazeal et al., 2016). Service interactions with social, non-human agents already have had some significant effects on value co-creation. The co-creation of meaningful customer experience is a top marketing research priority (McKinsey & Company, 2017; MSI, 2018), such that it is imperative to find new evidence of how the robotic revolution will affect network value co-creation, alter service roles and tasks, reshape people's psychology (e.g., humans' social cognition of robotic agents), or induce other unintended consequences. In this dissertation, I propose that one pathway to greater understanding is to embrace an interdisciplinary approach, combining theories, methods, and perspectives from different disciplines, including (service) design, service marketing and management, (social) psychology, engineering, and philosophy.

Many service and technology developers innovate solely by relying on their vision of what the technology should look like, feel like, and be capable of doing (McKinsey & Company, 2017). They thus impose their idea of what a solution should be on users who might have different needs, desires, and expectations of

technology-enhanced services. Engineers focus on functionality; designers focus on usability. From a marketing perspective, they should all focus on customers, who are the ultimate co-creators of value. With this dissertation, I advocate for human-centered, participatory approaches that tap into the explicit and tacit knowledge of users. For a holistic solution and enhanced customer experience, innovators need to acknowledge users as experts of their own experiences (Visser et al., 2005) and start leveraging user insights in the design of future services. By doing so, service developers can regard their offerings from a customer perspective and become better equipped to reduce discrepancies in value co-creation. Embracing and cultivating a service design mindset, through collaborative methods (i.e., engaging different network actors) to help balance technical, human, and profitability aspects of a service offering, yields value for diverse service beneficiaries (Stickdorn et al., 2018).

*Using in-depth exploratory interviews (i.e., **Context Disruption interviews**) with generative card activities (i.e., **Contextual Value Network Mapping**), I elicit informants' tacit knowledge and probe the anticipated effects of a future service (co-created with a social robot) on their existing value co-creation practices, in relation to themselves and other network actors.*

Dissertation overview

This dissertation contains four distinct manuscripts in which I take a value-centric perspective on the impact of social robots in care-based value networks. In the conceptual Chapter 2, I introduce an iterative framework of theoretical propositions for social robots in service, which functions as a backbone for my dissertation. The proposed iterative framework conceptually broadens perspectives on value, in that it combines trade-off, dynamic, and experiential approaches (Gallarza et al., 2017) and also links personal and context-specific values. Figure 1.1 depicts an overview of the four manuscripts and their research foci, according to my conceptual framework and theoretical propositions.

Figure 1.1 – Dissertation overview

In Chapter 3, I provide empirical evidence of how basic personal values (i.e., desirable end-states; Schwartz, 2012) get activated in a robotic care context. In addition, Chapter 3 highlights how academics and practitioners alike can leverage service design capabilities to elicit informants' explicit and tacit knowledge about salient values. In Chapter 4, I bridge personal values and context-specific values by proposing a typology of the value co-creation/co-destruction roles of social robots in services. I thus emphasize both positive (i.e., value enhancing) and negative (i.e., value hindering) potentials of robotic care. Finally, in Chapter 5, I empirically investigate how robots' affective and cognitive resources activate users' social cognitive mechanisms (i.e., perceptions of warmth and competence; Fiske et al., 2007) to affect their experiential perceptions of value (i.e., utilitarian and hedonic).

Table 1.1 contains an overview of the four chapters, highlighting the purpose, value focus, theories, manuscript type, methods, data, interdisciplinary focus, and journal outlets. Overall though, the aim of my dissertation is to achieve a better understanding of (i) robots' future value propositions and relationship with value co-creation, (ii) service design approaches for eliciting users' personal values, (iii) trade-offs between the value co-creation and co-destruction potential of social robots, and (iv) the effects of social perceptions of robotic coaches on experiential value.

Table 1.1 – Overview of dissertation chapters

	Chapter 2	Chapter 3	Chapter 4	Chapter 5
Purpose	Defining theoretical propositions and an iterative framework of users' evaluations of social robots in services	Proposing a novel network mapping method which leverages informants' visual phenomenology	Identifying the roles of socially assistive robots in elderly care-based value networks	Determining elderly peoples' social perceptions (i.e., social cognition, automated social presence) of robotic coaches
Value focus	Value co-creation/destruction with social robots in services	Basic personal values (i.e., dominant values in an elderly care context)	Value trade-offs (i.e., value co-creation/destruction roles)	Experiential value (i.e., hedonic and utilitarian value)
Principal theoretical lenses	Social cognition (Fiske et al., 2007); service-dominant logic (Vargo and Lusch, 2004); service logic (Grönroos and Voima, 2013)	Mental models (Norman, 1988)	Service-dominant logic (Vargo and Lusch, 2004); automated social presence (van Doorn et al., 2017)	Social cognition (Fiske et al., 2007); automated social presence (van Doorn et al., 2017)
Manuscript type	Conceptual	Empirical: Qualitative	Empirical: Qualitative	Empirical: Mixed-methods
Method	-	Contextual Value Network Mapping	Generative phenomenographic interviews	Field experiments + interviews
Data	-	20 elderly informants (Focus: 20 value network visualizations prior to the robot introduction)	Interview data from 20 elderly informants (Focus: narratives)	Survey and interview data from 58 elderly participants
Inter-disciplinary focus	Services (marketing and management) & robotics	Service design & services (marketing and management)	Services (marketing and management), service design & robotics	Robotics & services (marketing and management)
Manuscript submission status	Accepted for publication in <i>Journal of Services Marketing</i>	Under review (3 rd round) in <i>International Journal of Design</i>	Published in <i>Journal of Service Management</i>	Accepted for publication in <i>International Journal of Social Robotics</i>

Chapter 2

Value of Social Robots in Services: Social Cognition Perspective

The technological revolution in the service sector is radically changing the ways in which and with whom consumers co-create value. Robotic agents are progressively taking frontline service roles previously reserved for humans (e.g., receptionists, waiters, teachers, caregivers) and affecting value creation (e.g., KPMG, 2017; Mende et al., 2017). This conceptual chapter considers social robots in elderly care services and outlines ways in which their human-like affect and cognition influence users' social perceptions (i.e., two universal dimensions of social cognition: warmth and competence; Fiske et al., 2007) and anticipation of robots' value co-creation or co-destruction potential. Social robots represent a system with a physical interface and varying sets of services (i.e., functionalities), leveraging different degrees of affective (e.g., artificially programmed emotions, ability to mimic empathy and offer emotional support) and cognitive (e.g., ability to reason or to learn from past experiences) resources. I propose a matrix of four robot types, based on the varying levels of affective and cognitive resources: *mechanic robots*, *thinking robots*, *feeling robots*, and *robo-sapiens*.

Drawing from service, robotics, and social cognition research, this chapter expands conceptual understanding of the value co-creation/co-destruction potential of social robots. I introduce three theoretical propositions within an iterative framework of users' evaluations of social robots in services. First, social robots offer users value propositions, leveraging both affective and cognitive resources. Second, users' personal values become salient through interactions with social robots' affective and cognitive resources. Third, users evaluate social robots' value co-creation/co-destruction potential according to social cognition dimensions. Social robots in services represent an emerging topic in service research, with promising implications for organizations and users. This relevant, conceptually robust framework advances scholarly understanding of the key opportunities for realizing value, as well as the critical pitfalls. This chapter also offers guidelines for service managers as they design and introduce social robots into complex service environments.

Chapter 3

Beneficiaries' View of Actor Networks: Service Resonance for Pluralistic Actor Networks

The use of service visualizations in service design (e.g., Diana et al., 2009; Segelström, 2013) and service marketing/management (e.g., Bitner et al., 2008; Patrício et al., 2011) is important for understanding and assessing value co-creation. In designing (future) services, understanding value and the networks of actors that co-create value through visualizations is a key insight (Čaić et al., 2017) that remains largely unexplored. This chapter suggests that the social fabric of the service system (i.e., collaborative networks of actors) affects the service experience of the beneficiaries of that system, so it cannot be neglected in the design stage of the service. My review of existing actor maps (e.g., network maps, service blueprints) indicates that service beneficiaries usually participate in mapping activities indirectly (as informants), rather than directly (mapping networks of actors themselves using a predefined mapping tool). Actor network maps produced in such ways do not properly represent service beneficiaries' mental models (Norman, 1988) and lack information about their idiosyncratic understanding of service value. Instead, I advocate for visual phenomenology, to leverage the resourcefulness of individual actors and capture their phenomenological perspectives.

This study employs a qualitative interpretative approach, leveraging a material facilitation tool that uses participatory and generative elements (Sanders, 2000) to support user interviews. It engages service beneficiaries of future robotic services (i.e., elderly people) to map their care-based network contexts. The analysis of collected actor network visualizations reveals three different network types, *bundled*, *focalized*, and *hierarchical*, as well as hybrid configurations that combine at least two of the types. Further analysis of the accompanying narratives reveals the dominant values (i.e., affective, social, and functional) held by constructors of the network visualizations. My findings have important implications for service and design theory and practice. First, the study demonstrates that visual artifacts created by the service beneficiaries themselves contain relevant information about value priorities, value co-creation/co-destruction, and collaborative actor networks. Second, I introduce the concept of service resonance and emphasize the importance of developing services that resonate with the mental models of the future service beneficiaries.

Chapter 4

Service Robots: Value Co-creation and Co-destruction in Elderly Care Networks

The fourth chapter investigates the potential value co-creation and co-destruction roles of personal service robots in value networks of elderly care. It takes a focal actor (i.e., elderly people) perspective and defines robot roles through a lens of value transformation, not only with respect to oneself, but also reflecting on the consequences for other network actors (i.e., network-conscious service design approach). In a qualitative, interpretative study, I collect elderly people's expectations of a futurist world in which robots assume some caring tasks and roles. The in-depth phenomenographic interviews (Sandberg, 2000) combined with a generative card activity (Sanders, 2000) elicit informants' evaluations of current service scenarios, as well as their expectations of future ones. Thus it combines both elderly informants' narratives and their visualizations of future, technology-enhanced, care-providing networks.

My findings offer several contributions to service literature. First, I identify six roles that socially assistive robots might play in elderly care networks (i.e., enabler, intruder, ally, replacement, extended self, and deactivator), anticipated by elderly people themselves. I show that human-like robots, through their health-supporting functions of safeguarding, social contact, and cognitive support, offer both value co-creating and co-destroying potential. Second, I extend existing role conceptualizations (e.g., Frow et al., 2016; McColl-Kennedy et al., 2012; Moeller et al. 2013) to encompass value co-creation and co-destruction counterparts, but also to address network-conscious elements. Third, I introduce the Context Disruption interview protocol, leveraging Contextual Value Network Mapping as a new approach to better understand and design complex service systems and value networks. My findings suggest steering the design of robotic technologies toward meaningful value propositions for multiple service beneficiaries and the smoother introduction of robots into existing service networks.

Chapter 5

Robotic Versus Human Coaches for Active Aging: An Automated Social Presence Perspective

Finally, Chapter 5 taps into the (social) psychology of elderly people and compares their social perceptions of human versus robotic coaches in the context of an active, healthy ageing program. The elderly population is prone to physical inactivity, which may lead to deteriorated health, falls, and hospitalization, so healthcare providers continue searching for effective solutions that motivate elderly people to be physically active. Exergames (i.e., video games integrating physical activity) have emerged as a potential answer, with some positive results in terms of changing people's sedentary lifestyles and improving their physical and cognitive well-being (Wattanasoontorn et al., 2013). In this study, I focus on a motivational coach (human vs. robot) that invites and motivates elderly participants to play exergames. I analyze their perceptions of the warmth (i.e., well- or ill-intended) and competence (i.e., competent or incompetent) of their assigned coach, as well as their feelings about an automated social presence (van Doorn et al., 2017) evoked by the robotic coach. I further evaluate the effects of elderly people's social cognition (through warmth and competence; Fiske et al., 2007) on their perceptions of the hedonic and utilitarian value of exercising with the exergames.

I test my empirical model with field experiments involving 58 elderly participants in a real-life setting (i.e., elderly care facilities). The study leverages a mixed-method approach, combining quantitative questionnaires and qualitative interview data. The findings make several contributions to service research (e.g., Marinova et al., 2017; Rafaeli et al., 2017; van Doorn et al., 2017), along with some strong practical implications. First, socially assistive robots make elderly people feel as if they are in the company of a social entity (i.e., activation of automated social presence). Second, elderly participants evaluate human coaches higher on perceived warmth and competence relative to robotic coaches. Third, social cognition has an important role in the overall experience (i.e., elderly people's emotional and cognitive evaluations of the exergame and behavioral intents to continue playing in the future). My findings thus can inform future developments and designs of social robots and systems, to facilitate their inclusion into elderly people's social networks. Particularly, I suggest that socially assistive robots can improve elderly people's physical and psychosocial well-being by assisting human caregivers, through complementary motivational roles.

CHAPTER 2

Value of Social Robots in Services: Social Cognition Perspective

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INTRODUCTION

Social robots, defined as fully or partially automated technologies that co-create value with humans through their social functionalities, represent a rapidly growing element of service industries, where they perform frontline tasks. Robots thus have moved from industrial settings (e.g., factories) to public (e.g., retail, hospitality, healthcare) and private (e.g., homes) user settings (International Federation of Robotics, 2015). They are no longer isolated in controlled, structured environments; modern robots must operate in chaotic, potentially complex human interactions, often with multiple stakeholders. This proliferation of social robots in efforts to deliver superior customer experience (Mende et al., 2017, van Doorn et al., 2017) and euphoric predictions in industry reports (KPMG, 2016) conflict with the disappointments arising in real-world implementations. Key impediments to acceptance include unrealistic expectations and a lack of benefits for specific use contexts (Pino et al., 2015), suggesting that service providers need a better understanding of what constitutes a robot's value proposition and how value might be realised for service beneficiaries. This research therefore investigates users' evaluations of the value co-creation and co-destruction potential associated with social robots who engage in human-like behavior in a service setting.

Social robots span diverse contexts, including domestic (Young et al., 2009), hospitality (e.g., humanoid assistance, welcoming) (Fan et al., 2016), entertainment (e.g., toys) (Robinson et al., 2014), and healthcare (e.g., assistive devices) (Green et al., 2016) sectors. The current study focuses on a critical segment of healthcare: elderly care. Most countries face challenges associated with ageing populations (United Nations, 2017), and the consumer segment of people aged 60 years and older is expected to more than double by 2070 (European Commission, 2018). The growth in this segment has serious implications for healthcare, family structures, labour, and financial markets. Social robots can help address some of the challenges in those service settings, such as shortages of elderly care staff, particularly if the robots can support and exhibit human-like behavior resulting from the development and design of sophisticated systems that can express emotional sensitivity (affective resources) and engage in artificial intelligence (AI)-based learning (cognitive resources; KPMG, 2016). These developments transform robotic systems into what the current study defines as social robots in services, which feature autonomous systems that can

understand social cues through facial and voice recognition technology and can interact with users in human-like manners (Čaić et al., 2018; KPMG, 2016). For example, in an elderly care scenario, we expect social robots to detect and respond to social cues and interact with patients, relatives, and formal caregivers in a human-like manner using specific service functionalities, including fall detection, cognitive games, personal chats, and exercise motivation.

Designing future technologies that can enable robots to reflect human values and enhance the well-being of consumers thus represents a top priority (Ransbotham et al., 2017). In addition, exploring ways that value might be co-created or co-destroyed in collaborative human–robot interactions can inform these robotic technology developments to ensure their full transformative potential. The plethora of social robots in services creates a need to identify ways to co-create, rather than co-destroy, value in symbiotic human–robot interactions (Marketing Science Institute, 2018), such as through research that determines how service beneficiaries appraise the value co-creation and co-destruction potential of social robots in services. Because value originates in the interaction between service actors and social robots, which takes place in the joint customer–provider sphere (Grönroos and Gummerus, 2014), service developers need to understand how a value interplay affects users' attitudes and intentions to use robotic technologies.

A social cognition perspective might reveal how human actors perceive their human-like robotic counterparts in terms of two overarching dimensions that emerge during social interactions: competence (i.e., being skilful or efficacious) and warmth (i.e., being helpful and caring) (Fiske et al., 2007). The experiential, idiosyncratic nature of value (Vargo and Lusch, 2016) demands accounting for the risks of value co-destruction (e.g., lack of literacy, lack of personal touch, privacy intrusion); an advantage for one elderly person or a segment of elderly users might represent a disadvantage for others (Čaić et al., 2017). This could explain people's lack of willingness to accept social robots in service settings (International Federation of Robotics, 2015). The complexity of value, together with the disruptive nature of social robots in services, creates unique challenges to existing service processes. No extant research details how organizations can integrate appropriate resources and designs for effective human–technology interactions to ensure value co-creation in such conditions.

Therefore, this study addresses these research gaps by applying a social cognition lens, which produces two major theoretical contributions. First, the proposed conceptualization of social robots in services and their value propositions, leveraging affective and cognitive resources, advances the overall

understanding of service technology. Current research primarily has emphasized the appearance or feature-related characteristics of robots, such as their morphology and assistive tasks. In contrast, our conceptualization takes a value-centric perspective and focuses on resources necessary for collaborative value realizations. In that way it establishes a basis for continued research into robotic technologies' valuations and their influences on service interactions, representing a key question for both practice and research (Ostrom et al., 2015).

Second, this article advances scholarly understanding of valorisation of human-like technologies by offering an iterative framework of how value gets proposed and realised through interactions between service actors and social robots. The framework synthesizes different theoretical perspectives on value (Gallarza et al., 2017) and proposes that prior personal values (Schwartz, 2012) become salient during context-specific user-robot interactions, in line with an experiential, idiosyncratic value perspective (Grönroos and Gummerus, 2014). By integrating value co-creation/destruction and their trade-offs, this study addresses the need for a holistic approach to technologies that can produce both advantages and disadvantages for different service actors. In that way, it addresses a recent call from Kaartemo and Helkkula (2018) for a better understanding of the influence of social robots on value co-creation.

Beyond theoretical contributions, this study offers practical insights for service managers regarding the emerging role of social robots and how to integrate them within complex service systems through appropriate combinations of affective and cognitive resources. Social robots represent complex systems of hardware and software that can perform various services; their successful implementation hinges on understanding the potentially contradictory needs of diverse user segments and tailoring the robotic solutions accordingly before any costly roll-out effort. The proposed framework, along with managerial implications, offers insights with regard to designing and launching social robots in services in ways that can increase users' acceptance.

THEORETICAL BACKGROUND

Social cognition perspective for robots

In human-human interactions, interpreting others' mental states (e.g., intentions, affective states, beliefs, needs) enables people to thrive as social agents (Frith and Frith, 2007). Mentalizing, or ascribing mental states to others to interpret and anticipate their actions (Frith and Frith, 2012), is a critical component of social life. Different elements and processes of social interaction (e.g., speech, facial expressions, eye gaze, body posture) allow people to make inferences and forms

their social cognition (Adolphs, 1999). According to Gray et al. (2007), humans make these attributions by evaluating others' capacities to sense and feel and to plan and act. Fiske et al. (2007) suggested that, when interacting with each other, humans seek to determine whether the other is a "friend or foe" (warmth dimension) and able to act on its either friendly or hostile intentions (competence dimension). The capacities to feel and to do thus are universal dimensions of social cognition.

Humans usually ascribe minds to other humans by detecting the social signals that indicate another person's ability to perceive, feel, and intend (Meltzoff, 2007). However, minds can also be assigned to non-human agents (e.g., computers, gadgets, robots; Abubshait and Wiese, 2017; Waytz et al., 2010), particularly if their characteristics induce perceptions of intentionality. Reeves and Nass (1996) thus find that people automatically treat computers as social beings; advanced technologies, which mimic human appearances and behaviors (Breazeal, 2004), allow such non-human agents to exhibit a convincing mixture of affect and intentionality. The increased sense that technologies have "minds of their own" has important implications for robotic design, indicating the relevance of robots exhibiting a human-like mind in addition to a human-like appearance (Waytz et al., 2014). Studies of human-robot interactions also suggest that human-like service robots offer a potentially meaningful context in which to study human social cognition (e.g., Chaminade and Cheng, 2009; Wiese et al., 2017; Wykowska et al., 2016). That is, the mechanisms of social cognition may be activated when people encounter cognitively and affectively endowed social robots, such that they judge these social partners, despite their status as non-human actors, according to their warmth (friendliness, kindness, caring) and competence (efficacy, skill, confidence) dimensions.

Initially, robotics literature emphasized the development of competence traits by upgrading robots' cognitive resources and improving robots' functionalities (Pineau et al., 2003). Recently, robotics studies have increasingly acknowledged the importance of warmth traits resulting from enhanced affective resources, such as eye contact (Johnson et al., 2014) or companionship (Broadbent et al., 2009). Sharkey and Sharkey (2011) suggested that two user segments (children and elderly people) might have a stronger tendency to anthropomorphise social robots, with important consequences for future robotic developments and ethical ramifications. It is therefore not surprising that descriptions of robotic designs seem to emphasize applications in healthcare and elderly care (e.g., Robinson et al., 2014).

Characteristics of social robots

Social robotics literature has most commonly agreed on four robot design characteristics (Bartneck and Forlizzi, 2004; Fong et al., 2003; Lee et al., 2016; Paauwe et al., 2015).

Embodiment. First, a system is embodied if it is structurally coupled with its environment such that a physical body is not required (Ziemke, 2003). This concept reflects the system's relationship with its environment. A full review of different types of embodiment is beyond the scope of this research (see Ziemke, 2003), but the focus is on physically embodied robots with three-dimensional, physical bodies rather than virtual avatars or AI agents visible solely on a screen (Paauwe et al., 2015).

Morphology. Second, social robots' physical bodies can take various forms, from machine-like to human-like (Lee et al., 2016). Fong et al. (2003) proposed four robot morphology types: anthropomorphic (human-like), zoomorphic (animal-like), caricatured (cartoonish), and functional (appearance that indicates the robot's core functionality). Morphology relates closely to realism (or behavioral and visual fidelity; Paauwe et al., 2015) and the Uncanny Valley concept (Mori, 1970), which postulates that the more human-like a robot is (appearance, expressions, movements), the stronger a human observer's affinity toward that robot, up to a point. Beyond that point, however, when the robot's resemblance to humans is too high, human observers sense eeriness and intense repulsion toward the robot. The current study addresses users' perceptions of a robot's human-like mind and behavior rather than appearance, though a human-like appearance can induce perceptions of mind (Waytz et al., 2010). Therefore, human-like value propositions, both affective and cognitive, should resonate with a generally human-like appearance.

Autonomy. Third, autonomy measures the degree of human intervention and support needed for the robot to function properly. Levels of autonomy can range from none, such that humans remotely control the robot through teleoperation (e.g., Wizard of Oz; Yanco and Drury, 2004), to full autonomy, where robots function without any direct input from humans (Bartneck and Forlizzi, 2004). Autonomous robots must be endowed with navigation, perception, speech, decision-making, self-maintenance, and repair capabilities. This level of autonomy is difficult to achieve with current technology (Broadbent, 2017). The conceptualization in the current study proposes that social robots in services must function fully autonomously to reach the full potential of their affective and cognitive value propositions.

Assistive role. Fourth, an assistive role pertains to a service robot's purpose and core tasks. In the focal elderly care context, the wide array of potential robot roles broadly refers to physical, psychosocial, and cognitive assistance (Broadbent et al., 2009; Čaić et al., 2018). Robots aiding through physical assistance include rehabilitation robots and exoskeletons that can augment human physical weaknesses (Perry et al., 2007). For example, the Robot Bear lifts and carries bedridden or physically weak patients (Schwartz, 2015). Robots offering psychosocial assistance primarily attend to the emotional, psychological, and social needs of patients (Čaić et al., 2018) via a companion or sociable partner role (Broekens et al., 2009), offering a connection on a more emotional level. The companion seal robot Paro can help alleviate symptoms of loneliness and depression through its emotional support (Robinson et al., 2014). Finally, robots that provide cognitive assistance issue reminders of elderly patients' daily activities, medication, and scheduled appointments, while also monitoring their overall health (Robinson et al., 2014). The human-like robot Pearl attends to needs of demented or cognitively impaired elderly people, for example (Robinson et al., 2014).

Our conceptualization envisions that socially assistive robots, high on both cognitive and affective resources, should be able to perform all these assistive roles. The diverse typologies also suggest the need for further refinement of social robotics theory, as reflected in calls in robotics journals (e.g., Broadbent, 2017).

Services literature on robots

Existing typologies of social robots define social robot positioning relative to human actors. Accordingly, this study adopts a social cognition perspective, with the recognition that humans usually attribute affective (warmth) and functional (competence) elements to other actors, such as peers or caregivers, to assess their abilities (Fiske et al., 2007). To get an overview of the current work on (social) robots in services, this section reviews the literature focusing on the three service journals with the highest impact factors in 2017: *Journal of Service Research*, *Journal of Service Management*, and *Journal of Services Marketing*. We searched the Web of Science using the search terms "robot," and "robot AND value" and did not limit our search to a specific time period, as robots in services is still a nascent research area. Table 2.1 presents an overview of existing literature on (social) robots in services. The table indicates whether a particular study paid implicit or explicit attention to social cognition's core concepts of warmth and competence. By explicit we mean that the authors use the terms warmth and/or competence or refer to social cognition theory. By implicit we mean that the studies address affective or functional elements of the robot,

without mentioning the terms of warmth and competence. In addition, the table shows which articles address value related elements of the robots in services. We make a distinction between value co-creation and value co-destruction to demonstrate the prevailing focus on value in service robots.

Table 2.1 - Services literature on robots

Authors	Warmth		Competence		Value (co-creation)	Value (co-destruction)
	Explicitly	Implicitly	Explicitly	Implicitly		
Bolton et al. (2018)		Robots capable of exhibiting natural-appearing social qualities like cuddling		Robots are already showing promise in assembling furniture without human assistance	Robots can be seen as a service innovation that bring new value propositions	Tensions exist that, unless addressed, may inhibit the conditions necessary for value co-creation between robots and other actors in a network
		Machines cannot demonstrate empathy, but it is possible to create robots that display signs of empathy			There is a need for an integrated theoretical perspective on how value co-creation takes place within and across the digital, physical and social realms	
Čaić et al. (2018)		Robots can offer social contact as a supporting function		Robots can offer an enabler role which is based on the robot's competence	Robots present a value co-creation potential	Robots present a value co-destruction potential
Fan et al. (2016)	Robots can offer human-like traits such as warmth as a result of anthropomorphism					
Huang and Rust (2018)		Robots have the potential to offer intuitive and empathetic intelligence		Robots have the potential to offer mechanical and analytical intelligence		
Keating et al. (2018)		Robots do not have emotional intelligence, only artificially programmed emotions			Service research mainly takes a humanistic approach with limited attention for technology, assuming that humans are responsible for the definition of value propositions and for value co-creation	

Table 2.1 - Services literature on robots (cont.)

Authors	Warmth		Competence		Value (co-creation)	Value (co-destruction)
	Explicitly	Implicitly	Explicitly	Implicitly		
Khaksar et al. (2017)		The PaPeRo robot is a robot that is designed for emotional interaction			Elderly perceive value from co-creating with social robots	
Marinova et al. (2017)		Robots that can avoid FLEs' personal mood fluctuations and on the positive side enhance social interaction and engagement (relational, social)		Robots have the potential to offer instrumental and epistemic qualities	Smart technologies (i.e. robots) substitute or complement frontline employees to coproduce value for the frontline employee and/or customer	
Rafaeli et al. (2017)		The emotional competence of an employee can be far superior to technology (i.e. robot) when delivering such "bad news."		Robot is introduced in frontline research emphasizing both warmth and competence.	Future research is needed on psychological mechanisms that contribute to the transfer of technological functionalities to customers' value experience	
Singh et al. (2017)		Humanoid robots have the potential to enable interactions that are sufficiently rich with social content and cues to service interactions with humans.		Frontline interfaces (i.e. robots) have the potential to offer knowledge and problem-solving abilities		

Table 2.1 - Services literature on robots (cont.)

Authors	Warmth		Competence		Value (co-creation)	Value (co-destruction)
	Explicitly	Implicitly	Explicitly	Implicitly		
Van Doorn et al. (2017)	Social cognition (warmth and competence) mediates automated social presence's effect on customer service outcomes		Social cognition (warmth and competence) mediates automated social presence's effect on customer service outcomes			
Wirtz et al. (2018)	Warmth and competence are two fundamental dimensions of social perception that together account almost entirely how people characterize others.	Emotional tasks of frontline actors	Warmth and competence are two fundamental dimensions of social perception that together account almost entirely how people characterize others	Cognitive tasks of frontline actors	At airports robot to assist passengers could provide customer value	During the service encounter, customers often place a premium on pleasant relations with service employees and so providing emotional and social value. However, by 2020, it is estimated that 85 percent of all customer interactions will take place without a human agent

Table 2.1 demonstrates that the first study addressing robots in services literature appeared in 2016. Since then, robots have increasingly entered services literature to illustrate the role of Artificial Intelligence (Huang and Rust, 2018) or map research directions (Rafaeli et al., 2017; Wirtz et al., 2018). It is interesting to note that most of the studies are conceptual in nature; relatively few present empirical findings, which is typical for an emerging topic. The majority of papers have emphasized the impact of developments in robotics on frontline service roles, but only a few studies have explicitly emphasized an elderly care services environment (Čaić et al. 2018; Khaksar et al. 2017). With respect to the social cognition lens we take, it is remarkable that all existing studies acknowledge affective and/or functional elements of robots in services, but only Wirtz et al. (2018), Van Doorn et al. (2017), Fan et al. (2016) explicitly referred to warmth and/or competence. Addressing the value lens of our current study, Table 2.1 indicates that seven out of 11 studies address the robot's role in creating value or in value co-creation. Only three studies acknowledge a potential threat to value creation (value co-destruction) of introducing robots in services settings. Overall, Table 2.1 summarizes that robotics is an emerging theme in services literature with promising implications for organizations, users, and scholars.

Table 2.1 also shows which studies explicitly address the value that robots in services potentially add or co-create. Rafaeli et al. (2017) and Bolton et al. (2018) acknowledged that future research is needed for an integrated theoretical perspective on how value co-creation takes place within and across the digital, physical, and social realms. In an elderly care services context, both Khaksar et al. (2017) and Čaić et al. (2018) presented that robots do co-create value with elderly people. This is in contrast with the observation of Keating et al. (2018), who indicated that services research typically assumes humans are responsible for the definition of value propositions and for value co-creation. Finally, Marinova et al. (2017) and Wirtz et al. (2018) acknowledged that in frontline services interactions robots could potentially provide value. Only three studies (Bolton et al., 2017; Čaić et al., 2018; Wirtz et al., 2018) recognized existing inhibitors that are necessary for value-creation and included risks of value co-destruction.

To summarize, Table 2.1 provides an overview of existing studies on robots in services. These studies implicitly acknowledged the role of affective and functional abilities of the robot without explicitly referring to social cognition theory. In addition, the literature review shows that most of these studies acknowledged that some kind of value co-creation takes place between robots and other actors, although the potential risk of value co-destruction is largely disregarded. Given the apparent relevance of warmth and cognition as well as

the connection to value (co-creation), our paper proposes an iterative theoretical framework.

Conceptualizations of value

The concept of value has intrigued researchers from various disciplines for years; value is both an ambiguous and a pivotal concept for a wide range of theoretical frameworks, from utility theory (Fishburn, 1970) to customer value (Woodruff, 1997) to service-dominant logic (SDL; Vargo and Lusch, 2004, 2016) and service logic (SL; Grönroos and Voima, 2013). In the domain of (services) marketing, value has important epistemological implications for understanding customers' cognitive, affective, and behavioral responses to marketing stimuli (Homer and Kahle, 1988) and is a key determinant of competitive advantage (Parasuraman, 1997). However, existing value typologies and methodological approaches for capturing value remain abstract due to the multifaceted and complex nature of this concept (Gallarza et al., 2017).

A common distinction in marketing research cites *customer (perceived) value* versus *personal values* (Boksberger and Melsen, 2011; Woodruff, 1997). The former reflects the customer's context-specific value attainment (e.g., value for money), while the latter pertains to desirable end-states that span customer segments and cultures (e.g., self-direction, hedonism, achievement, benevolence; Schwartz, 2012). Traditionally, marketing academics have focused on customer perceived value, with several definitions (Holbrook, 1999; Woodruff, 1997; Zeithaml, 1988). Gallarza et al. (2017) identified three main approaches to customer perceived value, namely trade-off, dynamic, and experiential. While all three approaches have merits, over time, services marketing researchers have shifted their focus from the trade-off (the overall evaluation of utility after weighting 'give' and 'gets'; Zeithaml, 1988) towards the experiential ('interactive relativistic preference experience'; Holbrook, 1999, p. 5). The experiential approach supports broader conceptualizations of holistic value rather than being limited to mainly cognitive assessments, such that psychological foundations complement economic ones (Gallarza et al., 2017; Helkkula et al., 2012). Despite such on-going developments, marketers still call for further refinements of customer perceived value (Boksberger and Melsen, 2011; Gallarza et al., 2017). The current study proposes a value framework that can acknowledge and combine all three elements, that is, the trade-off, dynamic, and experiential nature of value.

Furthermore, many marketing academics have acknowledged that context-specific values reflect the influence of higher-level, abstract, personal values (e.g., Woodruff, 1997; Zeithaml, 1988). Personal values are desirable end-goals

(Rokeach, 1973) that serve as guiding principles navigating people through their everyday lives (Schwartz, 1992). Even though personal values are not contextually bound, when they become salient in certain contexts, they motivate actions and inform users' needs, attitudes, and behaviors (Homer and Kahle, 1988; Lages and Fernandes, 2005). The activation of personal values thus might enable users to realize both the benefits of value co-creation and the risk of value co-destruction in relation to a novel value proposition (Skålén et al., 2015).

Value propositions

The emergence of SDL and SL research has renewed interest in value and value co-creation. According to SDL, value is 'an improvement in system well-being' (Vargo et al., 2008, p. 149), whereas SL defines value as customers being or feeling better off than before engaging in a service (Grönroos and Gummerus, 2014). In both logics, value is idiosyncratic, experiential, and contextual (Grönroos and Gummerus, 2014; Vargo and Lusch, 2016). Furthermore, both logics acknowledge that service providers cannot simply deliver value to service beneficiaries but rather must invite them to engage their resources to co-create value by delivering compelling value propositions (Chandler and Lusch, 2015; Frow et al., 2016) or value promises (Grönroos and Gummerus, 2014). Value propositions hold strong promises for the involved actors, indicating that they can realize desired values through the activation of their own resources (Grönroos and Voima, 2013) or simply by engaging in co-creation. Realizing value-in-use or enhancing value entails improvements to customers' subjective well-being, defined as 'a person's cognitive and affective evaluations of his or her life' (Diener et al., 2003, p. 63). This state combines cognitive and affective evaluations of the situation, so value propositions must go beyond the pure enumeration of offered services, as represented by a cognitive approach, and promise improved well-being by leveraging both cognitive and affective value propositions.

Value co-creation and co-destruction

Both SDL and SL also agree that value is not created for but rather is collaboratively created with customers (Grönroos and Voima, 2013; Vargo and Lusch, 2004, 2016). SDL proposes that value is always co-created through resource integration of multiple service actors (Vargo and Lusch, 2016); SL suggests that value is only co-created through direct interactions between actors in a joint sphere (Grönroos and Gummerus, 2014; Grönroos and Voima, 2013). Interactions can be face-to-face or through the mediation of smart

technologies such as avatars or robots (Grönroos, 2017). According to SL, in the absence of direct interactions, service providers act as value facilitators, and customers can independently create value within their customer sphere (Grönroos and Gummerus, 2014). To trigger interactions, service actors offer compelling value propositions that promise improved well-being. However, the outcome of the interaction does not guarantee greater well-being; service interactions can diminish well-being by destroying value for at least some actors (Echeverri and Skålén, 2011; Plé and Chumpitaz Cáceres, 2010).

Unlike early research that took an overly optimistic view and assumed enhanced value would always result from the collaborative integration of resources, recent SDL and SL contributions have acknowledged the potential for destructive phases that ultimately make a service actor worse off (Grönroos and Gummerus, 2014). Furthermore, though most research investigates actors' perceptions of value enhancers and inhibitors after the service interaction (Baron and Harris, 2010; Zhu and Zolkiewski, 2015), many value co-destruction practices could be avoided if investigated earlier, before developing and introducing social robots to service contexts. This study seeks to understand how service offerings enable or prevent users from achieving desirable value outcomes (that is, value co-creation and value co-destruction) early in the service interaction process. In addition to studying the effects on value co-creation/destruction during or after the introduction of novel technology (e.g., Breidbach et al., 2013; Larivière et al., 2017), our iterative framework suggests studying expected value changes prior to technology development and deployment. In that way, many costly roll-outs could be avoided before being introduced to diverse service settings.

Context: Social robots in elderly care services

Robotic technologies can alter healthcare value networks and assist healthcare staff in surgeries, telepresence, and preventive and chronic care (Ransbotham et al., 2017; Stone et al., 2016). The healthcare domain requires new, technology-enhanced service options, and technological improvements promise to facilitate human well-being. In particular, robotic technologies offer potential tools for increasing the well-being of elderly consumers by providing consistent service delivery, constant availability, and good reliability (Broadbent et al., 2009; Pineau et al., 2003). Yet this complex setting also includes vulnerable stakeholders, sensitive data, and inert institutions (Black and Gallan, 2015), provoking academic and public policy debates around the introduction of robots (Dell Technologies, 2018; Sharkey and Sharkey, 2012; Stone et al., 2016). Rather than predicting totally dystopian (e.g., loss of human touch, human obsolescence, privacy concerns) or utopian (e.g., panacea for social problems,

unburdening overworked care staff, prolonged independent living) outcomes, this study considers a clearly specified situation in which socially assistive robots provide assistance to the elderly through human-like social interactions (Feil-Seifer and Matarić, 2005). In an elderly care context, socially assistive robots should become able to gauge social cues through voice and facial recognition technology to provide humans with health and safety monitoring services, social mediation and interactions, and companionship (Broekens et al., 2009; Feil-Seifer et al., 2007). As the social dexterity of robots increases (e.g., listening, conversations, reading emotional cues), human expectations of robots' warmth and competence capabilities should increase as well.

Acceptance of social robots

According to Pino et al. (2015), the most critical barriers to social robot acceptance reflect the mismatch between what is offered (i.e., value proposition) and what is needed, expected, and valued. While the traditional technology acceptance model (TAM; Davis, 1989) proved its usefulness in evaluating functional elements (e.g., perceived usability and ease of use) that might promote or impede intentions to use new technologies, it needs to be adjusted to reflect the human-like aspect of social robots, the social cognition users form about their robotic counterparts, and additional influences on robot acceptance. Notable advancements of TAM in this regard account for social, emotional, and/or relational elements that can exhibit influence on technology acceptance. For example, Heerink et al. (2010) extended TAM by including additional social elements (e.g., social presence and perceived sociability) along with trust, anxiety, and perceived adaptivity. Wirtz et al. (2018) introduced the Service Robot Acceptance Model (sRAM), which further extends TAM by differentiating among functional (perceived ease of use, perceived usefulness, subjective social norms), socio-emotional (perceived humanness, perceived social interactivity, perceived social presence), and relational (trust and rapport) elements.

In addition to evaluating the sociability aspects of new technologies, the underlying mechanisms of technology acceptance (users' needs, wants, and values) need to be re-evaluated, since human-like technologies might tap into different aspects of value expectations than, for example, self-serving technologies (Meuter et al., 2005). The human-like appearance, minds, and behaviors activating users' social cognition mechanisms might make different personal values salient. Identifying different salient values across different user segments (e.g., elderly segment "X" emphasizes benevolence as a dominant personal value, elderly segment "Y" security, and elderly segment "Z" self-

direction) can help to design future technologies that resonate better with users' unique values and to advance technology acceptance models to account for such value-seeking variations. This paper proposes that understanding the motivation of (elderly) people to accept or reject social robots requires first embracing the interpretive research paradigm and uncovering the value-matching processes users undergo when presented with a new type of technology that can exhibit human-like behaviors. In that way, the proposed conceptualization addresses a recent call to advance the understanding of how new technologies affect value co-creation (Kaartemo and Helkkula, 2018).

THEORETICAL PROPOSITIONS

Congruence between value propositions and users' values

The theoretical background of the paper emphasizes how (i) robots' value propositions promise an improved well-being, (ii) subjective well-being can be assessed through cognitive and affective evaluations of one's life, (iii) users activate the mechanisms of social cognition when interacting with human-like social robots, (iv) personal values are desirable end-states that when activated in context affect cognitive and affective evaluations (i.e., perceived value of the robot) and influence behaviors (i.e., robot acceptance), and (v) users' perceived value combines trade-off, dynamic, and experiential evaluations or the value co-creation and co-destruction potential of social robots in services.

Building upon the theoretical background, this article advocates for the value congruence between novel value propositions (e.g., cognitively and affectively endowed robots) and users' personal values, which when activated affect the evaluation of value co-creation and co-destruction potential of social robots. We argue that a finer-grained understanding of users' value-matching processes (see Figure 1) can help disentangle factors that influence novel technology acceptance and can further advance the existing empirical models of assisting users' acceptance of social technologies (e.g., TAM, sRAM). We initially build our argument focusing on the elderly due to their propensity to anthropomorphise technologies; however, we propose that the following model (Figure 2.1), theoretical propositions, and iterative framework (Figure 2.4) also pertain to diverse user segments. Hence, we encourage other robotics and service researchers to study the generalizability of the proposed conceptualization in different service contexts.

Figure 2.1 – Congruence between value propositions and users' values

Value co-creation/destruction potential of social robots in services

Designing robots that can exhibit human-like minds, in addition to their human-like bodies, suggests new opportunities to study prospective users' social cognition, with meaningful consequences for predicting robot acceptance.

Proposition 1: Social robots in services offer users value propositions leveraging affective and cognitive resources.

In terms of robots' social capabilities, human-like social robots in services differ in their cognitive and affective resources. Figure 2.2 presents a matrix of social robots in services that differentiates their affective capacities (e.g., artificially programmed emotions, ability to mimic empathy and offer emotional support; Bolton et al., 2018; Keating et al., 2018; Wirtz et al., 2018) and cognitive capacities (e.g., ability to reason or to learn from past experiences). Quadrant 1 includes *mechanic robots* that are low on both affective and cognitive resources. They can perform repetitive, predictable, tedious tasks that humans hope to avoid; they cannot scale up their services but instead function solely within the boundaries of their programming. For example, shelf-scanning robots introduced

by Walmart (Vincent, 2017) can move through store aisles and detect empty shelves that need to be re-stocked.

Figure 2.2 – Robot typology based on cognitive and affective resources

In Quadrant 2, the *thinking robots* are high on cognitive but low on affective resources. Such robots function in a calculating and rational manner and can make logical inferences to optimize processes. They can be valuable in service settings because their artificial reasoning skills can be enhanced through learning. Thinking robots promise to offer timely, reliable information and weigh all possible pros and cons before making a decision. For example, future thinking robots are expected to be capable of real-time big data processing and giving personalized medicine recommendations to patients based on their genomic–metabolic–microbiome profiles (Rijcken, 2018) without involving feelings in the process.

Quadrant 3 features *feeling robots* with high affective but low cognitive resources that can perceive human emotions and act accordingly. Leveraging their affective capabilities, these robots respond to human moods in personalized ways. For example, Cynthia Breazeal's Kismet can recognize and express emotions and promise therapeutic applications in child and elderly care, settings in which a rapport-building capability is important (Breazeal, 2001). Future feeling robots are expected to be capable of mimicking emphatic behaviors (e.g., emphatic listening) when interacting with human actors, but their actions will not necessarily be rational.

Finally, Quadrant 4 introduces *robo-sapiens*¹ with high cognitive and affective resources. This group combines the characteristics of both the feeling and thinking robots and should be able to mimic empathic behaviors toward their interaction partners while also providing meaningful solutions (Čaić et al., 2018). No compelling example currently exists of a robot that is autonomous, fully functional, and capable of sensing, comprehending, and acting in meaningful ways (Eyssel, 2017). That is, when interacting with a person, a feeling robot might detect sadness and attempt to provide comfort by playing soothing music; a thinking robot would evaluate the same person's past medical history and provide the most appropriate remedy, such as a reminder to take anti-depression medication. Robo-sapiens should effectively combine both feature groups such that they would provide the most appropriate remedy for that person at the time while considering her or his emotional state, and perhaps they would engage in comforting conversation before issuing the medication reminder.

In service contexts like healthcare that require service providers to exhibit both affective and cognitive capabilities, social robots can co-create or co-destroy value. Due to the human-like behaviors of thinking and feeling robots and robo-sapiens, human interaction partners likely evaluate them similarly to a human service actor in terms of their value co-creation and co-destruction potential, such that they assess perceived warmth and competence. **Proposition 2:** Users' personal values become salient through interactions with social robots' affective and cognitive resources.

¹ Inspired by the book "Robo sapiens: Evolution of a new species" by Peter Menzel and Faith D 'Aluisio (2001)

Proposition 2: Users’ personal values become salient through interactions with social robots’ affective and cognitive resources.

Leveraging the theoretical background, this study brings users' personal values to the fore to consider ways they might be activated in context. In particular, this conceptualization builds on Schwartz's (2012) theory of basic values that identifies the 10 basic personal values in Figure 2.3.

Note: Adapted from Schwartz (2012)

Figure 2.3 – Basic personal values

These 10 personal values are universal across cultures, but individuals and segments of people assign different importance to the different values to form their own priorities (Schwartz, 2012). For example, according to socio-emotional selectivity theory, older people assign more weight to emotionally meaningful goals such as benevolence (Carstensen, 1992). Personal values steer people's actions in context, mostly through unconscious processes. However, if they experience a conflict among different value priorities, their evaluations of the potential outcomes of engaging in a certain action become more conscious (Rokeach, 1973; Schwartz, 2012). Through a novel interaction with a robot's

affective and cognitive resources, such that they become acquainted with its value propositions, users likely perceive the greater salience of some personal values. If the robot's ability to assist suggests that it might augment or replace human actors, users might recognize values such as health, self-respect, privacy, and sense of belonging. The robot's affective resources should make emotion-infused value items more salient; its cognitive resources likely make functional value items more salient. In addition, a social robot might cause value conflicts, such that elderly users might recognize the value of self-direction if the robot helps them remain more independent but at the expense of a loss of a sense of privacy.

Proposition 3: Users evaluate social robots' value co-creation and co-destruction potential according to the dimensions of social cognition.

Building on the assumption that users may experience conflict across different personal values, the proposed conceptualization suggests that users engage in a mental trade-off (Zeithaml, 1988) to evaluate the social robot's potential for helping them achieve their cherished, salient, personal values, both in terms of likely value co-creation potential and the risk of value co-destruction potential. These evaluations should capture both affective and cognitive appraisals of value through lived and anticipated experiences (Helkkula et al., 2012). Because of the social robot's human-like capabilities, users likely activate social perceptions and evaluate the robot according to the warmth and competence dimensions of social cognition. The non-human actors can signal their warmth through their affective resources and their competence through their cognitive resources. Such cues encourage users to anthropomorphize the non-human actors and evaluate their instrumentality by using these warmth and competence dimensions. Referring back to a previous example, a sense of a loss of privacy might be evaluated according to warmth (e.g., 'Does the robot genuinely care for me? Is it collecting data only to help me?') and competence (e.g., 'Can the robot protect my private data?') dimensions.

DISCUSSION AND IMPLICATIONS

Theoretical implications

This article introduces a value-centric conceptualization of social robots according to a resources-focused view of technology (Kaartemo and Helkkula, 2018; Vargo and Lusch, 2016). While acknowledging the variety of existing robot design criteria, this conceptualization prioritizes a social cognition perspective and suggests that users evaluate social robots on their affective and cognitive resources, in addition to their human-like appearance, that induce mind

perceptions (Gray et al., 2007). Such perceptions of a human-like mind arise from both direct interactions with the social robot in a joint sphere (Grönroos and Gummerus, 2014) and predicted or imagined experiences prior to the actual interaction (Helkkula et al., 2012). Although this article focuses specifically on robotics, the resulting insights may have implications for other technologies that act as social entities too, such as voice-based personal assistants. By emphasizing warmth and competence as universal dimensions of social cognition (Fiske et al., 2007), this conceptualization establishes a social psychology perspective on technology-enhanced service interactions. Continued research in turn should include human social-cognitive processes to clarify similarities and differences in human–human versus human–robot value co-creation/destruction practices. Such efforts will have particular importance for frontline research and for investigating which complementary or substitutive roles technology might offer humans in the future (Huang and Rust, 2018; van Doorn et al., 2017; Wirtz et al., 2018).

The proposed iterative framework also conceptually broadens perspectives on value, in that it combines trade-off, dynamic, and experiential approaches to value (Gallarza et al., 2017) and links personal and context-specific values. As a bridge between basic personal values and context-specific value co-creation/destruction potential in value attainment, this framework demonstrates how various types of value are intertwined; they should not be analyzed independently but rather require an integrative approach (Schwartz, 2012). In addition, this study emphasizes the importance of studying both positive value co-creation and negative value co-destruction possibilities associated with human–robot resource integration (Čaić et al., 2018). Considering the many destructive consequences of technology for personal values, such as a loss of privacy, personal data leaks, or monitoring concerns (Sharkey and Sharkey, 2012), further research should address this point in more detail. The proposed conceptualization also reveals the dynamic, iterative nature of the alignment between offered value propositions and desired value outcomes. For service researchers, iterations are inevitable for forming value propositions that resonate with users' values (Chandler and Lusch, 2015). Therefore, researchers should take a long-term, rather than short-term, perspective on value co-creation/destruction, such that they first gain a better understanding of the social-cognitive mechanisms that users employ when interacting with social robots (van Doorn et al., 2017; Wykowska et al., 2016) before attempting to develop a set of meaningful cognitive and affective value propositions.

Managerial implications

The fourth industrial revolution that is currently underway features new technologies (e.g., Social Robots, Artificial Intelligence, Internet of Things) that are radically changing how and with whom people interact (KPMG, 2017). Even if most service organizations recognize the transformative power of new technologies (Marinova et al., 2017), many struggle to understand customer value and how to develop value propositions that will resonate with it (Payne et al., 2017). Our value-centric approach enables service organizations and their partners tasked with developing robotic services to gain a better sense of which future value co-creation opportunities are more likely to benefit users (Grönroos, 2017).

Map robotic functionalities according cognitive and affective value. A social robot's value proposition should be an invitation issued to a diverse set of users to engage with the robot's configuration of affective and cognitive resources. To leverage these resources, service managers can ask users to map the robot's functionalities (e.g., recognizing user's moods or alerting caregivers in case of an emergency) according to the different quadrants of the proposed robot typology in Figure 2. Such a mapping activity would reveal which functionalities need to be included in the system to achieve a particular type of social robot in services. Managers should decide which robot type is most relevant for their context and understand the implications of their decisions for users.

Use interpretative approaches for eliciting personal value. Value propositions also can activate a spectrum of personal values (Schwartz, 2012) that become salient through either an initial interaction or anticipated interaction with the robot. As emphasized previously, personal values tend to be unconscious, so managers need a broader methods toolbox that includes more interpretative approaches (e.g., user narratives, generative interviews, phenomenographic interviews; Čaić et al., 2018; Helkkula et al., 2012). These techniques allow a deeper view into users' underlying drivers of technology acceptance (e.g., through laddering during interviews) and demand qualitatively coding user insights against the personal values as presented in Figure 2.3. The analysis provides service managers with information about which values get activated as users gain familiarity with robotic service actors. Such methods might be applied during trials with social robots to complement and augment observational and survey data.

Beware of and design around value trade-offs. This study argues that users accept or reject the value proposition of the robotic service depending on the positive and negative evaluations of the robot's instrumentality for users' value

attainment. For example, the robot's reminder function to take medicine can enhance the goal of independence by relieving users trying to recall medicine intake, which they no longer can perform autonomously, while at the same time decreasing their feeling of independence since they then become reliant on the reminder service. Thus, users engage in a mental trade-off of value co-creation/destruction potential. To deal with the trade-off, service managers need to determine stepwise for each robotic component (e.g., functionalities, interface, aesthetics) the positive and negative impact for the user's warmth and competence perception and potentially forgo components if the disadvantages outweigh the benefits. This systematic impact assessment of each robotic component serves as input for the robot developer.

Develop the service offerings from social robots iteratively. The developed framework of value co-creation/destruction potential of social robots (Figure 4) offers service managers a stepwise process for developing service offerings that enable users to achieve desirable value outcomes and avoid others. Performing the process through multiple iterations allows starting with some incremental offerings (e.g., one functionality) to obtain use feedback before adjusting the robotic design and adding further incremental offerings during the next iteration. This iterative approach is increasingly common in designing services (Mahr et al., 2013) because it reduces the risk of mis-development inherent to all-inclusive solutions and increases the likelihood of user acceptance of the radically new technology.

Figure 2.4 depicts the iterative process with three steps, each linking a theoretical proposition to a managerial implication.

Figure 2.4 – Iterative framework of value co-creation/destruction potential of social robots in services

Future research agenda

This study focuses on social robots in elderly care services, reflecting the societal relevance of their use in this sector, as well as the growing challenges associated with elderly user segments. However, there are plentiful opportunities for research that undertake further explorations of social robots in other healthcare services and frontlines in general. Table 2.2 provides a list of suggested research topics. The suggested research questions are organized according to the three theoretical propositions that are at the core of Figure 2.4. It does not attempt to be exhaustive; rather, this list offers directions for researchers interested in social robots in services, value-related phenomena, service experiences, and social cognition.

Table 2.2 – Future research agenda

Potential research topic	Selected questions
Social robots in services offer users value propositions leveraging affective and cognitive resources	Using insights from different network actors, is it possible to establish relevant design criteria for developing valuable robotic services? In addition to human-like appearance and behavior, what are other important social robot design criteria?
	What are determinants of robotic solutions that are simultaneously customizable (to customer needs), (technically) feasible, and viable (with a network operations model)?
	In which service contexts are robots' affective resource more important? In which contexts are cognitive resources more important? How do different configurations of cognitive and affective resources affect the perceptions of the humanness of robots?
	Will social robots ever be capable of genuine emotions? If so, how will empathy and authentic companionship obtained from social robots affect service experiences?
	Can the transformative potential of human-like robots be optimized by addressing the interplay of physical-psychosocial-cognitive health?

Users' personal values become salient through interactions with social robots' affective and cognitive resources	Which value priorities are predominant in different service contexts and different customer segments?
	Do value priorities change when moving from a focal actor level to a value constellation level (micro to meso/macro)?
	How to translate the complexity of contradicting user expectations and value priorities into the design of social robots?
	Do salient personal values differ depending on whether users anticipate (prior to technology development) or actually experience interactions with social robots in services?
Users evaluate social robots' value co-creation and co-destruction potential according to the dimensions of social cognition	Which element of social cognition, warmth or competence, is predominant when evaluating service interactions with social robots? In human-human interactions, warmth takes precedence (Fiske et al., 2007); in human-robot interactions, the dynamics of warmth and competence still need to be addressed.
	Do social robots build trust primarily through competence or warmth?
	How do users' evaluations of value co-creation/destruction potential change over time?
	How to address varying evaluations of value co-creation and value co-destruction potential among the diverse set of stakeholders? This is particularly important for network services, in which value co-creation for one actor might imply value co-destruction for another.
	How to design human-robot interactions that will maximize the network well-being?
	Which ethical considerations (e.g., privacy, dehumanization, social deprivation, lack of agency) affect evaluations of value co-creation/destruction potential?
	What effects do social robots have on users' and service providers' roles in value co-creating networks? How do they affect evaluations of social robots? Do novel role distributions and role-related tasks affect the quality of service co-created with an automated actor?

Conclusion

This conceptual paper focuses on the value of social robots in services, an area which is still in its infancy. The paper argues that because of their human-like appearance, minds, and behavior activating the social cognition mechanisms of users, different personal values might become activated compared to interacting with non-human technologies. The three propositions resulting from our study are: (i) Social robots in services offer users systems of value propositions leveraging affective and cognitive resources, (ii) Users' personal values become salient through interactions with social robots' affective and cognitive resources, and (iii) Users evaluate social robots' value co-creation and co-destruction potential according to perceived warmth and competence of the robot. A future research agenda based on these three propositions offers relevant, conceptually robust directions for stimulating the advancement of knowledge and understanding of the influences of social robots on users' values and value co-creation. As the domain of service robots is still nascent, we trust that this future research agenda inspires scholars and practitioners alike to explore the value co-creation potential and co-destruction challenges of social robots through a social cognition lens of users in diverse service settings.

CHAPTER 3

Beneficiaries' View of Actor Networks: Service Resonance for Pluralistic Actor Networks

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INTRODUCTION

In new service development and service design, an increasingly common practice is to map networks of the actors engaged in value co-creation (e.g., Bitner et al., 2008; Diana et al., 2009; Segelström, 2013; Shostack, 1984). An underlying assumption is that these actor networks, as phenomenological artefacts and not just as maps, can provide a clearer understanding of service and its value co-creating processes.

In the service (dominant) logic, value or improvements to well-being (Vargo et al., 2008) are determined by service beneficiaries, who in turn are actors in networks (Grönroos, 1990; Vargo and Lusch, 2008). Networks are governed and influenced by institutional arrangements, which reflect the formal and informal ties built among actors (Akaka and Vargo, 2015; Edvardsson et al., 2011). Finally, value is co-created among actors (Grönroos and Voima, 2013; Prahalad and Ramaswamy, 2004) and over time, through acts of resource integration (Gummesson and Mele, 2010; Lusch and Vargo, 2006). However, in design, value is strongly linked to meaning and meaningfulness (Almquist and Lupton, 2010; Krippendorff, 1989; Ylirisku and Arvola, 2016), such that individual actors look for locally articulated values (Blomkvist et al., 2013). The focus is on human-centered co-creation of value (Sanders and Stappers, 2008), which stems from resourcefulness and participation (Holmlid, 2012a). Furthermore, value is determined by the individual rather than the organization (Boztepe, 2007), such that value creation appears idiosyncratic (Wetter-Edman et al., 2014), and various beneficiaries form different understandings of value, through the value creation process (Moeller et al., 2013).

Thus, the network itself is central to an understanding of service, as are the networks of actors that collaborate to create value, and they are therefore central to our understanding of design for service. Yet the practice of making maps of these actor networks remains somewhat underexplored—or at least less well documented. We therefore explore the configuration of actor networks from the phenomenological perspective of the beneficiary, to determine:

- The ways in which actors in a service system (i.e., configuration of people, technologies, and institutions) describe the network, as a structure of actors and relationships;
- The types of visual artefacts they use to represent the network;
- The manner in which the visualizations expresses instrumental qualities; and
- The dominant value goals stemming from their narratives.

Through this, we contribute new insights into modelling actor networks, as part of a human-centered design practice. Furthermore, we show how service beneficiaries' different mental models frame an understanding, and the expression in the maps, of service systems in which they actively co-create value, and how a service can resonate with a variety of mental models. These findings provide justification for the use of open and participatory mapping activities that do not impose strict formats, according to a predefined set of templates presuming the network structure, as an appropriate knowledge elicitation tool.

CONCEPTUAL BACKGROUND

Service design practice has prompted studies of different kinds of visualization (Diana et al., 2009) and their role in user research (Segelström, 2009) as well as their role in service prototyping (Blomkvist, 2016). The categorisation of visualization formats reflects various dimensions, such as time or abstraction. For example, Blomkvist and Segelström (2014) distinguish using visualizations to represent something *current* from using them to represent something in the *future*. In their framework, Diana et al. (2009) address whether development over time is part of the representation. If time is represented, the visualization is *diachron*, but otherwise, it is *synchron*. They also highlight that the means of representation may be *abstract* or *realistic*. Blomkvist and Segelström (2014) focus on the representation as such, distinguishing between *definite* representations, which are formats that do not change when we “use” them, and *on-going* representations, which emerge in the process of being represented.

Actor Networks in Design

As Table 3.1 summarizes, a set of genre-typical visualizations thus has emerged to represent a current service in service design practice. First, the customer journey type is a diachron technique, and its visual appearance stresses how time develops and runs through the service, from a beneficiary's perspective. In many ways, it is similar to a blueprint (Shostack, 1984), except that less actors are represented directly in a blueprint. Second, the service system type tends to mix synchron and diachron techniques, with a visual appearance that stresses how technology and other resources relate to one another. This frequently abstract technique represents processes or system resources. Third, the ecology or network type, a synchron technique, is usually, but not necessarily, abstract and static. Specific phenomena are directly represented, but others can only be inferred, such as the actual organizational structure. This technique often results in visual artefacts, or is based on templates, that place the object of inquiry

(typically, a focal actor or user) in the middle, with everything else ordered around this object.

Table 3.1 – Actor networks in design

Tool	Who makes the map?	How is data collected?	Template provided?	Visualization Example
Customer Journey	Customer and/or service provider	Ethnographic studies including observations, in-depth interviews, and generative sessions	Yes	<p>Customer journey stages: _____</p> <p>The diagram illustrates a customer journey starting with a person (A) interacting with a mobile phone, then visiting a storefront, followed by a shopping cart, and finally receiving an email notification.</p>
Service System	Service provider	Internal company information, interviews with various stakeholders, observations	No	<p>The diagram shows a central storefront connected to various actors (A) and a bank. Arrows indicate different types of flows: information flows (dashed double-headed arrows), material flows (solid arrows), and monetary flows (dotted arrows with a dot at the tail).</p> <p>Legend: - - - - - Information flows ————— Material flows Monetary flows</p>
Ecology or Network	Service provider	Internal company information, interviews with various stakeholders, observations	Yes	<p>The diagram shows a central actor (A) surrounded by concentric circles, representing different levels of interaction or network structure. Other actors (A) are positioned around the circles.</p>

A search of leading design journals for publications pertaining to maps of stakeholders, actor networks, or service ecologies yields very few hits. Across the top three journals (Design Studies, Design Issues, and International Journal of Design), only six articles were found, three of which relate to actor-network theory (Brodersen et al., 2015; Petersen and Riisberg, 2016; Venturini et al., 2015). The other three do not describe how the networks were conceived, nor do they provide any visualizations (Ceschin and Gaziulusoy, 2016; Heylighen and Nijs, 2014; Stompff et al., 2016). One of the publications referring to actor-network theory (Venturini et al., 2015) offers an example of a complex actor network, in the form of a web of nodes and links. By widening our search for maps, we find a representation called “Actor Networks or Service Ecology Maps” (see Figure 3.1) in a service design textbook by Polaine, Løvlie, and Reason (2013). These authors suggest that the Actor Network map or Service Ecology emerged from desk research and interviews, and it depicts a system of actors and the relationships among them.

Figure 3.1 – The Actor Network or Service Ecology Map (Polaine et al., 2013)

A number of other network visualization tools were detected, including the value network analysis (Allee, 2008), value framework (den Ouden, 2011), and value flow model (den Ouden and Valkenburg, 2011), which rely on a researchers' representation of actor networks, usually spreading outwards with a focal actor set in the centre of the visualization. Furthermore, a mapping concept, called Power Mapping or net-map (Schiffer and Hauck, 2010), was found that features

maps built by the informants, individually or in groups with the intent to be shared with each other, without any pre-set template to follow, except the material used to do the mapping.

Actor networks in service

Moving to the domain of service marketing and management, the focus of many visualizations is on interactions, service processes, and operations (Patrício et al., 2011; Sampson, 2012). They tend to rely heavily on the well-established service blueprint technique (Shostack, 1984), a diachron representation of service delivery. Different variations of service blueprinting emphasise a strong customer focus, such as by cross-referencing insights from multiple data sources, including observations, in-depth interviews, focus groups, and so forth (e.g., Patrício et al., 2008). Usually researchers, as members of multidisciplinary teams (e.g., marketing, operations, design, human–computer interaction experts), draw on the plethora of collected data and try to experience and map the service from customers' perspectives.

Similar to our search of leading design journals, we conducted a search in the top service journals (*Journal of Service Research*, *Journal of Service Management*, and *Journal of Services Marketing*) and identified only five papers that attempt to visualize actor networks or use other visualization techniques to analyse current service or actor networks (see Table 3.2). However, we also note some increasing interest of the service community in understanding networks of actors that co-create value through service interactions (e.g., Barile et al., 2016; Fyrberg and Jürriado, 2009; Pinho et al., 2014). Various authors indicate the importance of zooming out from dyads to networks, yet few offer guidance for how to approach such complex network contexts. For example, in the *Journal of Service Research*, we find a variation of blueprinting, the Multilevel Service Design framework (Patrício et al., 2011), that maps a service onto Edvardsson et al. (2000) three levels: service concept, service system, and service process. On the service concept level, the map reflects the customer value constellation of service offerings, a synchron representation such that actors can only be inferred from the representation. On the other two levels, diachron visualizations that represent processes and interactions are presented. The Process-Chain Network (Sampson, 2012) instead outlines network actors and their interactions simultaneously. However, this visual technique uses a dyadic perspective, with one provider and one customer, and mainly represents their interactions. Finally, the Service Delivery Network (Tax et al., 2013) depicts actors and their interdependencies while describing their interactions in the explanation of the visualization. All three approaches are suitable for understanding and designing

complex service systems, yet none of them involves network actors themselves in the mapping process.

An exception is Value Network Actor Map (Pinho et al. 2014; Pinho et al., 2013), which aims to provide an integrated view of the network relations among sets of actors. To create these visualizations, the researchers invited network actors to map how they envision value co-creation, though they include only five participants as representatives of different network actors. The network map is structured into a single, integrated map, with categories based on a card-sorting task performed by the representatives. The main actor (in this case, the citizen) appears in the centre of the visualization. The practice of finding consensus through card-sorting, and placing a main actor in the center, may be participatory, but gives little room to individual views to show through. In the quest to understand how customers conceptualize and experience service, few visualization methods ask the involved actors to map how they perceive the interactions among the actors who will be part of the actual service.

Table 3.2 – Actor networks in service

[illegible]

Tool	Who makes the map?	How are data collected?	Template provided?	Visualization Example
Multilevel service design (MSD) (Patrício et al., 2011)	Service provider, multi-disciplinary team (manager of the business area and representatives from marketing, information systems, and operations)	Through observations, in-depth interviews, focus groups, usability testing, or walkthroughs	Yes	
Process-chain network (PCN) analysis (Sampson, 2012)	Service provider	Internal company information, interviews with various stakeholders, observations	Yes	
Service delivery network (SDN) (Tax et al., 2013)	Service provider	Internal company information, interviews with various stakeholders, observations	No	

Actor Network Maps as Mental Models

Mental models make it possible to reason about how people understand phenomena in general and how their understanding shapes the way they engage with their surroundings (Norman, 1988). Along these lines, Norman's (1988) dilemma between mental and conceptual models in human-centered design may apply in the service domain. Norman describes the dilemma in that designers have their mental models that they use when designing a system, and the users have their own mental models when they use that system. The designers use their mental models and "translate" it into a system, also called a system image, which may or may not fit well with the user's model. The usage of the system, along with the experiential parts of the system image, are what the user combines with his or her own mental model, to achieve their goals. The differences between the user's model and the system image often create unnecessary friction. In human-centered design, the goal is to build systems based on the user's mental model, rather than the designer's.

Norman's (1988) ideas have gained particular traction for designing and using IT systems. The dynamic nature of the system image often is restricted by laws of computation. However, within service systems, "users" are part of the system itself, as actors, so the complexity of how mental models interact and develop with the service system in action increases. In a service system, the actors also participate in resource integration (Gummesson and Mele, 2010), actively co-creating the prerequisites for the system, the system itself, and the co-created value (Maglio et al., 2009). That is, the actor's mental model of the service system functions actively to manipulate the structure and components of the service system, and thus the system image. In addition, the system is partly built around technology, which may be used collaboratively or through self-service options, and it is governed by institutional arrangements (Edvardsson et al., 2014), which are assumed and ingrained through service cultures, genres, and routines.

One aspect of the system is the network of actors that build the social fabric of the service system, as well as the action possibilities of the system, because acts of resource integration are what drives any service system. Therefore, the mental models of the individual actors in that actor network constitute one key entry point to understand how individual actors in the service system view and understand the system and how it works, such that they might shed light on some of the norms and institutional arrangements.

However, most of the actor network maps cited in the previous section either represent the mental models of service management researchers or else restrict representations of an actor's mental models to a predefined network structure template. Moreover, most of them work on an aggregate level, either by combining several maps into one, or combining several actors in making one map. For many other studies of networks, it is these aggregate networks that are in focus (Wasserman and Faust, 1994). In effect, there is little understanding of individual actors' mental models of service systems, and little research on what such mental models might be or look like. Allowing individual actors to do the mapping themselves therefore is critical, because "When someone externalizes a structure, they are communicating with themselves, as well as making it possible for others to share with them a common focus" (Kirsh, 2010, p. 444).

Actor Networks as Concept Mapping

In service design, mapping techniques help designers collect and summarize knowledge, together with beneficiaries (Blomkvist and Segeslström, 2014). Finding a way to allow actors to express their own mental models of the service system, building on a human-centered ideal, is preferable. In the case in which informants use mapping as a knowledge elicitation tool, the maps represent so-called concept maps (Novak, 1991; Trowbridge and Wandersee, 1998). A concept map reflects one individual's conceptualization of the world or some phenomena within it. It offers a means to organize and explore a person's thinking about and understanding of related concepts, because a concept map visually represents concepts and their relationships. Their use in learning studies facilitates assessments of new learning strategies, the communication of complex knowledge, and support for decision-making and learning processes.

Many mapping techniques relate to concept maps as a genre of representation, distinct from the "maps" described in the model by Diana et al. (2009), which is a more generic genre for certain kinds of visualizations. Concept maps do not restrict how something is represented (abstract or concrete), nor what the links across the different nodes denote (synchron or diachron). However, most mapping techniques in design settings are specialized, with predefined or inherent rules about what may be represented (and not) and how. A system map and a customer journey map thus might be considered part of concept mapping, but they also are more specialized. These discussions motivate our interest in finding ways to involve beneficiaries more in drawing networks and freeing them to represent the network in ways that they find plausible.

Maps as Representations and Engagement

Visualizations of current services have several purposes, such as for designers to develop insights or communicate insights to others, or for a design team to maintain empathy built previously in the process (Segelström, 2013). The network mapping techniques we have presented this far seem devoted to communicating with others or maintaining empathy. In some cases, they function less as representations and more as tools or protocols to document research. That is, they are representations of actor networks and shorthand notes for a researcher; in both these cases, they are created by the designer and may follow a template.

For facilitation and mediation in design processes, maps sometimes may be taken not only as models or representations of an actual network, but instead become the networks themselves. Manipulating the map, is understood as manipulating the network. Working with the representation as such would then be regarded as enough. However, the manner in which the techniques presented earlier impose restrictions on participation and resourcefulness, suggest that understanding and using maps as networks constitutes a switch from representations of something real, into a hyper-reality where reality is more or less obscured (Baudrillard, 1983). In some instances, it would be appropriate to say that the map is a simulacra (Baudrillard, 1983), without representing anything real, even though relying on claims to do so.

Malafouris (2013) argues that models that we use, especially those expressed in material form, do “not primarily embody a ‘communicative’ or representational logic, but an enactive one” (ibid, p. 90) based on extended cognition concepts that replace the dichotomy between the brain and the world with an embodied, systemic view of cognition (Clark and Chalmers, 1998). There is a dynamic to the material engagement of our articulations (Malafouris, 2013). However, Malafouris (2013) does not suggest that the enactive logic applies to linguistic signs, whereas in extended cognition theories, a map would be perceived as a way of thinking (Kirsh, 2010). Madary (2016), developing a visual phenomenology argument, concurs that cognition can be performed with visual experiences. A consequence is that maps thus could constitute articulations, with a certain dynamic for their material engagement, which in turn is directed toward what the maps represent.

RESEARCH METHODOLOGY

Research Setting and Approach

Our overall research objective is to acquire a better understanding of how elderly people conceptualize their care-based actor networks and value co-creation therein, before and after the introduction of a socially assistive robot to their assisted living contexts. We consider the insights of elderly people, living in a nursing home or with relatives, using a qualitative research method with an ethnographic approach (Segelström, 2013). We conducted in-depth phenomenographic interviews (Sandberg, 2000) on-site; these semi-structured interviews sought to gain a deep understanding of people's conceptualizations and their sense making of their caring networks and surrounding context. We also wanted to elicit informants' genuine needs and their affective reactions, in the form of data-rich stories.

A material facilitation tool, designed as a participatory and generative technique (Sanders, 2000), supports the interviews (Segelström and Holmlid, 2015) by enabling the articulation, in a visual/material form, of informants' models of the care-based actor network (Banks, 2001). The interviews were thus augmented with a card activity (see Sutton, 2011), that aimed to complement the explicit knowledge obtained from informants with latent and tacit knowledge (Polanyi, 1967). The network actor cards also represent a response to Clatworthy's (2011) call for service design to make better use of tangible artefacts in the development and design of intangible service systems.

Informants

The sample is diverse in gender, age, and living arrangements. To ensure the validity of responses, we defined clear inclusion and exclusion criteria (Table 3.3). In total, 20 informants with minimal age-related health conditions participated in the study, 10 women and 10 men. The target population was elderly persons living alone at home (i.e., independent living), in a nursing home, or at home with assistance from formal or informal caregivers (assisted living at home). Appendix A presents details about the informants, using pseudonyms to protect their anonymity. All interviews were conducted in person, in the informants' homes or nursing facilities where they resided, and lasted 40–90 minutes with an average length of 70 minutes. We conducted four data collection waves over the course of 10 months until we reached theoretical saturation.

Table 3.3 – Inclusion and exclusion criteria for prospective informants

Inclusion criteria	Exclusion criteria
Elderly at the age of 60+ with no or only light (age-related) physical or mental health problems at the time of the study	Elderly with severe physical or mental health problems (e.g., dementia)
Living arrangements: independent, nursing home, or with caregivers	Elderly with no autonomy in their daily activities
Both genders, variety of daily habits, capabilities, preferences, technological skills, social status, etc.	Elderly not competent to give their consent

Research protocol

After the initial recruitment, the informants who agreed to continue with their participation were first informed of the objectives of the study and then provided with an informed consent form. Those who voluntarily signed the consent form then answered a series of demographic questions related to their age, gender, living arrangements, and number of family members. After collecting this general background information, we initiated a four-step generative “Context Disruption” interview protocol (Čaić et al., 2018) (see Table 3.4).

Table 3.4 – “Context Disruption” interview protocol

Step	Name	Description	Aim	Timing (approx.)
1.	Contextual network mapping– <i>Current service</i>	Map the care-based actor network before the introduction of the socially assistive robot	Collect both what they say and what they make to get a holistic understanding of key network actors, their importance for the elderly's well-being, their value co-creating practices, and roles.	30 minutes
2.	Active immersion	Sensitizing to new technology usage	Make informants sensitive to an area of experience (i.e., new technology) before introducing an unfamiliar technological impulse (i.e., socially assistive robots).	15 minutes

3.	Introducing "disruption"	Introduce, assess, and prioritize socially assistive robot functions	Get the informants acquainted with the socially assistive robot (e.g., look and feel, functionalities), collect their genuine care needs, and illuminate value priorities.	35 minutes
4.	Contextual network mapping– <i>New condition</i>	Map the care-based actor network after the introduction of the socially assistive robot	Determine whether and how the conceptualization and visualization of the care-based actor networks change with respect to that from the first step (i.e., before vs. after the introduction of the socially assistive robot).	15 minutes

For this paper, we investigate the visual data from the first step and surrounding narratives to establish an initial understanding of how elderly people conceptualize these care networks. That is, in this first step, informants had to think about their everyday life experiences and the different people who currently take part in what we defined as their care-based actor network (i.e., informal and formal connections who are more or less actively involved in taking care of them, helping them with groceries, medicine intake, finances, moral support, and so on). They also completed the *contextual network mapping activity* using a set of specifically designed actor cards (Figure 3.2), blank canvas, and colour markers. It consisted of three steps: i) select appropriate network actors from a deck of network actor cards, ii) freely rearrange the selected cards into a conceptualized network configuration, and iii) add relations (i.e., pathways of value co-creation) among different actors.

In addition to probing frequency of contact and general relationship dynamics, after the network mapping activity, the interviewer used the following probing questions to understand the role of each of the identified care-providing actors:

- Why is this actor important to you?
- What does s/he do for you?
- What does s/he mean for you?
- Do you feel like you are burdening this person?
- How would you be affected if this actor were no longer part of your care network?

The objective of this step was to get an understanding of how the elderly make sense of their caring networks and network relationship dynamics. Cards and mapping technique were deemed an appropriate method because of their ability to spark discussions with elderly respondents and their tangibility (Brandt, 2006; Clatworthy, 2011). The cards featured both images and text, to ensure unambiguous understanding of their content. Thus this activity could collect both what the informants say (i.e., narratives built around the visualizations, in response to probing questions) and what they make (i.e., care-based actor network visualizations; Sanders, 2000; Stappers and Sanders, 2003). The result was a comprehensive, holistic view of the key actors in their networks, strong and weak connections in term of frequency of contact and physical proximity, but also emotional versus functional relevance. These insights are gathered through both informants' visualizations and their narratives throughout the interview. We did not presume to understand these informants' experiences and evaluations but rather encouraged them to express them, using "what" and "how" questions (e.g., What does s/he do for you?; How would you be affected...?).

Figure 3.2 – Network actor cards

These collected insights from the contextual network mapping illustrate informants' existing care-based actor networks, or the status quo, before the network relations and structures become disrupted by the robotic technology.

Data analysis

All interviews were digitally audio-recorded, and the visualizations created were photographed (informants agreed to such recording when they signed the informed consent). Interviews were transcribed, translated, and reviewed, resulting in 326 single-spaced pages of text. The unit of analysis was a particular actor network—for this paper, 20 out of 40 total visualizations and their accompanying qualitative content. Initially, each author read the transcripts individually and took notes on emerging themes. In parallel, each author analyzed the collected visualizations taking a visual perspective – focusing on emerging network structures. In the first joint session, the authors shared their understanding of the reoccurring network types, which resulted in a list of three distinct network configurations (i.e., network archetypes). In a subsequent series of group analysis sessions (see Figure 3.3), three authors first individually coded each of the 20 visualizations and then examined the agreement among them. We opted for involving at least three researchers from the author team to minimize individual author's biases and to test whether different researchers would detect the same network types from the visuals (Sandelowski, 1993).

Figure 3.3 – Data analysis session

The collected narratives were coded in parallel with the analysis of accompanying visualizations. First, the lead author applied line-by-line coding (Charmaz, 2014) to later develop a more focused coding scheme. In another group analysis session, two other researchers from the author team coded the raw data based on the established coding scheme, which led to the emergence of three overarching themes of values. The frequency analysis of emphasized

values per network types (the number of quotations and sources; Wunderlich et al., 2013) compared to the total number of quotations per a particular category (i.e., value type) reveals the existence of a dominant value for each of the three network archetypes.

RESULTS

In this section, we start by presenting how, by leveraging the employed participatory approach, we discovered different network types that emerged from the visualizations created by the users themselves. Next, we explain the different network configurations according to the expressed value priorities. Finally, we develop a framework that combines network topology with value priorities in an elderly care context.

Network archetypes

In ensuring the active involvement of users in the fuzzy front end of design research, we acknowledge that value is phenomenological and experiential in nature. Leveraging this approach, we uncover layers of complexity through an emerging network topology. Table 3.5 outlines three network types: bundled, focalized, and hierarchical, as well as a hybrid network configuration.

Table 3.5 – Network topology

Network Type	Visualization	Archetype Diagram
Bundled network
Focalized network

<p>Hierarchical network</p>
<p>Hybrid network</p>

Bundled networks

A bundled network centres on the collective of actors in a network. Visually, it locates all the network actors in the middle and shows their connections, representing the different streams of value co-creation on the outside (see Figure 3.4). The elderly person, as a pivotal actor, is either placed first from the left or in the middle of the row. The bundled network type appeared two times in a pure form and six times as a hybrid within our sample.

Figure 3.4 – Bundled networks: pure and hybrid

Focalized networks

In a focalized network, the focal actor is placed in the very centre, connected through value streams with surrounding network members (Figure 3.5).

Connections (i.e., lines) differ in length, however, solely from the visualizations, it is difficult to make claims regarding the meaning of their length. Narratives offer more insights on this matter, with the line length signalling one or more of the following: i) frequency of contact (e.g., shorter lines suggest more frequent contact, while longer lines less frequent contact); ii) physical proximity (e.g., shorter lines present geographically closer actors); and iii) emotional versus functional relevance (e.g., shorter lines connect the elderly person with their emotionally-relevant connections including close family members, while longer lines connect functionally-relevant support including formal caregivers). This focalized network type appeared four times in a pure form and four times as a hybrid version within our sample.

Figure 3.5 – Focalized networks: pure and hybrid

Hierarchical networks

In hierarchical networks, the focal actor is at the top. Participants put themselves at the top, connected to other actors in a hierarchical order (Figure 3.6). Again, inferences about connections can be made from the narratives: i) shorter lines (direct contact; frequent interactions; physical proximity; functional-dependability; emotional relevance; informal ties), and ii) longer lines and indirect lines (indirect contact; infrequent interactions; formal ties; support of less functional/social/emotional intensity). The hierarchical network type appeared five times in a pure format and eight times as a hybrid in our sample.

Figure 3.6 – Hierarchical networks: pure and hybrid

Hybrid networks

Finally, hybrid network configurations can be described by at least two of the network archetypes. In total, we identified nine such occurrences: A focalized/hierarchical network occurs three times, bundled/hierarchical occurs five times, and bundled/focalized occurs once. Figure 3.7 depicts the distribution of collected visualizations among the three network types.

Figure 3.7 – Network visualization clustering

Dominant values

With a further analysis, we also aimed to determine whether the different types of networks constitute just different ways of depicting the same thing, that there is a neutral actor network behind the visuals, or if more complexity might be hidden within these visualizations. To answer this question, we focused on the narratives shared by our informants, which revealed interesting value- and

context-related findings unique to each network archetype. The specifics of these narratives transform the synchronic scenes into diachronic ones, by adding more layers of contextual understanding. We started by analysing the codified values that resulted from our group analysis sessions. We used the definition of value rooted in the service-dominant logic, which identifies an "improvement in systems well-being" (Vargo et al., 2008, p. 149). All units of meaning related to the improvement in elderly persons' well-being were codified and subsequently clustered.

The identified values that elderly persons realize through their network membership ranged from emotional (e.g., love, sense of belonging) to social (e.g., entertainment; being connected) to functional (e.g., practical help, feeling of safety, sense of retained order). We tested whether elderly persons' ways of representing their networks were instrumental to the values that they sought to seize from their care-based actor networks. All three clusters of values (i.e., emotional, social, and functional) were generally present in all collected narratives, yet our analysis revealed dominant value (i.e., salient value) representative of each of the network archetypes too.

Bundled networks: Emotional values

In the data, we find eight bundled actor networks, in which the informants placed all their actor cards in the middle, then drew connections to the outside. Emotional values represent a metacategory (96 quotations from 20 sources) of emotional needs including "love", "attention", "companionship", "sense of belonging", and "family". After analysing 326 pages of qualitative data, we find 59 percent of emotional values belonging to bundled network narratives (57 quotations from eight sources). In analysing what informants said while drawing these bundled network, we determined that they invariably emphasised the importance of their families and the need to treasure such relationships:

My family is very important to me. I believe the family is a pillar, a backbone. Yes, one can have many friends, neighbours, relatives, but family is a constant, something that needs to be cherished; I have a family and I am happy to have it. I love my family. (Mrs. Cross)

By choosing to show their network as a bundled network, these informants convey the importance of their family, through their placement of the cards. Keeping family close together is one of their main goals, which intensifies their sense of belongingness:

Our family is very close. We organize a family day each year. My mom is still alive, she's 95 years old. The children, grandchildren, and great-grandchildren come together at my mom's place each month. (Ms. Gray)

Other common values mentioned in relation to these networks included attention and company:

They [family and friends] offer me attention and companion. They are not taking care of me ... because I can still help myself. (Ms. Gray)

[Because of the family], I am not alone! (Mrs. Cross)

A sense of belonging, attention, and companionship thus is expressed through these informants' depiction of the actor network.

Focalized networks: Social values

We detected eight visualizations in which informants put themselves in the middle, such that relationships with the other network members stem from their central position. Social values illustrates a metacategory (104 quotations from 20 sources) which subsumes social needs including "being connected", "socialization", "entertainment", and "comfortable and exciting life". The emphasis on social values has been detected in 63 quotations from the eight focalized network sources, representing 61percent of the total social value metacategory. From the analysis of narratives we identified that informants who drew such focalized networks accentuate the importance of social contact:

... but know this; it's difficult to be alone. There is this saying "Not in the mountain, not at the sea, not in the church, it is never good to be alone." I wish I had someone to talk to at least. (Mr. Davis)

Every day I go to the day care centre where other retired people go to. Some of them I know, others I don't. There we talk all morning, drink some coffee.... (Mr. Jackson)

Other common values that emerged included entertainment and a comfortable, stimulated life:

[My friend] comes by every week to catch up and play a game of Rummikub with me. (Mrs. Sanders)

I play games on my iPad.... I've got e-mail on my computer. I can send messages or forward messages.... I'm able to send an e-mail by using the computer or a text message by using my phone. (Ms. Penny)

Maybe the greatest satisfaction comes from my computer and all the possibilities I'm using ... from communicating with people, doing bank transactions, I can do many things with the computer not having to physically go somewhere. I can take care of everything from my home. (Mr. Cox)

These values thus were more strongly emphasised by informants who depicted the focalized network than the value priorities stressed by informants relying on bundled or hierarchical networks.

Hierarchical networks: Functional values

What we define as hierarchical networks appeared 13 times in the sample. Functional values presents a metacategory (165 quotations from 20 sources) comprising functional needs such as "practical help", "problem-solving", "organization", "power", and "security/safety". Functional values emerge as salient in narratives surrounding hierarchical networks (121 quotations from 13 sources, representing 73 percent of the total functional value metacategory). When informants placed the "me" card on top, with other network actors in hierarchical order underneath them, they communicate a specific organization of activities within their care-based actor networks and "care" primarily captures practical help:

Three of my sons take care of me. One takes care of my insurance and all the paperwork, one takes care of everything here in my room, and one takes care of the grocery shopping. (Mr. Wheeler)

My daughter does everything for me. She takes care of me, does the groceries. I'm not running short on anything. (Mr. Richards)

Furthermore, they emphasise a feeling of safety/security obtained from others in their networks:

When something happens, she [niece] is the one taking care. I know I can rely on her.... Yes, I feel safer because of her. (Ms. Ellis)

They [formal caregivers] help me take a shower. Luckily I still can do a lot of things myself.... When I need help, I just have to call and they will respond immediately. (Mr. Cooper)

Along with safety though, these informants stress the importance of retaining a feeling of independence, order, and power over their own lives:

... I want to be able to do by myself whatever I need to do for myself. It is important because I still feel strong, I mean ... how to say this ... that I have not yet stumbled. So this is important. Even if there is something that is difficult for me to do, I do it to prove myself that I still can. (Ms. Ellis)

My daughter often offers me to drive me around in case I need to go somewhere, but I don't want that. I want to be independent as long as I'm able to be on my own. (Ms. Gray)

Figure 3.8 depicts how the different network types relate to specific value priorities.

Figure 3.8 – Value priorities according to the network type

DISCUSSION

This research demonstrates how, by empowering people to map their network context freely and translate their mental models of service systems into visual artefacts, researchers can gather rich phenomenological conceptualizations—of care-based actor networks in this study, as well as of value co-creation. These findings have implications for service and design theory and practice.

Beneficiaries' Maps of Actor Networks

The participants in this study had the freedom to map their network contexts with the cards, without any predefined visual template for a structure to follow. They could have created highly similar visual networks, but instead, they chose to make maps in different ways, manifested in the visual renderings of these networks. The participants, however, were limited by the tool itself, the format of the cards and to drawing lines. The participants used these to project their conception of the networks that exposed a variation of networks through and despite the limitations of the mapping tools. The network maps are not theoretical constructs of an ideal network, nor a construct based on a single predefined network topology, nor a construct of aggregated networks, but instead are practice-based conceptualizations of specific networks that describe how each individual views their network.

If we regard network maps as articulations of mental models, Norman's (1988) dilemma is clearly at play. Three distinctly different types of actor networks arise, describing a particular standpoint of the beneficiary in the service system, in terms of how they structure and participate in resource integration (Gummeson and Mele, 2010). Only the focalized type features visual similarities with how most techniques and methods suggest actor network maps should be created. That is, the recommended techniques in the literature review uncover or structure either the mental models of service designers/developers or else mental models that do not fully represent the phenomenological perspective of the beneficiaries. If a service is designed and operationalized according to those models, prescribed by the service developer's practice, the system image will not align, or resonate, with the different ways beneficiaries understand how the service system works.

Moreover, because the suggested models from the literature review focus on an ego-centric type of mapping, they uncover a specific stance for human-centered design, namely, "putting the user in the centre" as a leading statement. Yet in this study, when users had the opportunity to show how they view actor networks, they did not always put themselves in the centre. We thus

need a different stance, to be able to build on people's resourcefulness and structure a design process that makes the perspective of the focal actor manifest (Holmlid, 2012b). That is, designers should not put the actor in the centre but rather must let the actor decide how to position him- or herself.

Despite these differences in the visual appearance of the networks, we also note similarities, which suggests possibilities for aggregating network descriptions in new ways, according to their visual appearance, or their archetype. Instead of only aggregating on the basis of the content of all the networks, which eradicates some uniqueness of the different types, aggregation might reflect the use of archetypes.

Maps and Dominant Values

The interviews reveal that the different network types are associated with different dominant values. Thus, the network types differ not only in how they look but also in what they are saying. Value statements potentially could have been added to the network mapping, to establish value co-creation maps, by adding text to the links between actors. However, three factors limit this possibility. First, the simplicity of the mapping with the cards would be hampered if we were to add another task to the mapping exercise. Second, the requirement to add words or information to the arrows would direct the type of representation format, toward ones that separate the cards at some distance from one another. This push would make it almost impossible for an informant to choose to create a network expressing visually the bundled network. Third, the interviews produced more than just single value statements that characterized relations and clusters of relations. Either all of these clusters would need to be mapped onto the arrows, which would require large amounts of space, or some of the rich knowledge would be lost, because the interview would flow away from arrows that already had been labelled, even if this drift would be non-deliberate.

Instead, using the interview data, we can rely on visualizations that communicate these value relations, in accordance with one of the common roles of visualizations in design (Segelström, 2013). We do not claim a general or direct correlation between network types and the dominant values. We instead argue that a thorough analysis of actor networks should be open to how beneficiaries view the network and enable those beneficiaries to articulate how the network works.

Design Tools for Mapping Networks

Tools used today to map networks, in service design, service management, and marketing, seem less well developed than the phenomena they try to capture. Several tools assume a single, best manner for mapping networks, with a template directing the mapping and the resulting map. We posit that there are two possible reasons for this gap. First, practitioners may believe that they are capturing the network with their restricted methods, such that they unintentionally ignore how these techniques limit the active participation of actors in describing the network. Second, practitioners know that understanding networks is a complicated task, beyond what a single mapping method can support, so they perceive no compelling need to develop such a method or technique, but rely on many different techniques. Design tools and methods that support many different ways to conceptualize networks thus might offer a promising way forward, to expand on both of these positions. With the assumption, as in the current study, that there are multiple ways to see networks in a service, new tools and methods likely are needed to clarify how different networks interact, how adaptation to the situatedness of the different networks takes place, and how certain actions work as bifurcation points, among other topics.

Introducing Service Resonance

Noting that there are different ways to understand the actor network, with their varying dominant values, service designers and developers must take pluralism into account. Several, non-exclusive approaches are possible and in common use today to handle such pluralism. One common strategy is individualization, where a core service offering is developed, and additional service offerings are added to cater to individual needs. Another common strategy is customization (Shostack, 1987), where a general service offering is developed and resources in the service system are developed to be customized. This could e.g. be a service where staff is handling different service situations, to handle such customization. These approaches seek to minimize variation through standardization (Shostack, 1987).

However, when the dominant values and ways of understanding the network differ radically, they uncover or expose variations in institutional norms and beliefs (Edvardsson et al., 2014), that goes beyond approaches focusing on the service offering.

In one sense, a service that 1) operates under differing dominant values and a variation of mental models, and 2) is well designed, one would expect to

resonate with these different values and models. Hence, as a strong concept (Höök and Löwgren, 2012) to describe this characteristic of a service, we here suggest service resonance. In a simplified conceptualization of service resonance, based on our study, we will focus on pluralistic mental models, though we claim that the concept also is relevant with pluralistic dominant values and pluralistic institutional norms. Service resonance describes a characteristic of a service that is generative and evaluative, as compared to more descriptive concepts such as institutional norms and beliefs

Service resonance refers to the relationship between the service and the different mental models (dominant values or institutional norms) for which it is intended. A service, in operation, can resonate well or poorly with any mental model for which it is intended. The strategies referred to above constitute approaches to handle resonance; some limit the offering to fewer mental models, while others put trust in staff to adapt to differences in the mental models of the beneficiaries. In this study, we have highlighted differences based on elderly people's mental models, but for any service, there are many actors whose mental models are significant, such as the patient, the informal and formal care-givers, etc. As a consequence, the different mental models of any person involved in co-creating the service influence that service (Holmlid, 2012a), as do all system images of artefacts or technology involved in it. Service resonance therefore entails relationships with all the mental models in play for a specific service.

Consider the simplified example based on the networks of the elderly persons in the study. The service resonance of the formal caregiver's service, if being regarded as the same service across all of the elderly people, relies on whether that service resonates with the three network archetypes (bundled, focalized, hierarchical). That is, a service that resonates well, is a service that resonates with elderly people relying heavily on family relations as well as elderly people having a functional view of actors in the network as well as elderly people leading an active social life. However, it is not a necessary condition that a specific service have to resonate with all three, it may be a strategic decision to develop several different services with a smaller scope that resonates only with one of the models. As a consequence of this, when developing new services, or new resources that changes how a service operates, one need to understand the different models with which the service need to resonate. For example, a service relying on letters and paper as a means of communicating with patients in a health-care system, resonates well with several of the archetypes, while a service relying on electronic communication with requirements of secure personal identification, resonates less well with archetypes where family is an integrated part of informal

care. That is, there is a design difference in allowing for family to open letters form a formal caregiver, and requiring an elderly person to share login and secure identity information with family.

CONCLUSION

We contribute to an expanded understanding of beneficiaries' perspective on how actor networks are configured, for the network to work as a co-creative base for the beneficiary. Our study shows that beneficiaries of a service have different models of the actor network that vary in their structure and dominant values. It is clearly wrong to assume that there is a single service network or service ecology for any service. We detected three kinds of networks: hierarchical, focalized, and bundled and three metacategories of dominant values: functional, social, and emotional respectively. While we do acknowledge that all types of values appear irrespective of the network type, we emphasize the dominance of one value for different types of networks. We corroborate our claims through both i) quotation frequencies and ii) the researcher's specific understanding of the research context. Furthermore, we argue that the insights regarding different dominant values affect designs of future robotic services and communications targeting the elderly care beneficiaries – which we capture in the service resonance concept.

We also show that by allowing informants to map their network conceptually in an interactive session, researchers and designers can access the different ways they view networks. Accordingly, using pre-structured mapping tools is likely to produce partially incorrect results. This caution is important for researchers trying to capture and structure a network on the basis of interview data. Researching service ecologies may require the participation of informants to conceptualize the ecology in the first place.

Moreover, we have described ways in which participants, or co-creators of value in a service, conceptualize the network of actors and resources that are necessary for their co-creation of value. We thereby highlight the importance of understanding service ecologies, actor networks, and so forth as social constructs, which may take many different forms, depending on the individual actor. A service that relies on an actor network for its "delivery" features complexity far beyond the actual nodes and connections of the network, spreading into the very way that a network's meaning and relevance is described, as well as how the network gets put to work by the different participants, through the roles assigned or taken by specific actors and agents in the network.

Finally, we suggest the strong concept of service resonance, as a relationship between the service and the different mental models (or institutional norms) for which it is intended, and the degree to which the service works well under the varying models.

Limitations and Future research

While our study introduces interesting and novel insights into how service beneficiaries make sense of their care-based actor networks, through both visual and verbal conceptualizations, it is important to acknowledge the boundaries of our study. First, although we conducted a considerable number of in-depth phenomenographic interviews, it is difficult to make claims about generalizability of our findings outside of the elderly care context. Future research should examine other service contexts - to explore how suitable our "Context Disruption" method is for understanding other types of actor and value networks. Second, while we acknowledge that including a quantitative validation for our dominant values claims is uncommon for qualitative research, we argue it substantiates our qualitative analysis, as well as the understanding about dominant values that the researcher who was embedded in the research context developed during the data collection. We suggest that future research should search for ways to empirically validate and enhance our dominant value claims.

Third, we acknowledge that our "Contextual Network Mapping Activity" still has properties of a template – with cards representing network actors and lines representing their value co-creating relations, we provide evidence that it gives informants a higher degree of visual freedom in representing their network conceptions than other reviewed mapping techniques. In other words, we do not provide our informants with a predefined network structure – forcing their network visualizations into one of our detected network types. However, we do recognize that a different shape of cards could yield different network types. Fourth, our mapping tool and accompanying instructions did not explicitly ask informants to indicate distances, make connections between alters, or show if connections are directed. As a result, we do not report established network analysis metrics (e.g., centrality, density, reciprocity). Finally, we emphasize that the collected data is cross-sectional and anticipative in nature, hence we open a promising area for other researchers to conduct longitudinal studies to examine how elderly persons' network conceptualizations change as they cohabit with socially assistive robots.

Our results suggest several possible questions and challenges for continued research. First, do similar multiple perspectives appear in other synchron service representations? If so, how? And in what way may user involvement in making

the representations uncover that? Second, is there a similar effect on diachron representations? Assuming that similar differences exist, are they central to how we need to understand diachron representations? Third, how can pertinent variations be manifested as a design concern? Fourth, would we gain an increased degree or quality of variation from involving more actors in the mapping? Finally, if we assume that there are many different networks, how does adaptation to the situatedness of the different networks take place, and how does certain action work as the collection point between networks?

Our finding that informants map different network types, with different dominant values, and that these differences do not seem superficial, suggests an important route for pursuing increased understanding of service and design for service.

CHAPTER 4

Service Robots: Value Co-Creation and Co-Destruction in Elderly Care Networks

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INTRODUCTION

The success of a new service depends on the value it creates for the user but also on the value it creates or destroys for the network in which that user is embedded. For example, smart alarm systems for consumers' homes might increase one family member's feelings of security, while other members find the false alarms and constant notifications stressful and feel more vulnerable when relying on such technology. In weighing the benefits and risks, each member of the network might support or impede an individual's acceptance of a service, particularly if it is co-created in a novel way. According to Skålén et al. (2015), a service innovation implies new value propositions that hold promises of value creation for a diverse set of actors. If service providers hope to encourage individuals to adopt an innovative, future service scenario, they must understand the value networks in which these individuals interact and the impact that a new service will have on the value created/destroyed therein. Such a holistic perspective can offer service managers insights into the disruptive nature of a new service and its effect on value co-creation and co-destruction throughout the value network.

Healthcare offers an ideal setting in which to investigate value co-creation/destruction in networks, because it comprises complex webs of interactions among multiple actors, technology, and ambiguous institutional rules and norms (Black and Gallan, 2015; McColl-Kennedy et al., 2012, 2016). Many new services in healthcare, especially technology-intensive ones (e.g., healthcare robots, tele-health), confront resistance (Broadbent et al., 2009; Green et al., 2016). In this setting, an especially critical segment to study is the growing elderly population, with its strong network characteristics and generally lower receptiveness to new technologies (Smith, 2015). This population is expected to increase by a staggering 18%–28% by 2060 (European Commission, 2015), putting great stress on national systems and compelling innovative solutions to ensure the well-being of the elderly while also enabling formal (i.e., professional care staff) and informal (i.e., family and friends) actors to perform service functions. For example, the well-being of the elderly and their network of caregivers may be improved by socially assistive robots, which may enhance seniors' quality of life and alleviate their sense of solitude and isolation (Augusto et al., 2012). Socially assistive robots can understand social cues through facial and voice recognition technology, interact with users in human-like manners, and assist with health monitoring and household activities (KPMG, 2016; Robinson et al., 2014). However, elderly people and their value networks of formal and informal caregivers have exhibited some reluctance to accept robotic services

(Broadbent et al., 2009; IFR, 2015); this reluctance is a key challenge for service innovators in this and other fields where technology enables value networks.

Existing robotics literature explores both desirable and undesirable effects of introducing socially assistive robots in elderly care (e.g., Ray et al., 2008; Robinson et al., 2014); yet it mainly addresses positive roles of the robot to the neglect of unwanted roles elderly people attach to the robot. In contrast, current service research does consider a service innovation as a positive or negative change in value for different network actors (Plé and Chumpitaz Cáceres, 2010; Skålen et al., 2015; Snyder et al., 2016). However, no empirical studies take both value co-creating and co-destroying potential of a future robotic service into account. Especially for services which involve both human and non-human actors (Breidbach and Maglio, 2016; Lusch and Nambisan, 2015), researchers need to look for novel ways to evaluate expected value transformations for different individuals within value networks. This implies advancing existing research methods to better capture the network element.

To address these gaps, the current study provides three main contributions. First, it introduces socially assistive robots as actors in value networks and identifies their value propositions through acting in human-like manners. An underlying assumption is that “value is always uniquely and phenomenologically determined by the beneficiary” (Vargo and Lusch, 2016, p. 18). Accordingly, the central research question asks, “How do focal actors (e.g., elderly people) perceive the roles of socially assistive robots in their care-based value networks, in terms of the expected value co-creation/destruction potential with themselves and other network actors?” Specifically, this study demonstrates that human-like robots that are capable of engaging with users on a social level, through facial and voice recognition technology (i.e., high automated social presence; van Doorn et al., 2016), offer both value co-creating and co-destroying potential. This ambidexterity provides a more balanced view of socially assistive robots and advances research on the complementary or substitutive nature of technology in service networks.

Second, the study advances scholarly understanding of value creation practices by taking a network-conscious approach that covers both the value co-creating and co-destroying potential. Such an approach aligns with recent trends in service research, to shift the innovation foci from an individual actor toward relationships in value networks – for this study defined as service beneficiaries' conceptualizations of actor constellations and their value co-creating/destroying dynamics for a particular service. The resulting typology extends existing role conceptualizations (e.g., McColl-Kennedy et al., 2012;

Moeller et al., 2013), to encompass not only value co-creation and co-destruction counterparts, but also to address network-conscious elements. This study takes the focal actor's perspective, which acknowledges other pivotal actors and value creation constellations. The novel focus on future, rather than current, value co-creation and co-destruction can stimulate service innovation in complex service systems, such as healthcare (Danaher and Gallan, 2016).

Third, the network-conscious approach to technology-enabled services advances insights on how to design complex service systems (Chandler and Lusch, 2015). To address the need for more suitable methods to understand value co-creation/destruction in value constellations, this study introduces a "Context Disruption" interview method—a generative technique that uses vivid representations of future service scenarios to collect data-rich narratives. This phenomenographic approach (Sandberg, 2000) integrates in-depth exploratory interviews (i.e., Context Disruption Interviews) with generative cards activities (i.e., Contextual Value Network Mapping) to elicit elderly informants' tacit knowledge and probe anticipated effects of a future service (co-created with an automated actor) on existing value co-creation practices, in relation to the elderly self and other network actors. This methodological contribution can help service researchers address a key service research priority, that is, designing adaptive service systems to respond to dynamic environments (Ostrom et al., 2015).

THEORETICAL BACKGROUND

Value co-creation/destruction in networks

Service systems can be defined as "configurations of people, technologies, and other resources that interact with other service systems to create mutual value" (Maglio et al., 2009, p. 395). Contemporary service systems are increasingly complex, not least due to disruptive, rapidly evolving information technologies (e.g., robotics, big data, social networking; Ostrom et al., 2015; Rust and Huang, 2014). To improve acceptance of technology-enabled service innovations, service providers need to translate their technical aspects into value for different individuals involved. In line with Skålén et al. (2015) who equate service innovation with "the creation of new value propositions" for involved actors (p. 137), it also entails shifting the focus from new features of an offering to formulating compelling value propositions and inviting network actors to collaboratively create value. Service literature views value as being created when engaging in the service leaves actors better off or increases their well-being relative to their initial conditions (Grönroos, 2008; Prahalad and

Ramaswamy, 2004). Yet service interactions can also result in diminished or destroyed well-being for at least some actors in the value network (Echeverri and Skålén, 2011; Plé and Chumpitaz Cáceres, 2010).

Zooming in on a service system uncovers the multiple value networks that constitute it and whose actors can be affected by a novel service, including service delivery (Tax et al., 2013) and customer (Epp and Price, 2011; Schau et al., 2009) networks. Using Normann and Ramírez's (1993) notion of value networks as a mental construct and adopting the view that service beneficiaries ultimately assess which actors take part in value co-creation, this study defines value networks as service beneficiaries' conceptualizations of actor constellations and their value co-creating/destroying dynamics for a particular service. Therefore, future services should be evaluated through the trade-off of value co-creation and value co-destruction potential for different actors in the value network. Although several authors explore value co-creation within networks of multiple actors (Cova and Salle, 2008; Pinho et al., 2014), empirical research on value co-creation in network contexts is largely lacking. Especially in the healthcare environment with changes due to digitization, automation, and human-to-non human interactions (Breibach and Maglio, 2016; Danaher and Gallan, 2016) it is necessary to rethink value. More in particular, how new technology-enabled service interactions among multiple actors result in strengthened or weakened well-being of the individuals involved.

Following the definition of value networks, the knowledge of network actors serves as an important asset for improved design of service systems. When designing service systems, researchers often utilize system (e.g., service blueprints, system maps; Patrício et al., 2011) and network (e.g., service delivery network; Tax et al., 2013) visualizations. While customer-centric, these mapping approaches are not without shortcomings. First, they often rely on the service provider's perspective, hence excluding service beneficiaries themselves from the mapping process. Second, they focus on the structure (i.e., number and configuration of actors; Briscoe et al., 2012) and flows of goods, information, or money, rather than value co-creation. Such research approaches cannot capture service beneficiaries' understanding of value co-creating networks or the importance of different actors for the realization of value.

Socially assistive robots in elderly care

The study context centers on service robots, in particular socially assistive robots in elderly care. Understanding their role in elderly care demands a close consideration of the origins of this technology. Robotic developments traditionally were motivated by aspirations to automate repetitive, tedious,

complex, or time-consuming tasks (Matarić, 2017). In healthcare, the first generation of robots primarily assisted with tasks that were difficult for either the patient or healthcare professionals (Broadbent et al., 2009). The value proposition for these assistive robots emphasized functional assistance to humans, through physical interaction (Feil-Seifer and Matarić, 2005), such as robotic exoskeletons that augmented humans' physical capacity in areas they suffered weaknesses (Perry et al., 2007). Accordingly, these early assistive robots took functional roles, like assistants, helpers, servants, and butlers (Dautenhahn et al., 2005; Fong et al., 2003). Parallel to their development, a new generation of robots appeared, with a primary value proposition of engaging in social interactions. These socially interactive robots (Fong et al., 2003) are autonomous and can interact with people in a human-like way (Breazeal, 2004). For example, the socially interactive robot Jibo looks, listens, learns, and reacts with expressive movements and responses (van Camp, 2017). Such robots perform affect-based roles, as conversation partners or socially interactive peers (Fong et al., 2003).

Along with technological developments, robots' social dexterity improved, creating new avenues for providing social support. Accordingly, the latest generation of robots combines assistive and socially interactive functions. These socially assistive robots offer assistance through social interactions in a human-like manner as their main value proposition (Feil-Seifer and Matarić, 2005). In a healthcare context, socially assistive robots are autonomous, understand social cues through facial and voice recognition, and can provide both child (e.g., autism therapy; Huijnen et al., 2016; Scassellati et al., 2012) and elderly (e.g., medication reminders, Broekens et al., 2009) care. As they perform more socially engaging tasks (e.g., health promotion, consoling), these robots take roles of companions, collaborators, partners, pets, or friends (Dautenhahn et al., 2005; Fong et al., 2003). Figure 4.1 summarizes these three types of robots.

Assistive value co-creation/destruction potential	YES	Assistive robots Robots that provide assistance through physical interaction (e.g., exoskeletons, rehabilitation, wheelchair robots) Roles: assistants, helpers, servants (e.g., Chen et al., 2013; Perry et al., 2007; Roco and Bainbridge, 2003)	Socially assistive robots Robots that provide assistance through social interaction (e.g., robots that monitor health, provide social companionship, etc.) Roles: companions, collaborators, partners, friends (e.g., Feil-Seifer and Mataric, 2005; Mataric, 2017; <i>this study</i>)
	NO	N/A	Socially interactive robots Robots that provide social interactions in a human-like manner (e.g., speak, gesticulate, gaze, show emotions) Roles: conversational partners or socially interactive peers (e.g., Breazeal et al., 2016; Fong et al., 2003)
		NO	YES
		Social value co-creation/destruction potential	

Figure 4.1 – Robot types

Value propositions of socially assistive robots

In an elderly care context, the value proposition of socially assistive robots relates to their offer of both assistive and social value co-creation potential, through services such as health monitoring and safety, encouragement to engage in rehabilitation or general health-promoting exercises, social mediation, interactions, and companionship (Feil-Seifer et al., 2007). Several studies note the variety of benefits of socially assistive robots in elderly care, including reduced stress and loneliness, prolonged independence, maintained dignity, and improved well-being and quality of life (Broekens et al., 2009; Feil-Seifer et al., 2007; Ray et al., 2008; Robinson et al., 2014). Yet as is true of many service innovations, introducing socially assistive robots in elderly care also can lead to undesirable consequences, such as a loss of privacy, stigma of disability, fear of even greater dependence, or reduced human contact (Broadbent et al., 2009; Ray et al., 2008). These potentially negative effects might hinder acceptance among or motivation by elderly users to interact with socially assistive robots. But interaction with the robot is the only way for people to perceive it as user-friendly

or come to feel physically, emotionally, and cognitively comfortable in its presence (Broadbent et al., 2009).

An additional layer of complexity marks the introduction of socially assistive robots in elderly care settings, because this context also involves a network of formal and informal caregivers. Their opinions and cooperation can be crucial for the effective operation of an automated actor. Therefore, the robot also must be responsive to the needs and requirements of various network actors (Feil-Seifer and Matarić, 2005), a challenge that has been largely neglected in existing research. In particular, the potential negative consequences of these service innovations, or value co-destruction, remain unexplored. To advance understanding of the role of socially assistive robots in elderly care, this study therefore considers both the value co-creation and the value destruction potential of robots, according to the perspective of the focal network actor (i.e., elderly person) in a network context.

METHODOLOGY

To capture the value of a novel service within the value network, emphasizing the beneficiary's experienced and expected value-in-use/context, a phenomenographic approach is appropriate (Sandberg, 2000). Such an approach is in line with the premise that value is always phenomenologically defined by the beneficiary (Vargo and Lusch, 2016). This methodology collects first-person descriptions of focal actors' context-dependent experiences (Schembri and Sandberg, 2002) and expectations of a service innovation. For this study, in-depth exploratory interviews were augmented with generative cards activities (Sanders, 2000), referred to as a Context Disruption Interview Protocol (see Appendix A), designed to uncover what informants find valuable within their personal contexts. The choice of a qualitative interpretative approach reflects the research goal of building, rather than testing, theory (Lincoln and Guba, 1985).

Traditional qualitative techniques (e.g., interviews, focus groups) gather explicit knowledge (i.e., what informants verbally articulate), which limits understanding of contextual complexity (Sleeswijk Visser, 2009). Instead, for this study, the informants were actively engaged through generative elements (e.g., by asking them to visualize their network contexts). The semi-structured nature of the interview protocol helped capture rich descriptions of the focal actors' network experiences and evaluations of novel value propositions (i.e., narratives). Simultaneously, the generative card mechanisms (Sanders, 2000) elicited their tacit knowledge (Polanyi, 1967), through network visualizations. Thus, informants' tacit knowledge could be represented by tangible artifacts that, combined with

data-rich narratives, represent elderly people's perceptions and expectations of robotic technology infusion into their value networks.

Research protocol: Context Disruption

After the initial recruitment of elderly persons, only those who expressed interest in participating in a broader study of the use of robots were invited to subsequent, individual interview sessions. In line with the request of the Ethical Review Committee, which approved the proposed research protocol, all informants signed an informed consent form before answering an initial set of demographic questions. After the collection of this general background information, informants entered a four-step, generative, Context Disruption interview protocol (see Table 4.1 and Appendix A). Considering the novelty of this method, the next sections detail the reasoning behind and objectives for engaging informants in each step.

Table 4.1 – Context Disruption Interview Protocol

Step	Name	Description
1.	Contextual Value Network Mapping, Status Quo	Map the care-based value network before the introduction of the socially assistive robot
2.	Active Immersion	Sensitize respondents to a variety of new technology usages
3.	Introducing “Disruption”	Introduce, assess, and prioritize socially assistive robot functions
4.	Contextual Value Network Mapping, Future Condition	Map the care-based value network after the introduction of the socially assistive robot

Step 1. Contextual value network mapping, status quo. In the first step, informants had to think about their everyday life experiences and different people who take part in what was defined as their care-based value network (i.e., informal and formal connections who are more or less actively involved in taking care of them, helping them with groceries, medicine intake, finances, moral support). Furthermore, they engaged in Contextual Value Network Mapping using a set of specifically designed cards. The mapping activity consisted of three steps: selecting appropriate network actors from a deck of network actor cards, rearranging the selected cards into a conceptualized network configuration, and adding the relations (i.e., pathways of value co-creation) among the different actors.

The use of cards for the data collection elicits lively accounts of experiences and helps make the informants' networks tangible (Clatworthy, 2011). Both images

and text were placed on the cards to ensure unambiguous understanding of their content (Figure 4.2). Thus this activity could collect both “what they say” (i.e., narratives built around the visualizations, in response to probing questions) and “what they make” (i.e., care-based value network visualizations; Sanders, 2000). The result was a comprehensive, holistic view of the key actors in their networks, their roles in value co-creation, the elderly people’s evaluations of the novel value proposition (i.e., service innovation), and their perceptions of how other network actors evaluate it. Informants’ experiences and evaluations were not presumed to be understood but rather were encouraged to be expressed through “what” and “how” questions (Sandberg, 2000). The collected insights from this first step detailed informants’ existing care-based value networks, or the status quo, before the network relations and structures became disrupted by a socially assistive robot.

Note: Blank cards provided informants the opportunity to add new actors to the set.

Figure 4.2 – Network actor cards

Step 2. Active immersion. In the second step, informants were sensitized (Sleeswijk Visser, 2009) to the topic of new technology usage and encouraged to share narratives about satisfying and dissatisfying encounters with a variety of technology. The objective of this step was to set the stage for the introduction of the socially assistive robots, which are unfamiliar technological tools that may affect informants’ care-based value networks. The questions were designed to

elicit the informants' new technology readiness and identify reasons for their acceptance or rejection of previous waves of technological advancements (e.g., PCs, smartphones, tablets).

Step 3. Introducing “disruption.” In the third step, informants became acquainted with a socially assistive robot project; they were part of the pretrial phase of this broader project. The robot's look and feel was evoked through photographs and robot functions cards (Figure 4.3 and Appendix A). Each of its 12 functions was explained using a simple description and vivid example. Informants were encouraged to share their opinions after each introduced function. Then they indicated the three functions they deemed most important/useful and least important/useful. This step thereby collected their genuine needs and enabled the interviewer to delve deeper into the desired value outcomes among the elderly informants.

Figure 4.3 – Tangible tools

Also in this step, informants indicated their overall impression of the robot and whether they would welcome such an innovation in their lives. To collect their different perceptions of robotic care and predictions about transformations in

their network relations, the interviewer used probing questions to covertly elicit both the value-creating and value-destroying potential of the robot.

Step 4. Contextual value network mapping, future condition. In the fourth and final step, informants again were invited to engage in Contextual Value Network Mapping, with an additional robot card added to the deck of network actors. They were encouraged to imagine a hypothetical situation in which the socially assistive robot becomes a part of their care-based value networks (i.e., starts residing in their homes and supports their daily activities). The objective was to determine whether and how their conceptualization and visualization of their care-based value networks would change, relative to the first step of the study (see Figure 4.4 and Appendix A).

Notes: Elderly informants denoted by a red circle/solid line; robot by a blue circle/dashed line.

Figure 4.4 – Examples of value network visualizations from the elderly persons' perspectives

In particular, informants indicated who, from their respective networks, would be granted access to the information stored in the robot, whether there would be different layers of the information access, and if so, why. Furthermore, they indicated which network actors would be first alerted in case of an emergency. More focused probing questions revealed the position of the robot in the care-based value network, its proximity to the focal actor, and its underlying role.

Sample

The sample included 20 elderly persons, 10 female and 10 male, with only minimal age-related health conditions (see Appendix B). Elderly persons suffering from severe physical (e.g., full physical immobility) or mental (e.g., dementia) health problems were excluded from consideration, as well those with no autonomy in their daily activities or who were incapable of giving consent. The target population comprised elderly persons living alone at home (i.e., independent living), in a nursing home, or at home with the assistance of formal or informal caregivers. The interviews were conducted in person, in informants' homes or nursing homes, and lasted 40 to 90 minutes with an average length of 70 minutes. Four data collection waves over the course of 10 months continued until theoretical saturation was reached. All collected interviews were digitally audio-recorded, and any visualizations created were photographed.

Data analysis

To gain a comprehensive understanding of the anticipated value co-creating/destroying roles that socially assistive robots play in elderly persons' care-based value networks, the authors undertook an iterative process with simultaneous data collection and analysis. After each data collection wave, the interviews were transcribed, translated, and reviewed, resulting in 326 single-spaced pages of text. Themes emerging from the analysis were further examined in subsequent interviews, in an attempt to reach closure (Lincoln and Guba, 1985). First, the authors read the transcripts independently to form their own understanding of each informant's narratives (Riessman, 1993) and applied segment-to-segment coding to depict robots' roles in the network. Second, the authors met for a joint analysis session to share emerging, initial codes and develop a more focused coding scheme for the subsequent analysis (Charmaz, 2014). Third, the first two steps were repeated for each data collection wave, ultimately producing jointly defined robot role categories.

The units of analysis were the individual abstractions of current and future care-based value networks, with a particular focus on the role of the socially assistive robot among the constellation of actors. In this phenomenographic approach (Schembri and Sandberg, 2002), codes and the thematic descriptions emerged from the data, rather than relying on the existing classifications (e.g., Robinson et al., 2014; Roy et al., 2000). This approach is not completely free of previous knowledge or experiences; rather, it allows for the emergence of new theory from the angle of value co-creation and co-destruction. As the data analysis evolved, additional literature provided meaningful comparisons with the

identified roles of the socially assistive robot to achieve the desired value outcomes.

RESULTS

Guided by the codes emerging from the verbal data and supported by collected visual artifacts, the authors derived a typology (Doty and Glick, 1994) that reflects the focal actors' conceptualizations of the robots' expected roles in the value networks. As indicated in Table 4.2, the top row reveals three desired value outcomes that elderly people strive for and hope to realize within their value networks: 1. physical health, 2. psychosocial health, and 3. cognitive health. To achieve these desired value outcomes, the elderly informants cluster the services that the socially assistive robot can offer into three, respective supporting functions: 1.1 safeguarding, 2.1 social contact, and 3.1 cognitive support. Furthermore, from these elderly informants' perspectives, each supporting function provided by the socially assistive robot has two counterparts or anticipated roles: one with high value co-creation potential and one with high value co-destruction potential.

The Context Disruption interviews and Contextual Value Network Mapping technique also aimed to collect in-depth insights on disruptive effects of a service innovation. The uniqueness of these methods stems from their focus on the value-creating practices of focal network actors (elderly) and concomitant acknowledgment of the effects on other, interdependent network actors (formal and informal caregivers). This network-conscious approach induces network thinking among informants, because the use of the tangible artifacts makes the elderly informants aware of the other actors in the network. Through the generative activity, by which they mapped their network context, informants shared narratives, including idiosyncratic views of how socially assistive robots affect other network actors (e.g., family members, nurses), positively or negatively. The findings pertaining to the other network actors support an emergent typology of roles, as empirically illustrated in Table 4.2 and described subsequently. They reflect elderly people's perspectives on how robots' supporting functions (safeguarding, social contact, and cognitive support) can be beneficial (value co-creating potential) or detrimental (value co-destroying potential) for formal and informal caregivers in their network.

Table 4.2 – Typology of roles

Elderly Person's Perspective						
Desired value outcome	1. Physical Health		2. Psychosocial Health		3. Cognitive Health	
Robot's supporting functions	1.1 Safeguarding		2.1 Social Contact		3.1 Cognitive Support	
Robot's role based on value co-creation (+) / co-destruction (-) potential with respect to self and other network actors	+	-	+	-	+	-
	1.1.1 Enabler	1.1.2 Intruder	2.1.1 Ally	2.1.2 Replacement	3.1.1 Extended Self	3.1.2 Deactivator
	<p><i>It's another rescue. In case you need a help... It means having help me with the problems that I might have at that time... I would feel more rested, less stressed... If I for example fail, I'm interested that the robot is there! (Mr. Jackson)</i></p>	<p><i>That [monitoring] is an issue for me. It's a violation of privacy... At first it would be a little awkward for me. I would have the feeling that it's watching me all the time. (Mrs. Sanders)</i></p>	<p><i>The robot should be beside me [in the visualization]. Yes, with me, so that it can call my family members if I couldn't do it... how to say... If I would be unable, to keep us connected. (Mrs. Bell)</i></p>	<p><i>People really know me, the robot doesn't know me... understand me. Yes... the care staffs over here know me and know what I want and need. They have emotions. (Mr. Richards)</i></p>	<p><i>I mean, while I'm conscious, I know I need to clean, vacuum, eat... but if I lose control, the robot knows what to do. (Mrs. Newman)</i></p>	<p><i>I want to do it myself... I know it exactly when I need to take them [medications]. I want to keep practicing my brain. I'm telling you, for now I don't need the robot. (Ms. Ellis)</i></p>
Quotes focused on the self	<p><i>... they would have some kind of security, they would have information, and they would have it 24/7 ... without having to reach out to me ... so to them, it would be a great relief. (Mr. Cox)</i></p>	<p><i>If it is something I need to hide from them [her children], then I would make sure to hide it from the robot as well... I mean if I don't want to share it with them. But they don't want to track my every move either, right? (Mrs. Cross)</i></p>	<p><i>I would rather be a burden to a robot Because I think it would be much easier with it. Because with the robot, I don't think about burdening it as I do with my family. If I ask my son for help, I would feel bad, because he might be having a hard time helping me, and it might happen that he doesn't have time or money so he suffers. (Mr. Evans)</i></p>	<p><i>Lately someone told me that I shouldn't participate in these robot projects, because it replaces a lot of the health care staff. (Ms. Penny)</i></p>	<p><i>Value co-creating potential is primarily for the focal actor.</i></p>	<p><i>Value co-destroying potential is primarily for the focal actor.</i></p>
Network-conscious quotes						

1. Physical health

Falls among the elderly are an alarming problem, often causing hospitalization and reduced physical autonomy due to severe injuries (WHO, 2008). Accordingly, the first desired value outcome that elderly people identified in this study is to maintain good physical health and delay physical decline. From the narratives shared by the elderly informants, it is evident that older people face some inevitable physical difficulties, particularly associated with mobility, such that many informants shared stories of falling and the serious injuries that resulted. For example, one informant explained,

Recently, I fell in my room and I couldn't move. I had wounds all over my elbows and legs from how much I fought [to get help]. I barely managed to reach my bed. And I don't know how much time it took me to get to my senses.... And the feeling is awful! You are on the floor and cannot help yourself. (Mr. Davis)

In situations such as this, elderly people depend on a prompt reaction from their formal or informal caregivers, who can ensure adequate medical attention and care. In addition, an imperative of elderly care is to find ways to circumvent falls, by encouraging physical activity or preventing potential safety risks. Unfortunately though, even with proper attention, caregiving services often are not available 24/7, so accidents take place.

1.1 Safeguarding

As a response to the raised issues, one of the emergent supporting functions of socially assistive robots is safeguarding elderly people. It combines systematic and continuous monitoring, such that the robot can call for help immediately in the case of an emergency, and offer spatial guidance by warning people of potential obstacles and raising alarms when they are susceptible to environmental threats. This function is primarily dedicated to protecting elderly people's physical health, which is a repeatedly emphasized and desired value outcome of interactions with socially assistive robots:

I could live a more quality life because I could rely on [the robot] that in case I need help, it will notify whoever is needed. That is a feeling of security that we lose with the old age. And physical safety brings us back the relaxation and then we can enjoy more in the few years of life we are left with. (Mrs. Moore)

Although the socially assistive robot's safeguarding function thus can be conducive to attaining the desired value outcome of physical health, it also

might destroy existing value (e.g., privacy) from the perspective of the focal actors, which could explain their reluctance to accept robotic innovations. Through a value co-creation/destruction lens, the robot embodies roles of being either an enabler or an intruder.

1.1.1 Enabler role

As an enabler, the robot is perceived to have a considerable value co-creation potential, because it empowers the focal actor and other network actors. Visions of the robot as an enabler in the care-based value network primarily result from its task of detecting falls or other accidents, then alerting predefined (in)formal caregivers. Thus, the robot is a lifeline to a quick medical assistance. Many informants note the importance of systematic monitoring to ensure prompt reactions by medical staff:

That's the most important to me. That I can receive instant help. If needed, to directly transfer me to the hospital. (Mr. Richards)

The robot co-creates value through health monitoring, its constant presence, security guarantee, and alert system; the elderly persons co-create it through their trust, cooperation, and acceptance. The informants in turn identify benefits including feelings of safety and secure rescue options:

I am afraid I will fall again in the future! [Having a robot] would give me a relief. It just gives a comfortable feeling.... Quick reaction is essential in case of an emergency. (Ms. Gray)

The network-conscious approach also reveals elderly people's opinions about how the safeguarding function might contribute to value co-creation with other network actors. The informants frequently assigned benefits to their informal caregivers, who would gain the positive outcomes of time savings, peace of mind, and alleviated stress. As described by one of the informants,

They [her family members] are in contact with it and they know what's happening to me. They can go to work and do not have to worry. Because while they are at work, they don't have to think whether something has happened to me, because they know they would be notified. That is some kind of security for them. (Mrs. Bell)

1.1.2 Intruder role

However, not all informants share these views, such that they may be reluctant to welcome the automated actor into their homes. As an intruder, the robot is

perceived to have considerable value co-destruction potential, because it interferes with the space possessed by the focal actor and other network actors. In this case, elderly people express unwillingness to cooperate with the robot, and they denote the robot's invasiveness primarily through the prism of continuous monitoring. Expressions like *"It's like having a Big Brother in my apartment"* (Mrs. Cross) or *"It will be watching me all the time and I don't like that"* (Mr. King) signal feelings of an intrusion of privacy evoked by the robot. The trade-offs associated with the intruder role are dominated by its value co-destroying potential, as shown by the following quote:

The robot could be useful because it could help ... but to rely on the robot only.... I wouldn't want that.... I wouldn't feel comfortable with it. No one likes to be monitored at all times.... I don't rely on technology, I rely on people.... The robot can be helpful but it cannot really help! (Mrs. Moore)

These feelings of privacy violation are accompanied by decreased trust and increased uneasiness, discomfort, and irritation, which ultimately produce strong aversive feelings toward the robot. Safeguarding thus could become a hindrance to the realization of physical health value outcomes, as the following quotes indicate:

I see that robot and I wonder what is it here for? What's its use? It would just be standing in a corner I think. (Mr. Cooper)

In the network-conscious approach evoked by this study, the elderly informants also describe the robot's potential to co-destroy value relative to other network actors, such as their family members, formal caregivers, or peers. For example, one informant, noting his informal connections, anticipated:

I think my granddaughter will find it a bit scary.... And I also hear from a lot of people here [other residents] that they don't want it in their room, because it sees everything. Me myself, I wouldn't mind. (Mr. Butler)

2. Psychosocial health

Ageing is linked to not just physical decline but also social deprivation in many cases (Banks et al., 2008). People who reach old age lose some of their social contacts (due to the death of peers) and are more prone to experience loneliness and other psychosocial problems. The changing lifestyles of working populations also imply that informal caregivers often have less time to care for their elders (e.g., visit daily, live with them), which further induces feelings of solitude among the focal actors. Thus, the second desired value outcome is

preserving and/or enhancing psychosocial health, as one of the informants explained:

...and children have their own obligation. They can help only financially if something like that [elderly living independently] would happen. And no one can really stay with you. Because those times have passed when people could stay with sick and old parents. It's not happening today. Everyone's children have left ... they are working and cannot abandon their jobs to serve you. It's the life; we are living in a different era. Things have changed significantly. (Mrs. Newman)

2.1 Social contact

In response to this problem, the second emergent function of socially assistive robots is to provide social contact. Existing research shows that the acceptance of socially assistive robots is increasing among seniors, especially if they are seen less as metal machines and more as human-like companions (Dautenhahn, 2007; Robinson et al., 2014). Socially interactive and socially assistive robots can communicate with humans, read and express emotions, suggest activities based on the person's mood, and scale up their social competencies (Dautenhahn, 2007). Consider the following perceived benefits of such functionalities:

At my age it's not easy to find new friends. And it's not like I'm looking for ones. But it all leads to being lonely. With the robot I wouldn't feel that way anymore. I would always have someone to talk to, share my thoughts, not to talk to myself anymore [laughs]. This aspect of the robot is what I like the most. It would be a company and entertainment. Life would be nicer. (Mr. Davis)

As evaluated by the focal actors, this social contact function of the robot can have value co-creating and value co-destroying potential. The empirical evidence reveals two robot roles in this function: ally and replacement.

2.1.1 Ally role

As an ally, the robot is perceived to have a considerable value co-creation potential, by collaborating with various network actors. Within care-based value networks, allies can engage in two activities. First, the robot can increase social engagement by directly interacting with elderly people or by facilitating social contacts with other network actors. Because of its social capabilities, the robot can accommodate the psychosocial needs of elderly people, as indicated in the following quote:

It [the robot] would be a friend. I would name it Boni, because it was a dog I loved a lot.... Yes, because Boni was very loyal to me. (Ms. Ellis)

Second, the robot can act as a communication and information-sharing interface that facilitates connections to the existing social contacts of the focal actor:

Because who has no one, who only has people on the outside [of the nursing home], this communication services are very important.... It [the robot] could intensify the relationship with my friends. Yes, because I could talk more often with them. (Mrs. Smart)

When prompted to think about the positive effects of introducing socially assistive robots on other actors in their value networks, the elderly informants frequently indicated how the supporting function of social contact might unburden their caregivers, as indicated in this network-conscious response:

Yes, the robot would call them [her household members] and transfer to them, I think, the information about what's going on with me. It would be of a help. It would be our friend. To me it would be much more acceptable to depend on the robot, to for example, unburden my household members. (Ms. Ellis)

2.1.2 Replacement role

Some of the informants instead expressed anxiety and fear that the robot might negatively affect their social networks and lead to even more social isolation. The role of a replacement implies that the robot is perceived to have considerable value co-destruction potential, by substituting for various network actors. The elderly informants frequently noted their concern that the robot might replace their human caregivers, deprive them of social interactions, and ultimately cause deterioration in their psychosocial health:

For the short time I have left, give me real people who are alive. It [the robot] doesn't live. The whole robot is just a dead person. (Mr. King)

Furthermore, the elderly informants fear that their network contacts might start neglecting them, because they could rely on the robot's alert system. As one informant explained:

I'm afraid it will take a lot of my contacts from me.... I would like to stay in charge ... I'm afraid to lose this contact in case the robot would take over things.... And then I'll become a number.... I'm afraid that things get less

personal ... it's already getting worse.... We should make sure that the robot doesn't take over too much. The robot is and will be made of metal. (Ms. Penny)

When thinking about other network actors, the elderly primarily emphasized their fear that if the robots were to succeed in replacing humans, caregivers inevitably would suffer job losses. In addition, humans might become dispensable and potentially pushed out of care-based networks, as the following quotes indicate:

First I'd like to say that I do not want this development [robotic technology] to be at the cost of the employees. (Mrs. Summers)

The only thing that really frightens me is if it would replace the caregivers. (Mrs. Sanders)

3. Cognitive health

Finally, various levels of cognitive decline and dementia affect the ageing segment of the population and accelerate their early institutionalization (Black et al., 1999). Among the interviewed sample, elderly informants repeatedly reported varying degrees of forgetfulness or decreased memory:

Sometimes I don't know where I left something. For example my phone. So I start calling it, and hear the ringtone somewhere, but I'm not able to locate in the room by myself. (Mr. Richards)

I can't find anything [laughs]. I lose my keys, I lose this, I lose that. (Mr. King)

As a result of the decline in their cognitive abilities, the elderly become more reliant on their caregivers, which affects their self-esteem and feelings of self-efficacy. Many informants vocalized their desire to stay independent for as long as possible:

My mother is 95 years old and is able to take care of her medicine totally by herself ... and she takes more than 15 capsules per day. She is my role model. I would like to grow old like her. With dignity and independence. (Ms. Gray)

3.1 Cognitive support

The last identified supporting function of the socially assistive robots thus is cognitive support. Increased forgetfulness in daily routines can lead to many unwanted consequences (e.g., neglected health due to poor medicine intake, eroded dignity due to an inability to track physiological needs). Socially assistive

robots can minimize the negative effects of cognitive impairments by offering systematic cognitive reminders (Pineau et al., 2003). As described by one of the informants:

If I would need it [the robot], I would need it for the alarm, the medication service and for the reminders. My memory is still good, but who knows what will be in five years' time. My wife lost her memory in six weeks' time. Then a robot would be useful. (Mr. Butler)

However, some informants see the cognitive support as having value co-destroying potential. The empirical evidence thus identifies two additional robot roles, specifically, extended self and deactivator.

3.1.1 Extended self role

The role of an extended self implies that the robot is perceived to have considerable value co-creation potential through its ability to augment the focal actor's capabilities. The robot often was described as part of the elderly person's extended self (Belk, 2013), because it enables them to prolong their independence and normal living routines. The perceived benefits can be seen in the following quote:

That's useful [agenda reminders]! It will help me remember appointments.... And it would be great if it [the robot] would tell to me to stay off the candy!... And it would come in handy to remind me to buy groceries I buy less often. (Mrs. Summers)

Many elderly informants acknowledge that cognitive support would be an ideal function for others, such as peers or other residents in the nursing home, but did not consider themselves in need of such services. For example,

People my age usually take many pills, so for them it would be useful for sure. A person loses himself. At one time she drinks blue pills, then green, then pink, then white. Who could remember? But thank goodness I have no such problems. (Mrs. Moore)

3.1.2 Deactivator role

Despite the described value creation potential of the cognitive support function, some informants fear that it only accelerates mental decline. In the role of a deactivator, the robot is perceived to have considerable value co-destruction potential, by disengaging the focal actor. This strong value co-destruction potential results from two perceived threats, such that reduced mental

activation might lead to cognitive deterioration, and relying on the robot feels like "giving up" or losing control over one's own life. The following quotes illustrate these deactivator roles of the robot:

I can still think for myself.... I think it's important to keep thinking for yourself, otherwise you get lazy. (Mr. Wheeler)

If I'm able to do it by myself, I should do it instead of the robot. At a certain point in time you fall asleep/drop off if you let the robot take the responsibility. So no, I want to keep control in my hands. (Ms. Penny)

Distinctly, the extended self and deactivator roles are perceived to have more considerable value co-creation/destruction potential for the individual, focal actor, rather than on the network level. Even though these roles seemingly could have positive or negative consequences for other network actors (e.g., unburdening of informal and formal caregivers), when discussing the effects of the cognitive support function, the elderly informants primarily shared expected outcomes with respect to themselves.

DISCUSSION AND IMPLICATIONS

This research investigates the potential roles of socially assistive robots in elderly care by taking the perspective of the focal network actor (i.e., elderly person). In-depth phenomenographic interviews, supported by generative card activities, collect vivid representations of how service beneficiaries co-create value within their value networks and how they expect these practices to change after the introduction of socially assistive robots. In this way, it empirically addresses a gap in service literature, by adopting a value transformation lens on future service (Witell et al., 2016). Furthermore, this study offers a more holistic perspective by investigating how the introduction of an automated agent (i.e., socially assistive robot) disrupts value-in-context, with respect to not only the self but also other, interdependent network actors. These results expand the knowledge base about socially enhanced technology (Danaher and Gallan, 2016; van Doorn et al., 2016), by uncovering how such novel value propositions disrupt institutionalized value creation, through both their value co-creating and their value co-destroying potential. The resulting finer-grained understanding of how to increase people's willingness to accept and reduce their resistance to socially assistive robots also produces some guidelines for offering meaningful value propositions for symbiotic human-robot interactions. Furthermore, it offers nascent strategic guidelines to achieve what Wirtz and Zeithaml (2018) call 'cost-effective service excellence' through robotic innovations that have the potential

to enhance the experience for a diverse set of network actors, while simultaneously improving service quality and productivity.

The results specify three prominent areas of support: physical, psychosocial, and cognitive health, in line with existing research in social robotics (e.g., Glende et al., 2015). It also extends these findings by relating robots' supporting functions to the desired value outcomes, through their value co-creating and co-destroying potential. The proposed typology of socially assistive robots extends existing research by defining robots' roles according to the value they can co-create with a service beneficiary, as well as the existing value that potentially could be co-destroyed. Furthermore, as Figure 4.5 indicates, the network-conscious approach yields a clearer understanding of which roles contribute more on an individual versus a network level. In particular, when analyzed according to the interplay of cognitive–physical–psychosocial desired value outcomes, robots' cognitive support roles, whether value co-creating (extended self) or value co-destroying (deactivator), mainly have the potential to enhance or inhibit value at the individual level (for the focal actor). The enabler and intruder roles stemming from the safeguarding function instead have co-creating/destroying potential for both the focal actor and the network (other network actors). Finally, the social support roles (ally and replacement) mainly have co-creation/destruction potential at the network level. In line with these results, the network-level roles might have the most resonating consequences for the entire caring network. Hence, in evaluating and welcoming technologies which offer such roles, service beneficiaries might move from trying to maximize the utility for themselves towards maximizing the utility for the entire network.

This understanding of individual- versus network-level value potential, from the perspective of a focal actor, offers important insights into the hindrances that must be mitigated or designed around to improve the receptivity of robots in an overall care-based value network. Not all value co-destruction potential can be eliminated through the design process though, so it continues to pose a barrier to the acceptance of robotic technology. As this study shows, robots' value co-destroying roles (e.g., intruder) should be counterbalanced by an emphasis on the value co-creating potential for other network actors (e.g., unburdening family members as an enabler) during the introduction phase.

Figure 4.5 - Value co-creating and co-destroying roles

Communicating robot roles shapes expectations among the network actors and can have an important effect on the introduction of robots. In the process of becoming members of human society, robots need to assure humans that they are well-intended and trustworthy, and that they will give their best to minimize the risks of value co-destruction (Kuipers, 2016). In a healthcare environment, the question of whether the robots will take assistive and complementary roles or whether they will make human caregivers redundant and completely replace them remains unanswered. However, responsible service system designers need to take these questions into consideration (Metzler et al., 2016). In line with Huang and Rust (2018), mechanical tasks such as vacuuming (see Nielsen et al., 2016), medication reminders and monitoring for falls are more easily replaceable with robots than the high-touch tasks involving personal concern, companionship, and genuine emotional responses.

This study thus contributes to service literature in three main ways. First, it indicates that automated actors, such as socially assistive robots that offer assistive value propositions through social means, can be evaluated similarly to human actors. Specifically, robots equipped with both assistive and social resources appear comparable to human actors in phenomenologically defined value networks. The collected narratives reveal that the elderly informants perceive robots as

capable of engaging socially (i.e., high on automated social presence; van Doorn et al., 2016), with both value co-creating and co-destroying potential, as well as considerable impact at individual and network levels. Thus, technology equipped with facial and voice recognition abilities can invoke perceptions of different anthropomorphized functions and roles. The human-like traits distinguish socially assistive robots from, for example, self-service technologies (Meuter et al., 2005), which do not have an active value co-creating/destroying role for the realization of desired value outcomes, from the focal actor's perspective. By acknowledging the potential to co-destroy value, this study also extends existing conceptualizations of healthcare robots. For example, Roy et al. (2000) identify five primary functions (cognitive prosthesis, safeguarding, systematic data collection, remote tele-medicine, and social interaction) but highlight only the positive consequences of these functions. Acknowledging how such functions may harm a service beneficiary is especially important in healthcare settings, which involve vulnerable service recipients and high delivery risks (Berry and Bendapudi, 2007). This ambidextrous perspective offers a more balanced view on social assistive robots and thereby advances research on the complementary and substitutive nature of technology in service networks.

Second, this study extends scholarly understanding of value creation practices, through its network-conscious approach that uncovers both positive and negative expectations of future service scenarios. The resulting typology identifies several potential roles of automated actors and also integrates evaluations of the impacts of technology on not only the informants themselves but also the other actors in their value networks. This proposed typology thus extends existing role conceptualizations (e.g., Frow et al., 2016; McColl-Kennedy et al., 2012; Moeller et al. 2013), to encompass value co-creation and co-destruction counterparts, but also to address network-conscious elements. Moreover, this study clarifies future service scenarios, according to the anticipated value co-creation/destruction roles and potential changes in value-creating/destroying practices, even before the technology is introduced. This novel focus on future rather than current value co-creation and co-destruction can stimulate service innovations in complex service systems such as healthcare (Danaher and Gallan, 2016). Evaluating technologies before deploying them also offers opportunities to mitigate future value co-destruction, by designing around hindrances to value realization. These results suggest important guidance for service managers who are formulating new value propositions (Skålén et al., 2015): In the design process, they must foster value co-creation potential, while also minimizing value co-destruction potential, to encourage the more seamless introduction of the service innovation.

Third, the network-conscious approach to technology-enabled services advances prior literature on complex service systems (Chandler and Lusch, 2015) and value constellations (Normann and Ramirez, 1993). Because value co-creation/destruction knowledge depends deeply on high quality, phenomenological insights, this research field requires more fine-grained, qualitative methods to illuminate idiosyncratic understanding of value-creating networks. As one option, this study introduces the Context Disruption interview method, which leverages Contextual Value Network Mapping to render vivid representations of current and future value constellations. The tangibility and collected visualizations also facilitate data-rich narratives, shedding light on both value co-creating and co-destroying practices of future service scenarios. In particular, when they evaluate innovations, service beneficiaries consider how the value co-creation/destruction trade-offs affect not just them but also other network actors. Value co-creation potential that benefits a close family member can offset value co-destruction that harms the focal actor. For example, privacy violations may be outweighed by benefits associated with unburdening family members. This holistic perspective on service innovation reveals the network dynamics and disruptive effects of service innovation in relation to both the self and the other actors who will appear in future service constellations. With this methodological contribution, which encouraged the informants to engage in network thinking and explicate the network value co-creation/destruction potential of service innovation through both narratives and accompanying network visualizations, the authors also give service researchers a new way to address the key service research priority of designing adaptive service systems that can respond to dynamic environments (Ostrom et al., 2015).

Managerial implications

The proposed typology provides some early strategic guidelines for overcoming the challenges of robotic introductions, for at least three groups of relevant stakeholders. First, technology developers and service designers, interested in the widespread acceptance of their socially assistive robots, need to focus on the service beneficiary approach and harness the power of the in-depth contextual understanding provided herein. Their better comprehension of actors' desired value outcomes and perceptions of health-related enhancers and inhibitors should result in robotic solutions that are better tailored for successful value co-creation. They should account particularly for the identified values (i.e., physical, psychosocial, and cognitive health) and ensure the functions of the robots improve their value co-creating potential. With a better understanding of how different functionalities contribute to current value creation practices, but also how they potentially impede the continuation of

existing value within service networks, technology developers and service designers have a better chance to realize a quantum leap in service improvements for the benefit of service beneficiaries.

Second, when introducing complex robotic solutions, service managers (e.g., assisted living facility managers) would benefit from taking a value network perspective rather than focusing on only one group of stakeholders. They should be guided by the interplay among the physical–psychosocial–cognitive health desired value outcomes. Before they design introductions or communication materials, they might screen elderly residents to determine their attitudes, then cluster them in different target groups, depending on their primary desired value outcomes. Furthermore, training programs for the involved personnel should sensitize them to the most frequent value co-creation/destruction themes. Finally, two-sided communications (e.g., user tutorials, training, flyers) should acknowledge elderly people's fears (value co-destruction potential) while accentuating the positive value outcomes for a diverse set of actors, in an effort to increase receptivity to and encourage adoption of socially assistive robots.

Third, involved healthcare personnel should realize that elderly people often perceive robotic technology as a threat or a challenge, so they need to strive to facilitate more positive feelings and increase perceptions of the usefulness of the innovation. In so doing, they can make the elderly more eager to allow the socially assistive robot into their care-based network contexts. Activities that might foster robotic technology acceptance include acknowledging concerns and suggesting means to circumvent possible value co-destruction, harnessing network influences by emphasizing the value co-creation potential for formal and informal networks, helping people understand how their desired value outcomes can be achieved by accepting socially assistive robots, and providing strong privacy protections.

Limitations and further research

Although this study offers an interesting perspective on current and future human–robot value co-creation/destruction in a healthcare context, it also contains some research limitations. First, the interview data are rich and support in-depth explorations of the involved actors, yet the time-consuming nature and challenging informant recruitment of this approach limits the breadth of the researched sample. The collected phenomenographic insights are thus limited to an elderly care context in Europe. Continued research might consider other healthcare or non-healthcare service settings and other geographic areas. Second, the collected data are cross-sectional, which restricts further analyses of the actors' actual behavioral changes, though they might offer a more

comprehensive understanding of their adoption of new technology. The theoretical framework and typology, grounded in qualitative data, thus open avenues for quantitative and/or longitudinal research.

Third, the research scope was limited to focal network actors, thereby neglecting the perspectives of other network actors. Further research could include the perceptions of the formal and informal caregivers, which could provide a fuller network perspective on value co-creation/destruction. Such an effort would address the service research priority suggested by Ostrom et al. (2015) and Barile et al. (2016), namely, to enhance understanding of multi-actor, network, and collaborative value creation in complex service systems. Fourth, the informants did not experience socially assistive robots becoming part of their care-based value networks; rather, they tried to envision how such a disruption would transform their interactions within the network. Therefore, the proposed Context Disruption interview approach should be used with caveats, especially in situations in which informants face difficulties foreseeing how service innovations might affect their lives or network configurations. For this particular study, the recruited elderly informants were part of the pretrial phase of a socially assistive robot project, so they had been introduced to the robot previously. Furthermore, the robot supported functions that the informants were already familiar with (e.g., fall detection, Skype communication, reminders), so it was possible for them to anticipate how it would change value co-creating interplays in their respective networks.

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CHAPTER 5

Robotic Versus Human Coaches for Active Aging: An Automated Social Presence Perspective

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INTRODUCTION

Many societies face the challenges of aging populations, at risk of reduced physical activity (WHO, 2015), whereas an active lifestyle has proven health-related benefits for aging adults (Bauman et al., 2016). When a sedentary lifestyle becomes routine though, falls among elderly people can develop into an alarming problem, often leading to hospitalization and reduced physical autonomy (Bernstein et al., 1999; WHO, 2008). Evidence links decreased motivation for physical activity to advanced age (Scholes and Mindell, 2012), which implies the need for healthcare systems to develop effective solutions to ensure the physical well-being of elderly people. Exergames offer an innovative way for seniors to avoid a sedentary lifestyle and combat the degenerative effects of aging; their easy-to-follow steps and gamified nature motivate seniors to remain physically active through playful interactions. The application of exergames in healthcare settings also has yielded positive outcomes for both physical and cognitive well-being (Boyle et al., 2016; Wattanasoontorn et al., 2013). Recent studies of the use of exergames in rehabilitation (Cardona et al., 2016; Skjøret et al., 2016) [71, 16] suggest comparable or slightly better results (e.g., balance, gait) than achieved with conventional fitness programs.

Figure 5.1 - Vizzy interacting with an elderly lady

According to a study of the usability of exergame platforms (Simao and Bernardino, 2017), elderly people's cognitive deficiencies can hinder their engagement with exergames though. We propose that a social agent can serve a supportive function, guiding and motivating elderly people through the

gaming process. Professionals in care institutions do their best to keep elderly patients physically and mentally active, but the unprecedented relative growth of the elderly population is creating a gap between the supply of and demand for care services (Janssen et al., 2016). As an aid, gaming platforms can include virtual agents that serve in guidance and motivational roles, with an automated social presence. Still, the presence of a physical entity enhances interactions with an autonomous agent, compared with a virtual or real entity presented on screen (Li, 2015; Powers et al., 2007; Shinozawa et al., 2005). These findings have motivated researchers to turn their attention to socially assistive robots (SAR), like Vizzy (Moreno et al., 2016), MBOT (Ventura et al., 2016), and GrowMu (Portugal et al., 2015), which understand social cues through facial and voice recognition technology, are capable of engaging in quasi-social interactions, and can cause users to feel as if they are in the company of a social entity (Čaić et al., 2018; van Doorn et al., 2017).

The extent to which current SARs are capable of helping people enjoy and perceive exergames as useful is a crucial research topic. The adoption of a user-centered design perspective, with continuous benchmarks and comparisons between SARs and care professionals, can support technological improvements that better suit professionals and elderly patients. In this study, we take the perspective of elderly users to address the following research question: How does an automated (i.e., SAR) versus human presence affect elderly people's experience with exergames to improve their physical activity? For this purpose, we use the Vizzy robot (see Figure 5.1) as a robotic coach and the Portable Exergames Platform for Elderly (PEPE) (Simao and Bernardino, 2017) as an exergame system. Vizzy is a semiautonomous robot, and PEPE is a fixed gaming platform. These systems were developed and designed specifically for use in elderly care institutions. With an experimental design, applied in five elderly care locations, we investigate users' experience with playing one of PEPE's exergames, in the company of a human or robotic coach (Vizzy), by gathering their responses to a questionnaire augmented with a set of probing questions. The resulting contributions and practical implications include:

- An empirical test of the new concept of automated social presence and how it influences exergame experiences for seniors.
- Quantitative and qualitative comparisons of the social perceptions elderly people form about human and robotic coaches.
- Evaluations of elderly people's experiences (i.e., emotional and cognitive reaction and behavioral intentions) with the exergame, depending on the company.

In Related work, we discuss prior end-user studies with SARs in motivational and conversational roles, which constitutes the background for our conceptual model in the Conceptual background section. We present the hypotheses in the Hypotheses development section. Next, we describe Vizzy, PEPE, the research setup, experimental design, and data collection procedures in Methods and materials. After we detail the results in the Results section, we discuss contributions and implications of our study in Discussion.

RELATED WORK

Social robots for older adults

Applications of SARs in elderly care constitute a trending research topic. Several studies with older adults test their acceptability and possible range of applications. In Iwamura et al.'s (2011) work, seniors used two robots as shopping partners, and the findings suggest that the robots' social skills (e.g., conversation) improve people's intentions to use them. McColl and Nejat (2013) present an exploratory study at an elderly care facility to investigate user engagement and compliance during mealtime interactions with a robot. Participants were engaged and compliant with the robot's instructions and also perceived the robot as enjoyable.

Other studies have investigated the evolution of seniors' perceptions of SARs over a longer period of time. In a study of which factors determine long-term user acceptance of social robots (de Graaf et al., 2015), the evidence reveals that hedonic factors gain the most attention, but utilitarian factors are a fundamental prerequisite of long-term interactions (i.e., the robot must have a clear purpose). A more recent contribution investigates older adults with dementia at residential aged care facilities over four years (Khosla et al., 2017). After each trial, the robot's services improved, reflecting staff and resident feedback, leading to statistically significant increases in engagement and robot acceptability.

Robotic coaches

Robotic coaches are platforms that engage, monitor, and support physical exercise activities, through verbal and non-verbal communication, demonstration of exercises, and real-time corrective or motivational feedback. An early study (Fasola and Mataric, 2012) explored interaction enjoyment and perceived utility, with a comparison of two different approaches. The first relied on a relational robot that praised, addressed users by name, and expressed humor and empathy. The second used a non-relational robot that just provided scores and help as needed. Users regarded the relational robot as a better

companion and exercise coach than the non-relational one. Robotic coaches thus need to provide motivational support to users during the exercise. In turn, users perceive relational robots as more intelligent and more helpful. Feasibility tests of a robot coach architecture with older adults also indicate promising acceptability results (Fan et al., 2017). This architecture includes a rule-based decision process but also can learn users' preferences, estimate their affective state, and recall past interactions. Users' perceptions of their interaction with the robot thus improved, relative to their initial expectations. Schneider and Kümmert (2016) also investigate the differences in motivation created by a robot that solely instructs users (instructor role) and one that exercises alongside the user (companion role); people appear more motivated by the robot companion role. Finally, in a robot coaching scenario (Görer et al., 2017), an elderly user study cites engagement and enjoyment while exercising but also reveals some difficulties, such as hearing instructions, focusing on the physical aspects of the robot while ignoring verbal instructions, and confusion associated with performing sequences of gestures.

Comparing human and robot actors

Extant studies also compare the performances of human and robotic actors in a variety of contexts. To summarize these findings, we start with studies in which participants have no direct interaction with the human/robotic actor, then continue on to studies in laboratory settings, and finally end our analysis in this section with findings from real-world field experiments.

The first group of studies relies on online surveys that present participants with written (Voiklis et al., 2016) or video recorded (Hoorn and Winter, 2017) scenarios, followed by a set of questions designed to evaluate their perceptions of human versus robotic actors. The foci of the studies varies, from moral dilemmas to the communication ability of the human or robot agent. For example, one online study (Voiklis et al., 2016) reports that participants assign higher moral obligations to human than robotic actors, such that they believe it is morally wrong for a hypothetical human actor to choose to act and save four, while sacrificing one, coal miner, but they expect the robot to make this choice when faced with the same moral dilemma. Another study (Hoorn and Winter, 2017) compares human and robotic doctors' ability to inform patients about their health conditions, following a standardized script. Participants evaluate the robot better at communicating bad news, though these researchers predict that human social presence might invert the results in a real-life scenario. Although the design of these experiments allow for replication and comparability between humans and robots, they have limited external validity, because they refer to specific, artificial

scenarios, and participants have no contact with actors or no immersion in the scenario. Such a limitation is especially important in critical scenarios (Hoorn and Winter, 2017), such as when participants do not experience a real health diagnosis.

Another group of studies relies on laboratory-based methodologies that enable participant–agent interactions. These studies generally report no significant differences in the behaviors of participants in the presence of robotic versus human agents. For example, in a shared attention memorization task with a human or robot agent (Kim et al., 2018), the participant and agent point at images and look at them together. Later, participants reviewed another set of pictures and had to identify which they had seen before. Recognition performance was better when the participant initiated the pointing behavior than when the collaborator did so, but it did not matter if that collaborator was a human or a robot. In a turn-based variant of the Tower of Hanoi experiment, conducted with a human or robot collaborator (Jerčić et al., 2018), participants performed significantly better with a collaborator than when playing individually, but again, there were no significant differences between the human and robot collaborator conditions. Because the collaborator always made the best move, the lack of performance differences could be because the game was too simple. Although these studies suggest that participants benefit equally from collaborating with other humans or robots, one contribution (Jerčić et al., 2018) assigns an advantage to humans, in terms of perceived social presence and perceived credibility. These designs are replicable and controlled, and they rely on participant–collaborator interactions. However, the laboratory setting might limit internal and external validity.

Finally, some studies use realistic field experiments to compare human and robotic teachers (Fernández-Llamas et al., 2017; Kennedy et al., 2016). For example, when teachers gave a tutorial on prime numbers, no significant differences emerged in the student evaluations of human or robotic teachers (Kennedy et al., 2016). The robot in this study was fully autonomous but could not adapt its gestures to events in the classroom or engage in mutual gazes with students. In a similar study of programming principles (Fernández-Llamas et al., 2017), students between 14 and 17 years of age performed better with the robotic teacher, whereas those 10 to 13 years of age performed better with a human teacher. Younger students (6–9 years) showed no significant performance differences. Although they do not suffer the limitations of the previously mentioned studies, strong novelty effects are present in these studies, especially in Fernández-Llamas et al. (2017). Beyond the novelty of interacting

with a robot, the participants were visiting students, unfamiliar with the university environment.

This literature review reveals that prior research has focused on different domains of social interaction, including moral expectations, diagnosis communication, shared attention benefits, gaming performance effects with a collaborator, and teaching. They also provide valuable insights into the issues and methodologies that are required to achieve successful experiments involving human and robot actors. First, in particular, they reveal that people evaluate humans and robots differently, even if the robot is perceived to be intelligent (Voiklis et al., 2016). Second, lab experiments allow for more control over the stimuli, but they might not be valid in real-life scenarios (Hoorn and Winter, 2017). Third, some elements of these methodologies are standard and necessary for interaction studies, to increase their internal validity. The human actor must be trained to follow the same script and move similarly to the robot; the task should match the robots' skills to reduce possible biases. However, literature is still sparse in this domain, and to the best of our knowledge, no study compares older adults' perceptions of exergames when they are coached by either a human or a robot. The following section substantiates the importance and relevance of such a study.

CONCEPTUAL BACKGROUND

Social interactions are not reserved to humans. Technologies mimic humans, in their appearance and behaviors (i.e., social robotics; Breazeal, 2004), and quasi-social interactions increasingly appear in diverse service settings, such as robotic waiters, bank tellers, and receptionists. These artificially intelligent social actors can engage in quasi-social interactions (Biocca and Harms, 2002). Robots are not social by nature but instead are programmed to act as conversational partners and socially interactive peers (Fong et al., 2003). Yet, when they engage in these quasi-social interactions, humans tend to perceive robotic systems as social beings (Heerink et al., 2010b; Reeves and Nass, 1996). This phenomenon is closely linked to the concept of social presence, broadly defined as the sense of being with others (e.g., in virtual reality; Heeter, 1992) or having the access to others' minds (i.e., cognitive, affective, and intentional states; Biocca and Nowak, 2001). Social presence is a property of humans, not technologies (Biocca and Harms, 2002), so current theories may benefit from using social presence as a lens to compare interactions with either human or non-human actors. The concept of automated social presence, as introduced in service literature, refers to "the extent to which machines (e.g., robots) make consumers feel that they are in the company of another social entity" (van Doorn et al., 2017, p. 44). If robots can interact with people in human-like ways, such as by listening,

conversing, or reading emotional cues, then people might automatically respond socially to them (Reeves and Nass, 1996). In particular, this study argues that people may activate their social cognition and judge the non-human social actor on the basis of warmth and competence dimensions, which are the universal dimensions of social cognition.

Social cognition

According to Fiske et al. (2007), when interacting with members of the same species, humans need to determine whether the other is friend or foe (i.e., warmth dimension), and whether it is capable of acting on good or ill intentions (i.e., competence dimension). Although robots are not members of the same species, their anthropomorphism (Nowak and Biocca, 2003) and increasing social dexterity make them resemble humans in many aspects. This study in particular focuses on SARs, which offer assistance through social interactions in a humanlike manner (Feil-Seifer and Mataric, 2005). In a healthcare context, SARs are autonomous, understand social cues through facial and voice recognition, and can provide both child (e.g., autism therapy; Scassellati et al., 2012) and elderly (e.g., medication reminders; Broekens et al., 2009) care. In an elderly care context, SARs offer services such as health monitoring and safety, encouragement to engage in rehabilitation or general health-promoting exercises, social mediation, interactions, and companionship (Feil-Seifer et al., 2007). By performing more socially engaging tasks, these robots take roles as companions, collaborators, partners, pets, or friends (Dautenhahn et al., 2005; Fiske et al., 2007). We build on the idea that humans judge a social interactor (even a non-human actor) on warmth (i.e., friendliness, kindness, caring) and competence (i.e., efficacy, skill, confidence) dimensions, which then determines their emotional, cognitive, and behavioral reactions. Thus we address recent calls for research on the effects of automated social presence on the perceived enjoyment and usefulness of service interactions and the acceptance of new technologies (Heerink et al., 2010a; van Doorn et al., 2017).

HYPOTHESES DEVELOPMENT

We test our empirical model through field experiments with elderly people. The research aim is to investigate the differences between human and robotic companions when it comes to motivating elderly persons to engage in physical activity. We introduce hypotheses related to robotic coaches only (H1), comparisons of human and robotic coaches (H2 and H3), and user experiences with the exergame (H4 and H5). Figure 5.2 depicts the empirical model.

Notes: H1 is tested through one sample t test; H2 and H3 are tested through independent samples t test; H4 and H5 are tested

Figure 5.2 – Empirical model

Using the argument that humans tend to treat non-human actors/systems as social beings (Heerink et al., 2010a; Reeves and Nass, 1996) and the definition of automated social presence (van Doorn et al., 2017), we investigate whether SARs, which display human-like social behavior and communicative skills (Breazeal, 2003), evoke feelings of social presence in humans. Furthermore, this study extends previous research (Fiore et al., 2013; Jerčić et al., 2018) by involving socially dexterous robots that are capable of engaging in a dialog, gazing, and responding to social cues. Thus, we hypothesize:

H1: Robotic coaches are perceived to have automated social presence (i.e., people feel they are in the company of a social entity).

If people feel like they are in the company of a social entity, they likely evaluate robots using the mechanisms of social cognition (i.e., warmth and competence), similar to their evaluations of human companions (van Doorn et al., 2017). We extend previous research (Fiore et al., 2013) with a comparison of human and robotic coaches, with the prediction that:

H2: There is a difference in the (a) perceived warmth and (b) perceived competence of human versus robotic coaches.

Moreover, in line with calls for further research (Heerink et al., 2008; Heerink et al., 2010b), we explore the effects of automated social presence versus the presence of human coaches on users' emotional and cognitive reactions, which may influence their acceptance of the technologies (Venkatesh et al., 2003). Being in the company of a human or a robot may determine whether elderly participants find playing the exergame enjoyable and effective. We therefore postulate:

H3: There is a difference in the (a) hedonic and (b) utilitarian value perceptions of an exergame, depending on whether the coach is a human or a robot.

Finally, assuming users evaluate both human and robotic entities using universal social cognition dimensions, we further consider how differences in people's social cognition-based evaluations of human versus robot coaches affect their emotional and cognitive responses and, ultimately, their intentions to use the exergame. Therefore:

H4: (a) Perceived warmth and (b) perceived competence of the coach affects users' (i) hedonic and (ii) utilitarian value perceptions of the exergame experience.

H5: (a) Hedonic and (b) utilitarian value perceptions affect users' intentions to use the exergame.

METHODS AND MATERIALS

Robot description

The robotic platform in these experiments is the Vizzy robot (Moreno et al., 2016), developed by the Institute for Systems and Robotics (ISR-Lisboa/ISR). Vizzy is a 1.3-m-tall, wheeled robot with a humanoid upper torso and a friendly, marsupial-like design (see Figure 5.3). It has a total of 30 mechanical degrees of freedom (DOF). The two DOFs of the differential drive base allow it to navigate planar surfaces easily and plan its trajectories using well-established algorithms (Quinlan and Khatib, 1993; Rösmann et al., 2012). The head can perform pan and tilt movements, and its eyes can do tilt, vergence, and version movements, for a total of five DOFs. Vizzy's arms and torso also have 23 DOFs, such that it can perform human-like motions. Two laser scanners at the bottom of the mobile base capture planar point-clouds of the environment, providing valuable information for the robot's safe navigation. Each of Vizzy's eyes contains a camera, used for object/people detection and tracking. A depth camera is mounted on Vizzy's chest, further enhancing the robot's sensing capabilities for human movement analysis. Other components include a loudspeaker and a microphone, useful for human-robot interactions, and 12 tactile sensors on each hand (Paulino et al., 2017), mounted on the finger phalanges.

Figure 5.3 – The Vizzy robot

Vizzy's actuators and controllers allow it to navigate, grasp objects, perform gestures, and gaze in a biologically inspired way (Avelino et al., 2016; Roncone et al., 2016). The robot also has software that enables it to detect and follow people in the environment, using an implementation of the Aggregate Channel Features Detector (Dollár et al., 2014) with appearance-based tracking using color features (Figueira et al., 2013). A set of RVIZ plug-ins allow the remote control of the robot (head and base) in Wizard-of-Oz (WoZ) experiments, in a gaming-like way, while visualizing the obstacles gathered by the laser and the people detected by the cameras. A web interface (see Figure 5.4) allows a “wizard” to select utterances for the robot to speak while listening through the robot's microphone. This approach supports faster replies and interactions, though at the cost of speech flexibility.

(a)

(b)

Figure 5.4 – Dialogue control GUI

(a) Default view with several buttons grouping verbal intentions

(b) One of button pressed, showing several options

Gaming platform description

To perform the exergames with seniors, we used the Portable Exergames Platform for Elderly (PEPE) (Simao and Bernardino, 2017), an augmented reality gaming platform that projects exergames on the floor, while a Kinect sensor captures the person's movements to control the game elements. Users can play through PEPE without requiring any wearable sensor or controller, which minimizes the burden and complexity for older adults. Two touchscreens on the top of the platform provide additional information to staff members monitoring the exercise. The games currently need to be initiated and terminated by a person, but in the future, the social robot will be able to control the gameflow. The chosen game for our experiments is ExerPong (Cardona et al., 2016), which requires players to control a green paddle (Figure 5.5(a)) with their body movements. The objective is to hit the yellow ball with the green paddle, making sure it does not leave the game area. Colored boxes populate the gaming area. When touched by the yellow ball, the colored boxes are destroyed and yield points to the player. After destroying all the boxes, the player completes the level. Every time the player fails to hit the yellow ball, and it leaves the playing area, a box reappears. During the game, audiovisual stimuli give performance information to the player, in the form of a red visual feedback and success and failure sounds. The players can either control the paddle by walking sideways or with horizontal arm movements. Thus ExerPong can be played by people with different degrees of mobility.

Participants

In total, 58 elderly persons (42 female, 16 male) participated in the study; they ranged in age between 48 and 94 years ($\mu = 78.79$, $\sigma = 9.85$). We excluded people suffering from severe physical (e.g., full physical immobility) or mental (e.g., dementia) health problems, as well those incapable of giving their consent. The target population comprised elderly persons living autonomously (e.g., in their own home) or in a nursing home who accept services from a care institution. Thus, the main inclusion criterion was that they were clients of the elderly care centers with which we partnered, which offer a wide range of tailored activities (e.g., card games, fitness, handcrafts). We randomly divided the overall sample into two experimental groups: 22 participants in the human coach group (16 female, 6 male), aged between 65 and 94 years ($\mu = 75.46$, $\sigma = 12.79$), and 36 participants in the robotic coach group (26 female, 10 male), aged between 48 and 91 years ($\mu = 80.83$, $\sigma = 6.98$). The human coach experiments were carried out at two locations (Location A: 10, Location B: 12 elderly participants), and the robotic coach experiments were carried out at

three locations (Location C: 11, Location D: 10, Location E: 15 elderly participants).

Experimental setup

The data collection, in collaboration with five elderly care institutions, took place during July–September 2017. Each participating elderly care institution provided a spacious activity area, an adjoining room for surveys/interviews, and an in-house psychologist. The activity area was essential, because we needed to fit the gaming platform and secure enough space for the robot to navigate throughout the area. We requested an additional room to ensure each informant's privacy during the data collection. Finally, the in-house psychologist helped screen elderly clients, to evaluate their fit for the experiment (exclusion criteria: severe physical or mental health problems). The visits were scheduled during the regular activities time held by each care center.

Experimental procedure

As a part of the study, the exergame platform was installed in the main activities room of each care institution. During the regular activities time, when people usually participate in various activities offered by the institution (e.g., drawing, knitting classes, yoga, card or board games), the seniors were approached either by a human or the robot, depending on their assigned experimental group, and invited to try a new activity that reportedly was being considered as an addition to the existing activity offers. Because all the activities took place in a main activities room, peers could observe the exergame activity, though some remained engaged in their own activities. To keep the experimental scenarios as constant as possible, we developed a standardized set of steps for each actor (i.e., human/robot) to follow: (1) Approach an elderly person who satisfies the inclusion criteria; (2) introduce the new activity (i.e., exergames) and invite the elderly person to join the game; (3) if the elderly person accepts, escort her or him to the gaming area; (4) provide instructions for how to play the game; (5) motivate the elderly person by words of encouragement and feedback on game progression; and (6) ask the elderly person whether to continue or terminate the game. The locations of the coach during Steps 4–6 were standardized, as depicted in Figure 5.5. Although the “wizards” directing the robots were present in the same room, they were described as technicians, available resolve any problems with the exergame system. Furthermore, they were standing in a non-visible area, out of the field of view of the participant during the game. The communication was standardized; both human and robot actors used the same sentence to introduce the exergames, give instructions,

and motivate players. Past studies have shown that gendered voices can influence perceived trust, likeability (Lee et al., 2000), and competence (Nass et al., 1997) if the agent is a computer with no gender-specific characteristics other than the voice. People tend to give higher ratings to agents whose voice gender matches their own, and they also apply gender stereotypes. Therefore, Vizzy had a female voice to match the gender of the caregivers, who were all women. On average, the time participants spent playing the exergame was 08:07 min, with a standard deviation of 02:32 min. The minimum playing time was 1:58 min, and the maximum was 12:25 min. After the game, a member of the research team escorted the elderly participants to the separate room to conduct the survey and interview. Prior to being surveyed, all elderly informants signed an informed consent, outlining the main objectives of the research project and guaranteeing the anonymity of their responses. We consciously decided not to ask for informed consent before their interaction with Vizzy or the exergame platform, because we wanted to mimic a regular activity at the center, rather than create a research environment.

(a)

(b)

Figure 5.5 – Experimental conditions

(a) Scenario 1, human coaches elderly user in playing the exergame using PEPE

(b) Scenario 2, Vizzy performs the coaching role

Data collection

To test whether a robot (i.e., automated social presence) is comparable to humans in terms of motivating elderly people to engage in physical activity, we chose a mixed-method approach, combining quantitative and qualitative

data. The main instrument was a questionnaire, augmented with probing questions to elicit more in-depth, qualitative insights.

Quantitative data collection

The 58 elderly participants were asked to allocate 10–15 minutes of their time and join the first author to discuss their overall experience with the activity. For that purpose, a questionnaire was constructed to guide the discussion. With the decrease of their cognitive functioning, elderly people often struggle with question and rating scales comprehension (Schwarz et al., 1998), so we decided to conduct guided surveys. The researcher read the question to the elderly person and explained the rating scale (e.g., totally disagree to totally agree), then asked the elderly person to indicate her or his response.

To measure the experience with playing exergames (i.e., emotional and cognitive reactions), we adopted two bipolar scales (Childers et al., 2002; Mullen et al., 2011). Specifically, we employed a five-item measure ($\alpha = .85$) to assess their hedonic value perceptions (i.e., users' enjoyment of the physical activity of using the exergame platform). We assessed utilitarian value perceptions (i.e., users' perceptions of the effectiveness of the physical activity of using the exergame platform) with a three-item measure ($\alpha = .85$). The responses were on seven-point bipolar scales. To add a component of behavioral intentions, we also measured elderly participants' future intentions to play exergames with a two-item measure ($\alpha = .91$).

Furthermore, we gathered the elderly participants' evaluations of whether the human/robotic coach was good- or ill-intended (i.e., warmth) and competent to perform the task. In line with prior conceptualizations of social cognition (Cuddy et al., 2008), we adopted a three-item measure for perceived warmth ($\alpha = .76$) and three-item measure for perceived competence ($\alpha = .88$). Participants responded to all items on five-point Likert scales ("totally disagree" = 1 to "totally agree" = 5).

Finally, to evaluate the experience of sensing a social entity when interacting with the robot, we developed a four-item measure ($\alpha = .7$) of automated social presence (Bailenson et al., 2001; Heerink et al., 2010b). Again, all items were measured on five-point Likert scales. Tables 5.1 and 5.2 contain the constructs and items used in the questionnaire.

Table 5.1 – Items related to the exergame

Hedonic Value ($\alpha = .85$)		Utilitarian Value ($\alpha = .85$)	
1: I hated it (1)	... I enjoyed it (7)	1: I find it harmful for my physical health (1)	... I find it useful for my physical health (7)
2: I felt bored (1)	... I felt interested (7)	2: I find exergames ineffective (1)	... I find exergames effective (7)
3: I disliked it (1)	... I liked it (7)	3: I feel like it cannot improve my physical health (1)	... I feel like it can improve my physical health (7)
4: I found it unpleasurable (1)	... I found it pleasurable (7)	Intention to use (1 - 5 Likert scale, $\alpha = .91$)	
5: It was not fun at all (1)	... It was a lot of fun (7)	1: I think I will play exergames during the next few days.	
		2: I will use the exergame platform in the future.	

Table 5.2 – Items related to the human/robotic coach

Perceived Warmth (1-5 Likert scale, $\alpha = .76$)		Automated Social Presence (1-5 Likert scale, $\alpha = .70$)	
1: I feel the human/robotic coach understands me.		1: I can imagine the robot to be a living creature.	
2: I think the human/robotic coach is well-intentioned.		2: When interacting with the robot I felt I'm talking with a real person.	
3: I think the human/robotic coach is friendly.		3: Sometimes the robot seems to have real feelings.	
Perceived competence (1-5 Likert scale, $\alpha = .88$)			
1: I think the human/robotic coach is competent.		4: I felt like the robot was actually looking at me throughout the interaction.	
2: I think the human/robotic coach is reliable.			
3: I think the human/robotic coach is an expert/knowledgeable.			

Qualitative data collection

We chose to employ a convergent parallel mixed methods design (Creswell and Creswell, 2017), in which we collected both quantitative and qualitative data at the same time, with the goal of determining whether the findings associated with both types of data support each other. During the survey process, the researcher probed particular items as appropriate, using either “tell me more” probes (Bernard and Bernard, 2012) or a laddering technique (Reynolds and Gutman, 1988). For example, after elderly participants indicated their enjoyment level (from “I hated it” = 1 to “I enjoyed it” = 7), the researcher would ask what in particular they found enjoyable or not. After they indicated their intentions to use the exergame platform again (scale from 1 to 5), the researcher would ask why and thereby potentially uncover the core values that guide their behavioral intentions.

All collected narratives were digitally audio-recorded and then transcribed, translated, and reviewed. The analysis proceeded in the following order: First, the authors all read the transcripts independently to form their own understanding of each participant's narratives (Riessman, 1993). Second, four co-authors met for a joint analysis session to share emerging codes and develop a more focused coding scheme. Third, the first two authors coded the remaining narratives according to the coding scheme. Due to the exploratory nature of the study, codes and thematic descriptions emerged from the data rather than from preconceived categories or theories (Hsieh and Shannon, 2005).

RESULTS

Automated social presence

To investigate H1, we ran a one-sample t-test to determine whether the mean value of automated social presence is statistically different from a neutral value, that is, the midpoint (=3) on the 5-point Likert scale. In support of H1, the mean score of 3.5 (SD = .97) is significantly different from 3, $t(35) = 2.97$, $p = .005$ (Figure 5.6). That is, elderly people experience some sort of automated social presence when interacting with the robot. When we complement these quantitative findings with the qualitative data, we identify the emergence of a thematic paradox that we label “*We know it's a machine, but it feels like a human.*” From the narratives, we recognize that the elderly participants experience some conflicting thoughts, as captured in the following quotes:

It's almost the same thing [as talking with a real person]. (Female, 80)

No, I mean ... we can see that it's a robot, right? But we can see that it's something intelligent ... but it's not a person ... but it's as if it is a person. (Female, 89)

It's a robot but ... I imagined it as a person there talking to me. (Female, 94)

It felt like talking to an adult person. It's like the grown-ups. (Male, 71)

Figure 5.6 - Automated social presence

The comparison of quantitative and qualitative data thus reveals similarities and support for H1.

Social cognition

To test H2, we ran an independent-samples t-test and determine if the means of two groups (human vs. robot) differ statistically. We find a significant difference in the mean scores for perceived warmth when the coach is a human ($M = 4.82$, $SD = .37$) or a robot ($M = 4.45$, $SD = .73$), $t(54.40) = 2.517$, $p < .05$. Similar results emerge for the perceived competence of the coach, as a human ($M = 4.84$, $SD = .47$) or robot ($M = 4.50$, $SD = .67$), $t(54.88) = 2.431$, $p < .05$ (Figure 5.7).

Figure 5.7 – Perceptions of warmth and competence

These results support H2, the difference for both perceived warmth and perceived competence is statistically significant. Elderly people perceive the robot to be friendly, well-intentioned, and understanding of their needs, but to a lesser extent than the human coach. Perceiving the robot as high on the warmth dimension is in itself an important finding, which we also can affirm with the qualitative data. In coding the narratives, we identified another, broader theme, which we label “*It’s a machine, but it’s kind and gentle.*” As emphasized by the participants:

The robot spoke very politely to us [laughs]. He is really friendly. (Female, 86)

The robot seems gentle to me. (Female, 64)

If he has revealed all of his intentions ... they are good. (Male, 72)

I was very loyal to the robot and it became my friend. (Male, 90)

Similarly, the elderly participants perceive the robot as competent, reliable, and a knowledgeable expert for the particular task at hand. They assign it an average of 4.5 on a 5-point scale, slightly lower than the human coach. The qualitative data yield similar results, in further empirical support of the high perceived competence of the robotic coach, as in the following quotes:

For what he is programmed, he is competent. He seemed smart to me. He did not say that much. If he had spoken about football ... [laughs] (Male, 72)

Wasn't it intelligent? It is more intelligent than I am. (Female, 84)

It is well-informed. If it wasn't well informed it wouldn't come here. (Female, 80)

It's smart to the max! (Male, 81)

Hedonic and utilitarian value

To investigate H3, we ran another independent-samples t-test, to determine whether the different types of coaches (human vs. robot) affect elderly participants' value perceptions regarding their enjoyment and the effectiveness of exercising using the exergame platform. As hypothesized, we find a significant difference in the mean scores, for both hedonic and utilitarian value perceptions, across the experimental groups. In particular, the mean for hedonic value when the coach is a human is 6.83 (SD = .33), whereas when it is a robot, the mean is 6.50 (SD = .73), $t(52.67) = 2.313, p < .05$. For utilitarian value, the means again are higher for a human coach (M = 6.40, SD = .78) compared with a robotic one (M = 5.56, SD = 1.31), $t(55.99) = 3.051, p < .05$ (Figure 5.8).

Figure 5.8 – Hedonic and utilitarian value perceptions of exergames

These results support H3 but do not explain the source of these differences. When we integrate the qualitative data, we realize that the elderly people had fun and enjoyed the experience with the exergames while in the company of a robot:

I loved it. I found it very interesting ... and believe me, I don't participate if I don't enjoy the activity.... I had the maximum score. It was very funny. And the robot was a good lad. (Male, 72)

I liked it a lot, lot, lot, lot, lot! The robot was always saying: 'Excellent, excellent'. That motivated me. (Female, 84)

Yet they enjoyed the experience slightly less than they did with a human coach, as indicated by their narratives:

I was a bit shy and anxious, right? Without knowing what to say, or what to do ... the movements I should do. (Female, 89)

I found it funny [enjoyable]. But I almost can't hear, so I couldn't understand most things that the robot said. (Female, 91)

Similarly, when asked to share their narratives of whether they found the exergames effective (i.e., utilitarian value perceptions) for improving their physical condition, some participants shared concerns:

Robot's explanations were not enough! I was there doing something that I didn't know if it was right or wrong. And if I really was ... as the robot was saying "Excellent", but those are the words it has inside and we cannot trust that very much. (Female, 81)

Let's see ... if the robot only does that exercise, that isn't much more than moving left and right, I think it's insufficient. So it should have more, more advantages ... (Female, 81)

Regressions

To test H4 and H5 (Figure 5.2) we estimate a system of five linear equations (see Table 4 for an overview of the dependent and independent variables in each equation), using the seemingly unrelated regressions (SUR) procedure in STATA. The SUR method is based on generalized least squares and is more efficient than ordinary least squares regression when the independent variables differ across a system of equations, because it accounts for correlated errors (Zellner, 1962). The significant Breusch-Pagan-Lagrange multiplier test for error independence ($\chi^2(10) = 28.306, p < .01$) indicates correlated errors in the five equations, and the

R-square for each individual equation is statistically significant at $p < .01$ (see Table 5.5). Therefore, using SUR is appropriate (Cameron and Trivedi, 2009; Dotzel et al., 2013). The first two equations have perceived warmth and perceived competence as dependent variables and the type of coach as the independent variable. These two equations control for the influence of the coach on social cognition. The third equation includes hedonic value as the dependent variable and perceived warmth and competence as independent variables; the fourth equation features utilitarian value as the dependent variable and perceived warmth and competence as independent variables. These two equations test H4. Finally, the fifth equation includes intention to use as the dependent variable and hedonic and utilitarian value as the independent variables, to test H5. Table 5.3 contains an overview of the descriptive statistics and correlations.

The unstandardized coefficients and their standard errors, obtained with the SUR estimator (sureg command) in STATA 14.2, are in Table 5.5. The perceived warmth of the coach has a positive, significant coefficient for hedonic value (.29; $p < .05$), in support of H4a.i; its impact on utilitarian value does not produce a significant coefficient though (.23; $p > .05$), so we cannot confirm H4a.ii. The perceived competence of the coach indicates a positive, significant coefficient for both hedonic (.46; $p < .01$) and utilitarian (1.08; $p < .01$) value, in support of both elements of H4b. Finally, hedonic value has a positive, significant coefficient for intention to use (.52; $p < .01$), as does utilitarian value (.22; $p < .05$). Therefore, we find support for H5a and H5b.

Table 5.3 - Descriptive statistics and correlations

Correlations	1	2	3	4	5	6
1. Coach (Human vs. Robot)	1					
2. Perceived warmth	-.28*	1				
3. Perceived competence	-.29*	.61**	1			
4. Hedonic value	-.25	.56**	.63**	1		
5. Utilitarian value	-.34**	.42**	.59**	.54**	1	
6. Intention to use	-.13	.43**	.55**	.56**	.53**	1
Descriptive statistics						
Minimum	0	3	3	4	2	1
Maximum	1	5	5	7	7	5
Mean	.62	4.59	4.64	6.62	5.87	4.52
Std. Deviation	.49	.64	.62	.63	1.20	.85

Table 5.4 - Overview of Seemingly Unrelated Regressions (SUR) Equations

	(1) Perceived warmth		(2) Perceived competence	
	Coefficient	Standard error	Coefficient	Standard error
Intercept	4.83**	.13	4.89**	.12
Coach (Human vs. Robot)	-.39*	.16	-.39*	.16
	(3) Hedonic value		(4) Utilitarian value	
	Coefficient	Standard error	Coefficient	Standard error
Intercept	3.15**	.51	-.20	1.04
Perceived warmth	.29*	.12	.23	.25
Perceived competence	.46**	.12	1.08**	.26
	(5) Intention to use			
	Coefficient	Standard error		
Intercept	-.19	.91		
Hedonic value	.52**	.16		
Utilitarian value	.22*	.08		

Notes: Sample size: 58; Breusch-Pagan-Lagrange: $\chi^2(10) = 28.306$, $p < .01$.

Number in parentheses above each dependent variable refer to the equations in Table 4

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

Table 5.5 - Overview of Seemingly Unrelated Regressions (SUR) Results

Equation	Hypothesis	Independent variable	Dependent variable	RMSE	R-sq	X ²	p
(1)	NA	Coach (Human vs. Robot)	Perceived warmth	.61	.08	5.64	.02
(2)	NA	Coach (Human vs. Robot)	Perceived competence	.59	.08	6.21	.01
(3)	H4.i	Perceived warmth	Hedonic Value	.47	.44	48.11	.00
(4)	H4.ii	Perceived competence	Utilitarian Value	.96	.35	37.09	.00
(5)	H5	Perceived warmth Perceived competence Hedonic Value Utilitarian Value	Intention to use	.66	.39	36.16	.00

Notes: Sample size = 58; NA = Not applicable.

DISCUSSION

This research evaluates the application of robots (i.e., SARs) in social contexts, formerly exclusively reserved for human agents. Motivated by the importance of physical activity for healthy aging, and the shortages of elderly care staff (WHO, 2015), our aim is to examine if SARs can take a coaching role and motivate elderly people to undertake physical activity, as well as potentially expand their social networks. In particular, we test whether SARs, which are not inherently social entities but are programmed to exhibit social behaviors, can give rise to social perceptions in elderly people and affect them in ways similar to those induced by human agents (Heerink et al., 2010a). With the idea that SARs equipped with social capabilities are comparable to human agents, we also seek to investigate their efficiency in motivating elderly people to engage in a new kind of physical activity (i.e., exergames), relative to the impact of human coaches.

Automated social presence and social cognition

Our findings suggest that elderly people sense that they are in the company of social entities when they interact with SARs (van Doorn et al., 2017). Our mixed-method empirical tests affirm that they struggle to classify the robot as a “machine,” because of its expressiveness, friendly voice, politeness, and considerateness. In their narratives, we detect evidence that they see the robot as a “metal box,” but due to the robot’s social dexterity, they humanize the machine in their imagination. This evidence implies that SARs potentially could extend elderly people’s social networks and support human caregivers in not just mechanical tasks but also tasks of a social nature (e.g., motivational coaches, playing games, conversational partners).

In these quasi-social interactions, in which elderly people perceive SARs as social entities, they also tend to evaluate SARs using the social cognition mechanisms they apply to humans. Our experiments shed light on social perceptions of automated agents (Reeves and Nass, 1996). Elderly people activate their warmth and competence judgments when interacting with SARs. However, when we compare human and robot actors, performing the same (coaching) task, we find that they evaluate humans as superior to the robot. We explain this slight difference with qualitative data, which reveal that the human coaches are better at responding to elderly persons’ individual needs. Even though they find Vizzy cute and funny, some elderly participants complained that they could barely hear what it was saying. Unlike Vizzy, for which the voice pace and pitch remained the same, and the volume could not be adjusted (i.e., it was already

set at its maximum), human coaches could adjust their voices to the needs of hearing-impaired participants. This difference likely affected both warmth and competence judgments.

Hedonic and utilitarian values

By conducting these experiments in a real-life context, we could test whether elderly people enjoy and appreciate this new type of gamified workout, depending on their coaching partner (human vs. robot). We demonstrate that seniors' hedonic and utilitarian value perceptions of exergames are driven by the social cognition they develop of their coaches. Elderly participants both enjoy and find the exergame more effective if they are instructed and motivated by a human, rather than a robot. The reason for this difference might be the slightly higher levels of anxiety that we find expressed in the narratives, due to interacting with the robot. For many of the elderly participants, this experience was the first time they had seen or engaged with an automated agent. Some noted their nervousness when the robot first approached them (*"Initially, I wasn't very relaxed, but I ended up being more relaxed as we continued," Male, 86*). Some seniors also lacked the information they needed to enjoy playing exergames (*"I did not quite understand the purpose of the game, because I could not hear well what the robot was saying," Female, 87*). These quotes provide insights into the participants' psychological states and physical (e.g., hearing) impairments, which hinder their full enjoyment of the exergames. These important inputs for technology developers and service designers can help them design robotic platforms to ensure the best experience for senior users.

Our analysis also demonstrates that perceived competence has a positive impact on both hedonic and utilitarian value perceptions. The effect of competence on hedonic value is even stronger than that of perceived warmth. We explain the effect by taking the exercise context into account. That is, the activity the participants were evaluating involved physical exercise, so they were particularly interested in the reliability and ability of the coach to react flexibly. Thus, it makes sense that competence judgments exhibit primacy over warmth judgments. Furthermore, for those with the robotic coach, the participants were being exposed to a new and unfamiliar agent, which increased their need to trust in its abilities before being able to enjoy the activity. We argue that human coaches might seem to perform better because they are able, if necessary, to demonstrate the movement. That is, some seniors had difficulty understanding the requirements of the exergame. In such cases, the robot could only repeat the instructions, in the hope that the participant would understand what was expected; human coaches could augment their voice instructions with a

movement demonstration, which likely improved the evaluations of their competence. Despite the robots' affective capabilities (e.g., kindness, care, emotional sensitivity), which enhance warmth judgments, their lack of competence might hinder the adoption of robotic coaches.

Contributions and implications

With these findings, we primarily contribute to the theory of social presence and explain cognitive mechanisms activated by interacting with artificial minds (Biocca et al., 2003). We advance current knowledge on the ways SARs, through their social resemblance to humans, allow people interacting with them to feel as if they are in a presence of social entities (van Doorn et al., 2017). In turn, by demonstrating that elderly people sense a social presence when interacting with SARs and develop social perceptions about them, we offer insights for further developments and designs of social robotics and systems. Including robots in people's social networks, as exercise coaches, could improve both physical and psychosocial well-being. However, in contexts that require high social engagement, humans still perform better than SARs. Social robots need continued improvements, in terms of their empathy, flexibility, and spontaneity, to adjust their behavior to the heterogeneity of human needs.

Still, SARs can be used to enhance elderly people's experience and assist human caregivers in certain tasks. Assisted living facility managers should make well-considered decisions about which tasks to automate and which to leave in human hands. Reflecting on our coaching tasks, SARs can be used to motivate seniors to be more active, but human caregivers should make sure the elderly users perform the exercises correctly and assist them if necessary.

Limitations and further research

This study provides an interesting and necessary perspective on ways in which SARs can support human caregivers in motivating elderly people to engage in physical activity, but it also contains some limitations. First, none of the elderly care institutions we collaborated with houses as many physically active clients as would be ideal for our experiments. Therefore, we conducted the study across several locations. Second, the participating care institutions, though located in the same region in the same country, feature heterogeneous elderly populations and varying conditions for the field experiments. Additional research might find other ways to expand the sample but also to minimize the differences across elderly populations and care institutions.

Third, the short-term nature of the study (i.e., single session) introduces a novelty effect, for both the robot and exergames. To rule out the effect of novelty, a longitudinal study might measure the same constructs in different phases of the experiment. Researchers then could track not only behavioral intentions but also actual behavior (i.e., whether elderly people keep playing the exergames in the future). Fourth, the robot's speech abilities were controlled with a WoZ method, which limits the spontaneity of dialog. Continued research could provide for more flexibility, moving beyond preset utterances to allow for more natural social interactions (e.g., typing responses that exactly address the questions/statements raised by the elderly participants), at least until we reach the point that the human granting agency to the robot can be eliminated and the robot can interact completely autonomously. Although the volume of the robot's speech was already at its maximum, it seemed insufficient for some elderly participants. Robot developers thus should find ways to enhance robots' volume and produce sounds on a range of frequencies that older adults can hear more easily (Pearson et al. 1995).

Fifth, in addition to speech, we controlled the robot's navigation and gaze, so our experiment does not involve fully autonomous robot behavior. Efforts to endow the robot with autonomous navigation, perception, speech, and decision making could reduce the degree of human intervention needed to ensure appropriate functioning. However, this level of autonomous behavior is rare and difficult to achieve, considering the currently limited capabilities of social robots (Broadbent, 2017). Sixth, another limitation is the robot's inability to mimic humans' nonverbal communication, such as facial expressions and gestures. It would be interesting to investigate how robots endowed with nonverbal capabilities, in addition to verbal ones, affect users' perceptions of their warmth and competence. We expect that facial expressiveness (e.g., smile, eye contact) influences warmth judgments and gestures (e.g., use of the limbs to demonstrate the exercise) might affect competence judgments.

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CHAPTER 6

Conclusion

“Hands-on experience is the best way to learn about all the interdisciplinary aspects of robotics.” (Rodney Brooks)

The compilation of chapters within this dissertation advances theory about how social robots can affect customer value (i.e., disrupt existing and shape future customer value networks) and increase customer acceptance of value-aligned robotic designs. As presented in the introduction, the four main chapters each focuses on different stages of value co-creation with social robots in services, targeting mainly the fields of services marketing, service design, service management, or engineering/robotics. In this final chapter, I leverage this interdisciplinarity by analyzing how the targeted disciplines overlap and advance novel insights.

"Interdisciplinary research (IDR) is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice." (National Academy of Sciences, 2005, p. 39)

Figure 6.1 depicts the interdisciplinary contributions of my dissertation; I discuss each contribution in the following sections.

Figure 6.1 – Overview of the interdisciplinary dissertation

CONTRIBUTION 1

At the intersection of service design and service management, I introduce the concept of **network-conscious service design and management**, which highlights the need to collect network-conscious user insights (i.e., evaluations of how novel value propositions affect their own lives, but also the lives of other network actors) to determine the value co-creation/co-destruction potential on individual and network levels (Čaić et al., 2018). By adopting a network-conscious approach to

robotic services, I advance prior literature on complex service systems (Chandler and Lusch, 2015), value constellations (Normann and Ramirez, 1993), and designing for resourcefulness (Holmlid, 2012).

MANAGERIAL IMPLICATIONS

Integrating methods and knowledge from these two disciplines also offers important implications for service practitioners. The use of interpretive, qualitative methods (e.g., user narratives, phenomenographic interviews, generative interviews; Čaić et al., 2018; Helkkula et al., 2012; Sanders and Stapper, 2012) can yield findings

relevant for a diverse set of network actors and thereby equip service managers with insights helpful for maximizing the utility of not just the focal actor but the entire network. Such insights are particularly important for network services, in which value co-creation for one actor might imply value co-destruction for another (e.g., monitoring service can be value-adding for a formal caregiver but raise major privacy concerns for an elderly person).

CONTRIBUTION 2

At the intersection of service management and services marketing, I extend the conceptualizations of value from the service-dominant (Vargo and Lusch, 2004, 2016) and service (Grönroos and Voima, 2013) logics, by empirically validating **value co-creation and co-destruction trade-offs**. I propose a novel iterative framework of value co-creation with social robots in services (i.e., dynamic perspective) and link it with the phenomenologically defined value co-creation and co-destruction potential of social robots (i.e., value trade-offs). Thus I advance the concept of service idiosyncrasy (Payne et al., 2008) and propose a way to bridge the gap between the concept and the measurement of value co-creation (Gallarza et al., 2017).

MANAGERIAL IMPLICATIONS

Users accept or reject the value proposition of robotic service, depending on their positive and negative evaluations of the robot's instrumentality for users' value attainment. Users engage in a mental trade-off of value co-creation/co-destruction potential. In turn, managers need to be aware of and design around value trade-offs (Čaić et al., 2019b). To deal with this trade-off, service managers should determine, for each robotic component (e.g., functionalities, interface, aesthetics), positive and negative impacts on the user and potentially forgo components if the disadvantages outweigh the benefits. This systematic impact assessment of each robotic component can serve as input for robot developers.

CONTRIBUTION 3

In Chapter 2, I introduce the universal dimensions of social cognition (i.e., warmth and competence; Fiske et al., 2007) and propose that users evaluate social robots according to their **affective and cognitive resources**, in addition to their human-like appearance, which induces perceptions (Gray et al., 2007). My conceptualization of social robots in services thus reflects a social psychology perspective on technology-enhanced service

interactions (Wiese et al., 2017; Wykowska et al., 2016). Furthermore, in Chapter 5, I find empirical evidence that, due to robots' social dexterity (induced by affective and cognitive resources), users humanize the robot in their imagination and feel as if they are in the company of a social entity (i.e., automated social presence; van Doorn et al., 2017). With these findings, I contribute to theorizing on social presence and explain the cognitive mechanisms activated by interacting with social entities (Biocca et al., 2003).

MANAGERIAL IMPLICATIONS

Elderly people anthropomorphize a robot's mind and behavior (i.e., feel as if they are in the presence of a social entity) and form social perceptions about the robot (i.e., warmth and competence)—findings that offer insights for the future development and introduction of social robots in care-based

value networks. First, I provide guidelines for mapping robotic functionalities according to the cognitive and affective value of the proposed robot typology (i.e., mechanic, thinking, and emotional robots and robo-sapiens; Čaić et al., 2019b). Second, I suggest that social robots could extend elderly people's social networks, if they manage to adjust their behavior to the heterogeneity of human needs (Čaić et al., 2019a).

CONTRIBUTION 4

At the intersection of service design and engineering, I illustrate the importance of aligning the social robot's design and programming with the dominant values vocalized by elderly informants. I demonstrate how visualizations of current and future service networks can help researchers maintain empathy with service beneficiaries (Segelström, 2013); different network maps, as articulations of users' mental models (Norman, 1988), represent different dominant values. This evidence of users' varying dominant values (i.e., emotional, functional, and social) implies that service designers and developers should account for service pluralism (Chapter 3). I contribute to service design and engineering by introducing a strong concept (Höök and Löwgren, 2012) of **service resonance**—the relationship between the service and different mental models (dominant values or institutional norms) for which it is intended. Then, in Chapter 5, I suggest that social robots could improve both the physical and psychosocial well-being of the elderly if they manage to master empathy and social sensitivity, which are the human characteristics most difficult to automate.

MANAGERIAL IMPLICATIONS

The recommendations for robot developers and designers are straightforward. To design robotic services that resonate with users' values, those responsible for imbuing robots with affective and cognitive codes (i.e., programming robots' minds and emotions) need to understand which values become salient when users are induced to think about future human–robot interactions.

CONTRIBUTION 5

The fifth contribution crosses the traditional boundaries of service design, service management, and service marketing. I introduce **Context Disruption** interviews, a phenomenographic approach (Sandberg, 2000) that accounts for the phenomenological nature of value, value co-creation/co-destruction, value transformation, and value networks. Disruption in the care-based network, resulting from the introduction of a new actor (e.g., social robot) or the offer of a novel value proposition (e.g., constant monitoring), disrupts institutional value co-creation in the network (Čaić et al., 2018). Designed to uncover what informants find valuable in their personal contexts, the Context

Disruption interviewing technique leverages both user narratives and their vivid representations of **current and future value constellations**. With this methodological contribution, which encourages informants to engage in network thinking and explicate the network value co-creation/co-destruction potential of robotic technologies, I address the key service research priority of designing adaptive service systems that can respond to dynamic environments (Ostrom et al., 2015).

MANAGERIAL IMPLICATIONS

The three groups of stakeholders should join forces and collect both network-conscious insights from the focal actors (i.e., elderly persons) and value co-creating/co-destroying dynamics in current and future constellations according to the other interdependent actors (i.e., formal and informal caregivers). In that way, they can detect if, for example, a benefit for a close family member (e.g., unburdening potential) can offset the loss for the focal actor (e.g., privacy concerns).

CONTRIBUTION 6

In Chapter 4, I investigate the potential roles of social robots in elderly care by taking the perspective of the focal network actor (i.e., elderly person). My findings extend scholarly understanding of value co-creation roles, by uncovering both positive and negative expectations of future service scenarios. The resulting typology identifies six potential roles of social robots (i.e., enabler, intruder, ally, replacement, extended-self, and deactivator). This typology of **anthropomorphized robot roles** extends existing role conceptualizations (e.g., Frow et al., 2016; McColl-Kennedy et al., 2012; Moeller et al. 2013), to encompass value co-creation and co-destruction counterparts, both on an individual and a network level. In Chapter 5, I empirically corroborate the finding that social robots can extend elderly people's social networks and support human caregivers in not just mechanical tasks (e.g., cleaning) but also tasks with a social nature (e.g., motivation, conversation).

MANAGERIAL IMPLICATIONS

The insight that different network actors might perceive robotic technology simultaneously as a “pain” and a “gain,” and thereby assign social robots both positive and negative anthropomorphized roles, has important implications for elderly care facility managers and robot developers. Possible approaches to deal with this dualism of roles include:

- Two-sided communications: acknowledging users' fears (value co-destruction roles) while accentuating the value co-creation roles and their positive impact for a diverse set of network actors.

- Programing around value hindrances: paying special attention to ethical considerations of robotic care (e.g., the intruder role can be diminished if the user has control over the collected information).
- Early prototypes: an iterative approach (Mahr et al., 2013) can reduce the risk of mis-development that is inherent to all-inclusive solutions and increase the likelihood of user acceptance of a radically new technology.

CONTRIBUTION 7

This dissertation demonstrates the importance of investigating mind perceptions (Gray et al., 2007) resulting from affective and cognitive capabilities of social robots. I advocate **for a value-focused design of artificial minds and emotions** in addition to other robot design criteria such as embodiment, morphology, autonomy, and assistive roles. My review of extant service literature shows that studies implicitly acknowledge the role of affective and functional abilities of a service robot (e.g., Bolton et al., 2018; Huang and Rust, 2018; Keating et al., 2018; Rafaeli et al., 2017). Continued research could explicitly include

human socio-cognitive processes to clarify similarities and differences in human-human versus human-robot value co-creation/co-destruction practices. Such efforts will have particular importance for frontline research and for investigating which complementary or substitutive roles technology might offer humans in the future (Huang and Rust, 2018; van Doorn et al., 2017).

MANAGERIAL IMPLICATIONS

The insights from my dissertation have implications that extend the boundaries of robotic design. In particular, my findings offer guidance for designing other technologies with social properties, such as voice-based personal assistants (e.g., Alexa, Siri), text-based chatbots (e.g., Uber, Pizza Hut), and hologram-based service providers (e.g., RICOH virtual self-serving holograms; RICOH, 2019). As the findings in Chapter 5 suggest, competence judgments exhibit primacy over warmth judgments for the case of motivational coaches for physical activity. This finding should inform future technology

developers: Despite inanimate social actors' affective capabilities (e.g., politeness, kindness, care, emotional sensitivity), a lack of demonstrated cognitive capabilities might hinder their adoption.

CONTRIBUTION 8

Chapter 3 emphasizes that well-established service design and service engineering approaches to visualizing service interactions, processes, and operations (e.g., service blueprint; Shostack, 1984) frequently rely too much on the perspectives of service developers, designers, or engineers, not users'. Even when users are involved in mapping the service or the actor networks, they either participate indirectly or receive a mapping template (e.g., customer journey, value framework; den Ouden, 2011). Such approaches can restrict users' participation and resourcefulness. The **Contextual Value Network Mapping**, a generative cards activity, renders visualizations of current and future value networks. It includes three generative steps: (1) selecting appropriate

network actors from a deck of network actor cards, (2) rearranging the selected cards into a conceptualized network configuration, and (3) adding the relations (i.e., pathways of value co-creation) among the different actors. This methodological contribution to literature on actor network mappings (e.g., Patrício et al., 2011; Pinho et al. 2014; Sampson, 2012) can help extend understanding of the phenomenological perspective on actor networks.

MANAGERIAL IMPLICATIONS

Practitioners can uncover additional layers of complexity in conceptualizing value networks (e.g., as in Chapter 3, in the network topology comprising hierarchical, focalized, and bundled networks) by empowering people to map their network contexts freely and translate their mental models of service systems into visual artifacts. Different network types emphasize different dominant values; service designers and engineers thus need to collect both visual data and user narratives to uncover the underlying reasons for different network structures. Collecting data using Contextual Value Network

Mapping proved useful in defining different user segments and creating respective personas.

CONTRIBUTION 9

The final contribution of my dissertation is that it introduces a **value-centric perspective on social robots in services** according to a resource-focused view of technology (Kaartemo and Helkkula, 2018; Vargo and Lusch, 2016). By adopting a value-transformation lens (Witell et al., 2016), I enhance extant knowledge on social robotics in service-related contexts (e.g., van Doorn et al., 2017; Mende et al., 2017) by (1) conceptualizing an iterative framework of the value co-creation potential of social robots in services; (2) analyzing,

comparing, and contrasting current caregiving networks with anticipated robot-enhanced caregiving networks; (3) qualitatively collecting salient basic personal values; (4) accounting for both the value co-creation and co-destruction potential of social robots; and (5) investigating the social cognitive processes in which humans engage when interacting with social robots in real-life scenarios. This transdisciplinary contribution features a value-centric framework that synthesizes four different disciplines.

Final thoughts

This dissertation addresses an important and societally relevant topic of value co-creation with social robots in elderly care services. My findings suggest a positive outlook on future, robotic services and their role in ensuring the well-being of elderly people and their care-providing networks. Thus, I concur with and further extend the roboticists Rodney Brook's viewpoint that *"The benefits of having robots could vastly outweigh the problems"*, by emphasizing the need to design robotic technologies (i.e., robot's mind, appearance, and behavior) which resonate with human values.

APPENDICES

Appendix A. Chapter 4: Context Disruption Interview - Protocol

The interviews were conducted in the elderly informants' homes or nursing facilities where they reside. Two hours were planned for each interview, which were conducted in private, usually in a meeting room (in nursing facilities) or dining room (in homes) that contained a large table or desk to perform the generative activity. Open spaces were avoided, to emphasize the confidentiality of the collected data and ensure the quality of audio recordings. After signing the informed consent form and answering the initial set of demographic questions, informants began the four-step, generative, Context Disruption interview protocol.

STEP 1: Contextual Value Network Mapping, status quo

- a. **TIMING:** Approximately 30 minutes
- b. **METHOD:** Generative technique/Value-network mapping
- c. **TOOLS:** Blank canvas, different color markers, and "actor network cards"
- d. **DESCRIPTION:** Informants were asked to think about their everyday lives and different persons who take part in their "care-based value network" (defined as informal and formal connections who are more or less actively involved in taking care of them, from helping them with groceries, to medicine intake, to social aspects of their daily lives). They had to choose different network actors from the deck of cards and place them on the canvas on the table in front of them. They were asked to:
 - i. organize and display their care-based value network,
 - ii. indicate the importance of each actor, and
 - iii. show connections between different actors using available colored markers.

After this mapping activity, the interviewer used probing questions to collect narratives about each identified network actor and the existing relationships, such as:

- Why is this actor important to you? (focusing on the care aspect)
- What does s/he do for you?
- What does s/he mean for you?
- Do you feel like you are burdening this person?
- How would you feel if this actor were no longer part of your care network

- e. **PURPOSE:** Visualization of how elderly persons perceive their care-based value networks (formal and informal). Collect information, from both what they say and what they make, to gain a better understanding of the key actors in networks, interactions among the actors, and actors' importance.

STEP 2: Active immersion

- a. **TIMING:** Approximately 15 minutes
- b. **METHOD:** Critical incident technique/Sensitizing to technology usage
- c. **TOOLS:** N/A
- d. **DESCRIPTION:** Informants were encouraged to share narratives of extremely satisfying or dissatisfying encounters they had with different types of technology (e.g., personal computers, smartphones, microwaves, Skype, dishwasher). The probing questions for satisfactory experiences included:
- Please try to remember a situation where you were extremely satisfied or fulfilled with usage of some new technology. Can you describe what led to your satisfaction?
 - Why is this technology important for you?

The probing questions for unsatisfactory experiences were:

- Please try to remember a situation where you were extremely dissatisfied and frustrated with usage of some new technology. Can you describe what led to your dissatisfaction?
 - Do you ever feel helpless when being faced with some new technology?
 - What would in your opinion have to change on this particular technology (design, additional services...) so that you would be less frustrated by it, or so that you would not be dissatisfied with this technology?
- e. **PURPOSE:** To make informants sensitive to the key experience area (i.e., new technology) before introducing an unfamiliar technological impulse (i.e., socially assistive robot). Set the stage for Step 3, which introduces an automated actor that might evoke both pains and gains in informants' care-based value networks. Collect narratives on both frustrations elderly people face while using different types of technology but also on how technological advancements make their lives easier. By identifying different emerging themes (e.g., ease of use, instructions and

explanations, design, time management), this step provided a finer-grained understanding of how value is created, as well as potential hindrances to value creation in various technology use situations.

STEP 3: Introducing “disruption”

- a. **TIMING:** Approximately 35 minutes
- b. **METHOD:** Laddering technique
- c. **TOOLS:** Canvas, robot photographs, “robot function cards”
- d. **DESCRIPTION:** Informants were informed/reminded about the project, whose main goal was to develop an affordable, socially assistive robot for elderly people. Photographs of the robot in the company of the lead author, combined with detailed descriptions, were used to evoke its look and feel. Each of its 12 functions was introduced using a robot function card containing both a graphic and a label. The interviewer always followed the same order and the same description protocol, to avoid order effects, when introducing the functions:
 1. **Medication service:** This service will contain key medical information about the user, such as medication specifications, descriptions, and dosages. The robot will remind users to take medication in accordance with a pre-established schedule. It will also notify a caregiver when the elderly person refuses to take medication.
 2. **Meal preparation assistance:** This service will provide users with voice and video instructions during meal preparation. The robot will dictate recipes, suggest ingredients, remind users how to use kitchen appliances, and so on. Robots will not be able to cook, but they can give advice and describe the process, in case users forget certain steps during meal preparation.
 3. **Communication via Skype:** At the user’s request, this service supports video or voice calls with family/friends/physicians and will provide help in creating contact lists. The user will not need to turn on a laptop or computer anymore but rather can connect through the robot’s screen with the person they wish to talk to.
 4. **Agenda service:** This service will monitor users’ daily routines and send reminders so that users do not forget their daily responsibilities (e.g., household chores, medical appointments, family visits). The robot will learn about users’ routines through daily interactions.
 5. **Organization of joint activities service:** This service will inform users about events and activities in their neighborhood/community.

Users will have an option to create an activity/event and invite other networked friends to join.

6. **Fall detector and alert service:** This service will ensure continuous tracking of primary users (i.e., elderly people) and automatically inform their formal or informal caregivers if they fall or have any other type of accident.
7. **Motivation for physical activity:** This service will stimulate and motivate users to engage in physical activity and support them during that physical activity, through voice and video instructions.
8. **Alarm clock:** This service provides standard alarm clock settings but also enables users to choose the alarm music or ring-tone they prefer.
9. **Nutritional advisor:** This service will provide elderly persons with nutritional advice and remind them about balanced nutritive intake. For example, if the robot notices through its sensors that the temperature outside is higher than average, it will remind elderly persons to drink more water.
10. **Interactive games:** This service will provide users with specially designed games to enhance their cognitive capabilities (depending on users' preferences).
11. **Object locator reminder:** This service will provide reminders to elderly persons regarding where they usually leave objects in their homes. Some frequently used objects (e.g., keys, wallets, glasses) will have sensors so the robot knows exactly where they are.
12. **Shopping assistance service:** This service will help users create grocery shopping lists and send the list to a person responsible for shopping (e.g., family members).

After all the functions were explained, informants were asked to indicate three functions that they deemed most important/useful, and then indicate three that they found least important/useful for their contexts. Next, the interviewer used a laddering technique to probe the top and bottom three functions, with the goal of eliciting core values:

- Why is this function important to you?
- (Depending on the reply) Why is important to you?
- (Depending on the reply) Why is important to you?

- e. **PURPOSE:** To acquaint informants with the robot so that they can assess and prioritize its functions, which in turn would help the researchers collect their genuine care needs and value priorities.

STEP 4: Contextual Value Network Mapping, future condition

- a. **TIMING:** Approximately 15 minutes
- b. **METHOD:** Generative technique/value-network mapping
- c. **TOOLS:** Blank canvas, different color markers, and “actor network cards”
- d. **DESCRIPTION:** Informants were asked to imagine that the previously described robot had become a part of their care-based value network. They mapped how this intervention would change their current network contexts (which they previously mapped, in the first step). Starting from the blank canvas, they had to
 - i. again select the appropriate network actors,
 - ii. rearrange the selected cards into a conceptualized network configuration,
 - iii. place the new “robot card” within the network, and
 - iv. add the relationships among different actors.

After the Contextual Network Mapping activity, the interviewer asked:

- How would you name this robot? Would you consider it to be male or female? Please write the name on the line beneath the robot (on the card).
 - In your opinion, how will the introduction of the socially assistive robot change your everyday life?
 - How will the lives/tasks of your formal and informal caregivers change?
 - Who will be connected with the robot? Who will have access to the information from the robot?
 - How would this intervention affect different interactions in the value network?
- e. **PURPOSE:** To determine whether and how the conceptualization and visualization of the care-based value networks changed relative to the first step (i.e., before versus after the introduction of the socially assistive robot). By collecting both what they say and what they do, this step again uncovered their thoughts, fears, dreams, and expectations with regard to this service innovation and their future network contexts.

Appendix B. Chapter 3 & 4: Overview of informants

#	Pseudonym*	Age	Living Arrangements
1	Ms. Gray	72	Assisted living at home
2	Ms. Ellis	86	
3	Mr. Richards	90	
4	Mrs. Cross	61	Independent living
5	Mr. Cox	62	
6	Mrs. Bell	70	
7	Mrs. Newman	73	
8	Mr. Jackson	76	
9	Mr. Evans	78	
10	Mr. Butler	81	
11	Mrs. Moore	82	
12	Mr. Pearson	91	
13	Mrs. Sanders	78	Nursing home
14	Mrs. Smart	81	
15	Ms. Penny	82	
16	Mr. Cooper	83	
17	Mrs. Summers	83	
18	Mr. Davis	86	
19	Mr. King	90	
20	Mr. Wheeler	94	

*Note: Pseudonyms used to protect informants' anonymity

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Valorization Addendum

According to the Appendix 4 of the Regulation Governing the Attainment of Doctoral Degrees at Maastricht University, knowledge valorization refers to the “process of creating value from knowledge, by making knowledge suitable and/or available for social (and/or economic) use and by making knowledge suitable for translation into competitive products, services, processes and new commercial activities” (definition adapted from the National Valorization Committee 2011). I believe that new knowledge, just as any type of innovation, should not be only academically, but also societally relevant. In this addendum, I discuss the relevance and value of this dissertation for a diverse set of stakeholders, including managers, users, policy makers, and society at large. I show how my research findings and the research approach I have developed can be utilized in practice.

Chapter 2 - Value of Social Robots in Services: Social Cognition Perspective

This chapter introduces the conceptual foundations and the framework of value co-creation/destruction of social robots in services. I conceptualize social robots as systems of varying affective (e.g., perceiving and acting upon emotional reading) and cognitive (e.g., logical and rational thinking) capabilities which affect users' personal values which in turn can positively or negatively impact robot's acceptance. With the emergence of non-human actors in complex service systems, this conceptual chapter provides important value-centric implications primarily for technology developers and service providers. First, technology developers should map robotic functionalities (e.g., recognizing user's moods, processing user's medical history, alerting caregivers in case of an emergency) according to the proposed matrix of affective and cognitive resources to increase the likelihood of user acceptance. Understanding which functionalities contribute to perceptions of human-like warmth and which to perceptions of competence, can help in crafting value propositions which will better convey the value of different robot types (e.g., thinking robot, feeling robot, or robo-sapiens). Furthermore, understanding how different functionalities feed into warmth and competence dimensions can help technology developers focus on enhancing the users' perceptions of the robot's human-like mind and behavior.

Second, since values tend to be abstract and ambiguous, interdisciplinary innovations teams are advised to get their 'hands dirty' and employ interpretative approaches to get equipped with unconscious, tacit elements of user knowledge such as users' dreams, hopes, anxieties, and fears. Technology

developers need to understand which personal values get activated as users' network contexts get disrupted by novel technologies such as social robots. That implies extending their methods toolbox with qualitative, generative research approaches (e.g., user narratives, context disruption interviews, generative techniques) that gather in-depth network insights and tap into activated personal values. Third, service providers need to start introducing novel automated services by first releasing early service prototypes and testing them with users through participatory sessions. This process should be continued in an iterative manner to detect potential hindrances to value co-creation such as privacy and data management concerns, robot maintenance and repair, and authenticity of artificial emotions. In this way, service providers can translate users' positive and negative evaluations of the robot's instrumentality to their value attainment to technology developers, in order to design robotic technologies around value trade-offs.

Chapter 3 - Beneficiaries' View of Actor Networks: Service Resonance for Pluralistic Actor Networks

Chapter 3 zooms into the activation of users' personal values such as functional values (e.g., safety and organization), social values (e.g., entertainment and connectedness), and emotional values (e.g., love and companionship). It further argues that the tools that are currently used by marketers and designers might not be the most appropriate to understand the differences in how people perceive value and value-creating networks. To fill this gap, I introduce Contextual Value Network Mapping as a tool which allows users to represent their own understanding of network structures and value co-creation/destruction rather than assuming that there is a single service network type. In that way, this chapter and its accompanying mapping tool offer important implications for both user researchers and users themselves. Benefits for users include:

- An opportunity to freely map their understanding of what is implied by a care-network, without being pushed to fit their mental maps into pre-established network templates;
- A way to make abstract future scenarios concrete, intangible elements tangible, invisible more visible;
- A gamified approach that relaxes anxiety surrounding technology discussions;
- A way to externalize mental processes to capture social connections and elicit pain-points and gain-points of robotic technology introduction.

Here, I present a couple of quotes from my respondents' feedback regarding the interviewing method/mapping technique:

Yes, it certainly helps [having cards]. It gives more structure...And I have the tendency anyway to draw when I talk...it would be difficult to express everything just in sentences...And it also helps me to understand it better to clarify some things for myself before I talk about them. It really helps, yeah! (Respondent A)

Yeah, it helped [having cards]! Because then you [the interviewer] remember more things that I've said or done using the cards and then you can probe deeper on these things. For example, "At this point you've said this...". So it was fun! It really helped. And the visualization helped a lot. (Respondent B)

I like it how you ask questions with cards. It makes it easier to answer your questions. (Respondent C)

Benefits for researchers of using the mapping card activity include:

- Helps in the recruitment of participants since they feel excited about the card 'game';
- Helps elicit users' tacit knowledge revealing more than traditional interviews;
- Allows researchers to probe into users' thinking by observing their actor cards placements and changes in actor positions prior and after the technology disruption;
- Induces 'sensitivity to others' among users (i.e., makes users think of other actors affected by the technology) to provide a network-conscious approach to designing technology-enabled service systems.

Furthermore, the concept of service resonance informs service designers and developers that they need to take the diversity of users' networks and personal values into account. This chapter highlights the differences between elderly peoples' mental models of elderly-care expressed through network visualizations, but service developers need to take into consideration that for any service, there are many actors whose mental models are significant (e.g., patients, doctors, nurses, family members, facility managers, etc.). Hence, to design new technology-enhanced services, one needs to understand the different mental models with which the service needs to resonate.

Chapter 4 - Service robots: Value co-creation and co-destruction in elderly care networks

Chapter 4 focuses on identifying users' expectations of the robot's value co-creating/destroying roles in care-based value networks. This study offers valuable insights for technology developers, service designers, service managers, and healthcare personnel. My findings demonstrate that elderly people find robots that are equipped with social skills comparable to human caring actors. Specifically, the robots invoke perceptions of anthropomorphized functions and value co-creating (i.e., enabler, ally, extended self) and value co-destroying (i.e., intruder, replacement, deactivator) roles. Service providers should understand that different categories of users might have different hopes and fears when it comes to robots, in order to tailor robotic services to enhance rather than inhibit users' health-related goals. Furthermore, adopting a network-conscious approach can garner important value co-creation/destruction trade-offs between the self and others-orientation. This can be leveraged when developing social robot introduction activities and communication strategies (e.g., acknowledging users' concerns and proposing ways to circumvent possible value co-destruction potential; harnessing network influences by emphasizing the value co-creation potential for formal or informal caregivers).

Moving service design from user-centric to network-conscious focus acknowledges that the user is not an isolated island, but rather embedded within networks of actors - that have their own views of benefits and risks of a novel (technology-enhanced) service and can even be show-stoppers when it comes to service acceptance. Therefore, my recommendation to various stakeholders intrigued by networked innovations is to engage in Context Disruption Interviews and Contextual Value Network Mappings to gather in-depth insights on value co-creation and co-destruction potential of technology-enhanced services on an individual user and network levels, from perspectives of different network actors. I advocated for and introduced the CAIC method (1. **C**ontextual Value Network Mapping – status quo, 2. **A**ctive immersion, 3. **I**ntroducing disruption, 4. **C**ontextual Value Network Mapping – new condition) to diverse sets of audiences, by offering both academic and practitioners' workshops and conferences. Below, I provide a list of events where this method was presented (excluding the academic conferences):

- "The Disruption of Service Networks", workshop at the Service Design for Innovation Conference (Cologne 2017);
- "Socially Assistive Robots in Care-Value Networks", presentation at the Institute for Systems and Robotics (Lisbon, 2017);

- “Programmed to Care: Designing Value Networks Around Social Robots”, workshop at the AI | IA Conference – ‘AI & (strategic) InterAction’ at the Brightlands Smart Services Campus (Heerlen, 2017);
- “Assisted Living in Healthcare”; Service Science Factory's workshop for the Alhtour project (Maastricht, 2017);
- “Social Robots in Services”, presented at the Department of Computer and Information Science (IDA) of Linköping University (Linköping, 2018);
- “Design of Complex Service Systems and Value Networks”, workshop at the Service Design for Innovation Conference (Porto, 2019);
- “Programmed to Care: What is the value of Social Robots in Healthcare?”, masterclass at the Limburg Leads 2019 (Maastricht, 2019).

Chapter 5 - Robotic Versus Human Coaches for Active Aging: An Automated Social Presence Perspective

Chapter 5 draws on automated social presence theory to show that users activate mechanisms of social perception when interacting with a socially-capable robot and that users humanize the machine in their imagination. Based on real-life field experiments, I report that social robots make elderly users feel like they are in a company of a social entity. Furthermore, I show that human actors score higher on social cognition dimensions (i.e., warmth and competence) compared to social robots. However, I show that social robots do not lag far behind humans in their ability to motivate elderly people for physical activity.

Robotic technologies can be seen as a potential solution for ensuring the well-being of elderly people and their care-providing networks through improved service, constant presence, and reliability. Still, the introduction of robots within the elderly care setting provokes brisk academic and public policy discussions moving from dystopian (e.g., fear of losing human touch, human obsolescence, privacy concerns) to utopian (e.g., panacea for social problems, unburdening of the overworked care staff, prolonged independent living) projections. This study provides an early indication that socially-capable robots can act as exercise coaches for elderly people and thus have a potential to improve users' physical and psychosocial wellbeing. However, I emphasize how together with improved autonomy of robots, their affective capabilities (e.g., kindness, care, emotional sensitivity) and task competence (e.g., ability to demonstrate exercises, understanding of the elderly's physical impairments) need to be enhanced.

In line with the findings of this dissertation, I advise service managers to evaluate the robotic technology they intend to implement through robot's i) similarity to

humans in terms of looks, mind, and behavior, ii) affective and cognitive capabilities, iii) value co-creation/destruction roles, and iv) level of autonomy. For the state of art social robots, I recommend augmentational roles (e.g., motivational coach, gaming partner, conversation partner) rather than more advanced care-providing roles (e.g., nursing, consoling). However, as robot's autonomy, artificial empathy, reliability, spontaneity, and flexibility improve, I believe robots will be well-equipped to extend elderly people's social networks and support human caregivers in more challenging social tasks.

Summary

Academics and practitioners alike state that we are experiencing the fourth industrial revolution, characterized by new technologies (e.g., Robots, Internet of Things, Artificial Intelligence) radically changing the ways in which and with whom consumers co-create value. As service systems increase in their complexity due to the proliferation of robotic actors exhibiting human-like mind and behavior, there is a need for a better understanding of how such anthropomorphized automation affects actors who are an integral part of these complex service systems. This dissertation takes an interdisciplinary perspective, combining knowledge from service marketing and management, service design, robotics, and social psychology, to enhance the scholarly understanding of and provide practical implications to diverse set of stakeholders regarding users' i) personal values activated by the robot's value proposition, ii) evaluations of the robot's value co-creation and co-destruction potential, and iii) social perceptions of robotic actors.

Chapter 2 introduces the conceptual foundations and the iterative framework of value co-creation/destruction of social robots in services. In this chapter, robots are conceptualized as systems of affective and cognitive resources that affect users' personal values, which in turn can positively or negatively affect the robot's acceptance. I illustrate the four different social robot types (i.e., mechanical, thinking, and feeling robot, and robo-sapiens) through a matrix of varying affective and cognitive resources. I suggest that robots' value propositions make actors' personal values salient and activate users' universal dimensions of social cognition (i.e., warmth and competence) which are important for further expectations of robots' value co-creation/destruction potential. Finally, I suggest that users accept or reject social robots based on their evaluations of robots' instrumentality to value realizations. The chapter ends with a future research agenda which offers relevant, conceptually robust directions for stimulating the advancement of knowledge and understanding in this nascent field.

Chapter 3 brings the attention to the activation of users' personal values, arguing that existing service management and design tools for network mapping do not completely capture users' idiosyncratic understanding of value and value-creating networks. I further elaborate on the benefits of user participation in mapping activities and highlight the importance of allowing users to freely map their understanding of networks for the comprehensive elicitation of basic human values within disrupted network contexts. This empirical study introduces

Contextual Value Network Mapping – a generative cards mapping activity – as a tool for visualizing actor networks, where nodes represent social and quasi-social actors (e.g., robots), while edges contain information about value co-creation/destruction practices in current and future network scenarios. My analysis of 20 network visualizations reveals three distinct network archetypes (i.e., focalized, hierarchical, and bundled) and underlying dominant personal values. With this approach, I expand the service design toolbox; hence, the primary contribution is of a methodological nature. Furthermore, this chapter introduces the concept of service resonance and offers strategies to account for the pluralistic perspectives of the network actors.

Chapter 4 examines users' expectations of the socially assistive robot's value co-creation/destruction potential and investigates the potential roles for robots in elderly care networks. This empirical chapter employs in-depth phenomenographic interviews combined with a generative card activity with 20 elderly people to elicit informants' evaluations of current and expectations of future service scenarios in which robots will assume some of the caring tasks and roles. My findings demonstrate that elderly people find socially dexterous robots comparable to human caring actors. Specifically, the robots invoke perceptions of anthropomorphized functions (i.e., safeguarding, social contact, and cognitive support) and roles (i.e., enabler, intruder, ally, replacement, extended self, and deactivator). By acknowledging both value co-creation and co-destruction counterparts and by adopting a network-conscious lens (i.e., distinguishing the importance of the robot's role on a network versus an individual level), I extend existing role conceptualizations and offer practical guidance for mitigating hindrances to network value realizations. In that way, I substantially contribute to service research, in particular to a better understanding of value co-creation with social robots in services.

Chapter 5 investigates the (social) psychology of elderly people and compares their social perceptions of human versus robotic coaches in the context of an active, healthy ageing program. An empirical model is tested through field experiments involving 58 elderly participants in a real-life setting (i.e., elderly care facilities). This study leverages a mixed-method approach, combining quantitative and qualitative data. My findings reveal several contributions to service research, accompanied by strong practical implications. I show that i) socially assistive robots make elderly people feel like they are in the company of a social entity (i.e., the activation of automated social presence); ii) elderly participants evaluate human coaches higher on perceived warmth and competence relative to robotic coaches; iii) social cognition plays an important role in the overall exercising experience (i.e., elderly people's emotional and

cognitive evaluations of the exergame and their behavioral intent to continue playing in the future). These findings inform future developments and design of social robots and systems for their smoother inclusion in the elderly people's social networks. Particularly, I suggest that socially assistive robots can help improve elderly people's physical and psychosocial well-being by assisting human caregivers through their complementary motivational roles.

This dissertation addresses a societally relevant topic of value co-creation and co-destruction with social robots in elderly care services. My findings suggest an optimistic outlook on future robotic services and their role in ensuring the well-being of elderly people and their care-providing networks. I highlight the importance of aligning robotic designs with human values and users' mental models through human-centered, iterative, and holistic service design in order to maximize the value co-creation potential and minimize the value co-destruction potential.

Curriculum Vitae

Martina Čaić was born in Zagreb, Croatia on the 21st of October 1986. In 2005 she graduated from the International Baccalaureate (IB) programme of the XV. Gymnasium in Zagreb. She studied both the Bachelor of Science (BSc) and Master of Business Administration (MBA) with a specialization in Marketing at the Zagreb School of Economics and Management (ZSEM). In 2011, she started working as a teaching assistant at the Marketing and Communications Department at ZSEM teaching the three core marketing courses: Principles of Marketing, Marketing Management, and Consumer Behavior. In 2013, Martina spent four months as a visiting scholar at the University of Michigan's Ross School of Business, Ann Arbor, USA. Afterwards, she continued working at ZSEM as a Lecturer at the Marketing Communications Department, giving classes in E-marketing and Marketing Metrics in addition to the core marketing courses.

In September 2015, Martina started as a PhD candidate and Marie Curie Fellow at the Marketing & Supply Chain Management of Maastricht University. She was one of the nine Early Stage Researchers funded by the European Union's Horizon 2020 research and innovation programme **Service Design for Innovation Network** (SDIN). As part of SDIN training, Martina has spent five months as a visiting research at the Zuyderland hospital in Sittard, the Netherlands and five months at the Fraunhofer Portugal Research Centre for Assistive Information and Communication (AICOS) in Porto, Portugal.

Martina's research on social robotics in value networks was supervised by Prof. Dr. Gaby Odekerken-Schröder, Prof. Dr. Dominik Mahr, and Prof. Dr. Stefan Holmlid. She has published her doctoral work in Journal of Service Management, Journal of Services Marketing, and International Journal of Social Robotics. Her paper "Service Robots: Value co-creation and co-destruction in elderly care networks" received the 2018 Robert Johnston Outstanding Paper of the Year Award at the Journal of Service Management. She has also presented her research at numerous international, service management and design conferences.

At Maastricht University, Martina coordinated and taught the Brand Management course and give classes in Advertising: Marketing Communications of Brands and Management of Operations and Product Development.