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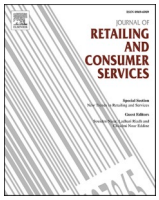

Consumers and service robots: Power relationships amid COVID-19 pandemic

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ABSTRACT

Robotics significantly influence retail and consumer services. The COVID-19 pandemic further amplified the rise of service robots (SRs) through social distancing measures. While robots are embraced widely by retailers and service providers, consumers' interaction with SRs remains an intriguing avenue of research across contexts. By taking a relative social power perspective, we report on a series of pre- and intra-COVID-19 studies. Our findings suggest that Gen-Z consumers hold more positive attitudes towards SRs perceived as lower in power vis-à-vis the human user. The longitudinal nature of our study also reveals that while attitudes towards such low-power services turned more negative during the COVID-19 pandemic, attitudes towards SRs that are high in power vis-à-vis the human user remained stable. In practical terms, while Gen-Z consumers hold more positive attitudes towards low-power robots, such service providers also face the challenge of relatively changeable attitudes towards them, especially during crisis times.

1. Introduction

Along with a 19 million population, the consumer service robots markets expanded at a double-digit (12 percent) pace worldwide, reaching 6.7 billion US dollars (Press Conference World International Federation of Robotics, 2021). Though robots have been gaining increased attention with their rapid expansion, research on service robots (SRs) has mainly remained conceptual, descriptive, and often conducted by robotic service providers and designers (Lin et al., 2020). Different customers can view the same technology (i.e., robots) in quite different ways (Siino and Hinds, 2005) based on their relative positions (Gretzel and Murphy, 2019). Empirical analysis of the interactive effects of automated social presence (i.e., robots) and human social presence on consumer service perceptions, experiences, and outcomes accelerated in tandem with the progress in the robotic services yet remained underexplored (Yoganathan et al., 2021). This research focuses on the relative social power relationship between consumers and SRs (low vs. high-power contexts) and their impact on individuals' attitudes and usage intentions.

Robot employees and SRs are increasingly in demand (Thomas, 2020) due to emotional, financial, informational, or physical safety concerns (Berry et al., 2020) with the COVID-19 pandemic. In response to the call for research specializing in the interaction of technology and human behavior during the COVID-19 pandemic (Guitton, 2020), this paper also aims to understand the impact of the COVID-19 pandemic on consumers' attitudes towards robotic services.

Therefore, the aim of the presented research is twofold: (1) to investigate the differences in consumer attitudes towards robotic services in low-versus high-power contexts; and (2) to investigate the possible effects of trait power and the COVID-19 pandemic conditions on attitudes towards low-versus high-power SRs. To these ends, we present findings of a pilot study to test robotic service stimuli, two main studies conducted before and during the COVID-19 pandemic with their longitudinal analyses, followed by a qualitative inquiry. To our knowledge, Jeong et al. (2021) conducted the only longitudinal study on consumer behavior during the COVID-19 pandemic. Their research on perceived pricing justice was the only one that used the same sample in two main studies, both conducted during the pandemic. Therefore, our research is a frontier in implementing within-subject longitudinal analysis with studies implemented before and during the COVID-19 pandemic. In addition, key themes emerging from our final qualitative inquiry provided rich detail as to the roots of the found differences. The themes

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elaborated upon in the final study include perceptions of the job market threat, accuracy, empathy, and the inevitability of robotic services.

Our results speak to many robotic industries, retailers, and service providers. Many consumer services and even physical retailers have incorporated robots at an accelerating rate in their day-to-day services, such as meeting major supermarkets' demand for robotic delivery. In response to the research call on how SRs can be effectively integrated into the store environment (Wirtz et al., 2018), our findings emphasize the importance of selecting store robots as low-in-power or high-in-power to evoke more positive attitudes by the consumers.

2. Literature review and hypotheses development

2.1. Service robots (SRs)

A service robot (SR) is "*information technology in a physical embodiment, providing customized services by performing physical as well as nonphysical tasks with a high degree of autonomy*" (Jörling et al., 2019, p. 405). SRs are used for elderly care (Kalogianni, 2015), for social assistance (Čaić et al., 2018), and in café and restaurant services (Frey and Osborne, 2017), and in physical retail stores (Brengman et al., 2021). The literature calls for further investigation into how the service customers respond to robotic technologies (Granulo et al., 2020; Jörling et al., 2019; Mende et al., 2017) since previous studies used either qualitative methods (i.e., Gretzel and Murphy, 2019), conceptual models (i.e., Kazandzhieva and Filipova, 2019), systematic literature reviews (Naneva et al., 2020), or took the managers' perspective (i.e., Xu et al., 2020).

In their conceptual work, Belanche et al. (2020) highlight the varying degrees of the autonomy-thus power - of the SRs inherent in their definition, as it varies widely, from a robotic arm in an assembly line to *Curiosity* - the robot utilized in exploring the Mars planet. Robotic entities, with powers of AI or related technologies, possess a certain amount of power in service relationships, unlike previous service technologies, i.e., vending machines or kiosks. As evident from the conceptualizations, the kind, and type of interaction with the robot, such as relative power and status, influence individuals' attitudes towards robots (Ozturkcan and Merdin-Uygur, 2018).

2.2. The power context of robotic services

The concept of power is highly tied to social context (Dubois et al., 2012). It is defined as "*an individual's relative capacity to modify others' states by withholding resources or administering punishments*" (Keltner et al., 2003, p. 265). SR-human relationships also occur on a social level (Van Doorn et al., 2017) since customers perceive that they interact with another social entity providing services (Belanche et al., 2020). Based on the varying degrees of power between human users and the SRs, some SRs can be perceived as threats that can attack, invade, or destroy human beings, while others empower customers by supporting them (Gretzel and Murphy, 2019).

Marketing literature often categorizes SRs based on either their roles or locations, such as robots in hospitals, airports, transportations, hotels, restaurants and scenic areas (Zeng et al., 2020) rather than by the nature of their relative social relationship with the humans in the way that this research aims. Wirtz et al. (2018) distinguished between professional service roles (PSRs) vs. subordinate service roles (SSRs). SSRs are lowly paid, have little education, have low engagement, and are surface-acting (i.e., cleaning service, room service, ticketing, and checkout). In PSRs, complex cognitive tasks are combined with emotional and social tasks that often involve a high degree of flexibility, out-of-the-box thinking, and creative problem solutions (i.e., divorce lawyer, surgeon). Only a few empirical studies analyzed the power relationship between users and automated presence (i.e., robots) using controlled settings. Jörling et al. (2019) demonstrated that robot autonomy decreases perceived behavioral control and perceived responsibility of the SR for positive outcomes but not for adverse outcomes. In the healthcare context, more positive perceptions of the robot were formed by human participants when the robot played the ophthalmologist looking after participants serving as patients compared to when participants played the ophthalmologist looking after the robot patient (Kim et al., 2013). Thus, being a recipient of caregiving led to more positive attitudes compared to a situation of caring for a social humanoid robot.

In summary, different social roles, functions, and services provided by SRs are highly related to the concept of social power in interactions. In line with differing outcomes in the literature, we argue that relative social power vis-à-vis the SR leads to differences in attitudes towards SR. Mainly, we aim to explore (1) the differences in attitudes towards and usage intentions of low-versus high-power robotic services; (2) the effect of individuals' sense of power on attitudes towards and usage intentions of low-versus high-power robotic services.

Moreover, to attend to the swiftly transforming context of the pandemic, we also aim to explore (3) the effect of the COVID-19 pandemic on attitudes towards low-versus high-power SRs due to the following contextual changes:

2.3. The COVID-19 pandemic and robotic services

First detected in the Republic of China on December 8, 2019 (Guardian, 2020), COVID-19 spread rapidly into other countries and continents, eventually earning a pandemic classification by the World Health Organization (WHO) on March 12, 2020 (WHO, 2020). Numerous changes have led to qualitative and quantitative increases in consumer vulnerability, fear of contamination (Hazée et al., 2017), and social isolation due to the pandemic. All types of consumer restrictions, from physiological to legal, social, economic, or self-imposed (Botti et al., 2008), have been in motion during these unprecedented times. The changing consumption patterns manifested themselves in the intersection of technology and retailing (i.e., adoption of e-commerce, Nielsen, 2020; robotic home deliveries, Willems et al., 2021). The SR industry also entered a rapid growth phase by seizing the opportunity (Willems et al., 2021). For example, McDonald's launched SR as cooks and waiters in their restaurants (Cellan-Jones, 2020).

In summary, the COVID-19 pandemic provided us, researchers, with a context where the power relationships between actors changed significantly - and perhaps to a certain extent permanently. Relatedly, the literature calls for research investigating the effect of COVID-19 on consumer attitudes towards SR and whether these attitudes have reversed in the new "1.5 m-society" (Henkel et al., 2020).

3. Methodology

A series of studies were conducted before and during the COVID-19 pandemic (see Fig. 1). First, a pilot study allowed us to verify whether the SRs to be used in the main studies are actually perceived as low-vs. high-power SR contexts. Then, we had the opportunity to run our main study twice - both prior to and during the pandemic. This design allowed us to control several other exogenous variables except for the pandemic conditions by keeping the participants the same. Lastly, we ran a final qualitative study that delved into the possible explanations and mechanisms inherent in the found effects.

3.1. Generation-Z

Except for the qualitative study, all studies were implemented as online surveys as part of a business course's requirements at a major European research university to focus on Generation Z (Gen-Z). We report all measures and demographic information of the participants in all studies in detail in Appendices A & B. There were several theoretical underpinnings of our sample choice.

Gen-Z is generally defined as people born after 1994 until the late 2000s (Williams and Page, 2011). Known as digital natives, it is the first

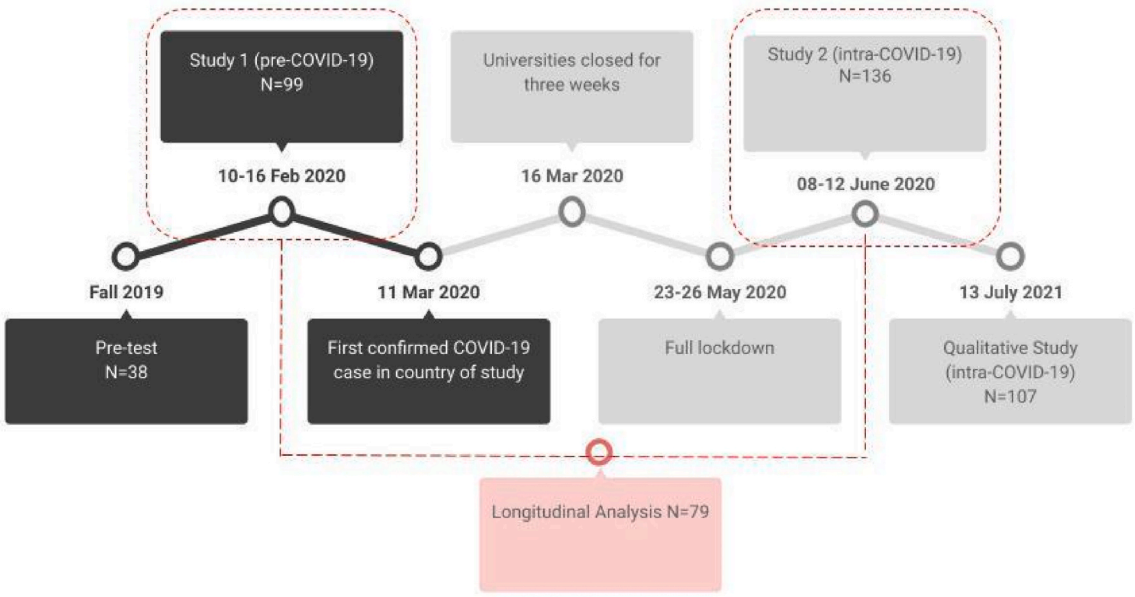

Fig. 1. Detailed research timeline.

generation to have lived wholly in a digital environment (Marron, 2015). They are frontier users of technology (Cheung et al., 2021) and various technological tools (Priporas et al., 2017), which in turn provides researchers valuable insights to unpack public response to such digital novelties (Cheung et al., 2021). Younger individuals generally hold more positive attitudes towards robotic technologies (i.e., Alkire, O'Connor, Myrden and Köcher, 2020) and are often eager to engage with them (i.e., Ezer et al., 2009). People's faith in robots increases as generational change progresses (Ruspini, 2019). Notably, Gen-Z is reported as highly welcoming and extraordinarily optimistic towards robots (DELL, 2018; Ranger, 2018). Thus, understanding the power relationships of the most embracing generation of all demands further research to foresee the broader horizon of SR better. Previous research analyzed generations in the context of COVID-19 and changed consumer behavior patterns, but not with a specific focus on Gen-Z (i.e., Eger et al., 2021).

3.2. Pre-test

Conducting stimuli pre-tests is a standard strategy in research to avoid priming participants in the main studies (Paharia, 2020; Perdue and Summers, 1986).

3.2.1. Participants

Participants (N = 38, 44.7% females, M_{age} = 23.34, SD_{age} = 3.47, range btw. 20–34) were undergraduate students enrolled in a business course at a major European research university.

3.2.2. Procedure and measures

Participants were first given the description of power, and then were exposed to eight robotic services to evaluate. From the literature on service encounters, especially robotic services that were common in both theory and practice, including humanoid and non-humanoid, AI-powered versus not, social versus not, with or without digital interface SRs, and both intuitively high-power and low-power services were selected. The final list included fast-food ordering robots (Curtis, 2016; Cellan-Jones, 2020), self-driving cars (Maurer et al., 2016; Belanche et al., 2020), airport check-in robots, robotic surgery, financial stock algorithm robots, medical diagnosis robots (i.e., IBM Watson), daily diet algorithm robots, and virtual home assistants (i.e., Amazon Echo, Alexa) (van Doorn et al., 2017). Relative power vis-à-vis the other entity is commonly measured in empirical studies in the power literature (i.e., van Kleef et al., 2006).

Customers' involvement levels affect their responses to technologies (Dholakia, 2001; Belanche et al., 2020). To control for the participant's overall interest in robotic technologies, we asked a single-item question along with gender, income, and age (see Appendix A).

3.2.3. Results

A repeated-measure ANOVA revealed a significant difference between the power ratings of robotic services (F = 1303.78, p = .000). As seen in Fig. 2, the participants rated the airport check-in robotic service as the service where they feel the most powerful vis-à-vis the robot, with a score of 5.55 over 7. As the robotic service where they feel the least powerful vis-à-vis the robot, the participants rated robotic surgery with a score of 4 over 7.

These scores as end-points are also consistent with the scores in previous literature on experienced or relative power vis-à-vis the other entity (van Kleef et al., 2006). We moved on to test whether these two end-points of the power-relationship continuum are statistically different from each other. According to the *t*-test results, individuals' perceived less power in robotic surgery than in the airport check-in, (t (37) = 4.421, p = .000).

In the single-answer questions, the majority of the participants (38%) chose robotic surgery among the eight options as the service encounter where the person would feel the weakest. Zero participants chose airport check-in as the service where one would feel the weakest. In the service encounter where the person would feel the most powerful vis-à-vis the SR, most of the participants (23.7%) chose the check-in robot among the eight options.

Based on the results, the robotic surgery and the airport check-in represented two end-points of service situations that people would feel in low-power and high-power vis-à-vis the SR, respectively (see Fig. 3).

Next, our main study was designed to investigate the differences in attitudes towards low-versus high-power SR.

3.3. Study 1: Low-vs. high-power SR before the COVID-19 pandemic

The first study was conducted between 10 and 16 February 2020, when no official cases were recorded in the region and no news depicted COVID-19 as a global risk. Study 1 had a single factor (high-power service as robotic check-in vs. low-power service as robotic surgery)

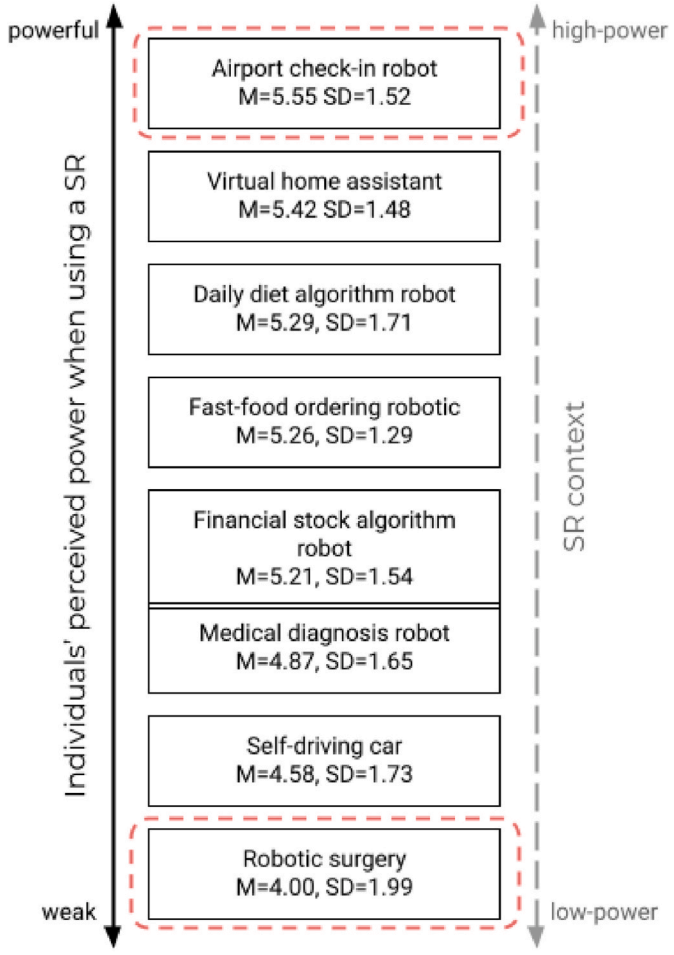

Fig. 2. Pre-test results on perceived power when using different SRs.

within-subjects design. Participants (N = 99, 61.6% females, M_{age} = 21.38, SD_{age} = 1.93, range btw. 18–30) were undergraduate students enrolled in a business course at a major European research university.

3.3.1. Procedure and measures

Participants initially responded to the sense of power scale (Anderson and Galinsky, 2006). Then, they received brief information about low- and high-power robotic services:

> "Robotic surgery is a type of surgical procedure that is done using robotic systems. Please rate how you feel about robotic surgery in terms of these dimensions."

> "Robotic airport check-in is a type of check-in procedure done using robotic systems before travel. Please rate how you feel about robotic airport check-in in terms of these dimensions."

Later, they evaluated robotic services via an attitude scale (Hesapci et al., 2016), binary choice, and intention to choose questions. Interest in robotic technologies, gender, income, and age were measured (see Appendix A).

3.3.2. Results

First, we investigated the differences in attitudes towards low-versus high-power SR. According to the *t*-test results, attitudes towards robotic surgery were significantly more negative than the airport check-in robots (t(98) = -5.829, p = 000; $M = 4.65$; $SD = 1.17$ for robotic surgery and $M = 5.49$; $SD = 1.38$ for robotic check-in).

Moreover, 77.8% of the participants opted for robotic check-in (vs. non-robotic check-in), whereas only 45% opted for robotic surgery (vs.

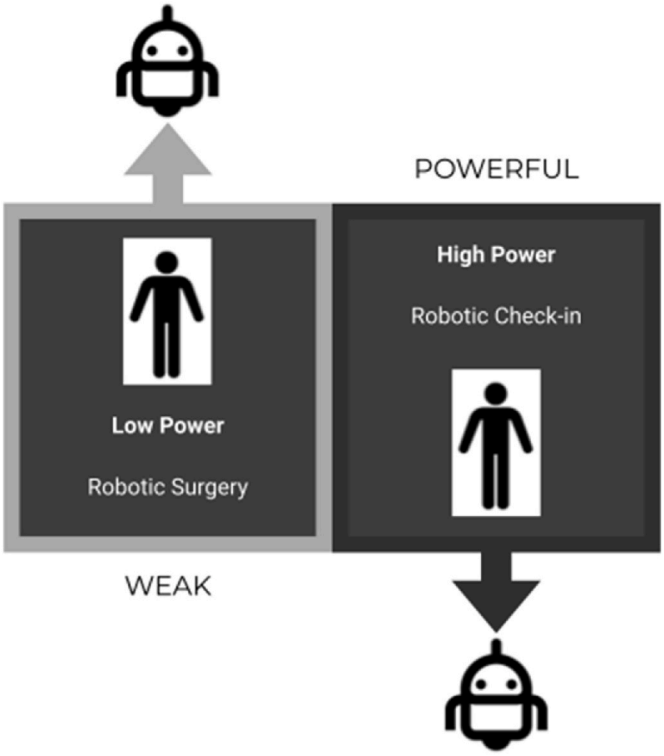

Fig. 3. Low- and high-power SR stimuli.

non-robotic surgery). Then, we moved on to analyze the role of a person's sense of power in this found effect. Neither of the attitudes towards robotic services correlated with the power of the participants (r = 0.052, p = .608 for robotic surgery; and r = 0.143, p = .157 for robotic check-in). Binary logistic regressions also revealed no effect of power on the choice of robotic versus non-robotic service in both the robotic airport check-in (p = .997) and surgery contexts (p = .904).

As the year 2020 progressed, as an attempt to investigate whether the COVID-19 pandemic affected users' perceptions of low-versus high-power SR in the forms of attitudes and intentions, we re-conducted our study.

3.4. Study 2: Low-vs. high-power SR during the COVID-19 pandemic

The data was collected between 8 and 12 June 2020 (see Fig. 1). At this point, the COVID-19 epidemic had been active for three months since its beginning in mid-March. Authorities have issued social distance and self-isolation precautions to prevent individuals from interacting with one another and enforced weekend lockdowns hoping to slow the COVID-19's progression.

Similar to Study 1, Study 2 had a single factor (low power service as robotic surgery - high power service as robotic check-in) within-subjects design and participants (N = 136, 62.5% females, M_{age} = 21.76, SD_{age} = 1.76, range btw. 18–30) were undergraduate students enrolled in a business course at a major European research university.

3.4.1. Procedure and measures

Same as in Study 1, all participants responded to the sense of power scale and evaluated both the robotic surgery and the airport robotic check-in service. Similar to Study 1, Study 2 also investigated the choice individuals would make between the robotic versus non-robotic options in case of a necessity. To rule out individual changes in perceived power due to the pandemic and its effect on attitudes towards the SR, we measured participants' power change due to the COVID-19 pandemic with a single-item rated on a seven-point bipolar scale (1 = Much

powerless compared to pre-Covid-19 pandemic, and 7 = Much more powerful compared to pre-Covid-19 pandemic). We measured their involvement with robotics, gender, income, and age.

3.4.2. Results

Participants' attitudes towards robotic surgery were significantly more negative than the airport check-in robots (t(135) = 3.194, p = .021; M = 4.62; SD = 1.21 for robotic surgery and M = 4.98; SD = 1.45 for robotic check-in). 67.6% of the participants opted for robotic check-in (vs. non-robotic check-in), whereas only 47.8% opted for robotic surgery (vs. non-robotic surgery). These findings replicated those in Study 1. However, binary logistic regressions revealed a marginally significant effect of individual's power on their choice of robotic versus non-robotic airport check-in service (B = 0.67, p = .06). The power of the participant correlated positively with their preference for robotic airport check-in to classical check-in (r = 0.325) and with their attitudes towards robotic airport check-in (r = 0.230). The power of the participant was not correlated with robotic surgery attitude or preference. These findings demonstrate that intra-pandemic, as the people's felt power increased, they held more positive attitudes towards airport check-in robots. In turn, they were more inclined to prefer robotic vs. human check-in service. Conversely, people perceiving themselves as powerless were less inclined to prefer robotic vs. human check-in services and held more negative attitudes. These findings deviated from the pre-pandemic study, where individuals' trait power was unrelated to their preference for any robotic service. Conversely, this time, power played a statistically insignificant role in predicting the choice of robotic versus non-robotic surgery.

4. Longitudinal analysis

For pre-post analysis of attitudes towards airport check-in robots and surgery robots measured pre- and intra-pandemic, we managed to match an exact total of seventy-nine participants (63.3% females, M_{age} = 21.82, SD_{age} = 1.77, range btw. 18–30) that participated in both Studies 1 and 2 based on their student numbers, which were removed from the dataset to ensure anonymity during the analysis.

First, we assessed whether the individuals' trait power significantly changed with the pandemic. Pre-post tests revealed that there was no significant change in terms of their trait power before and intra-pandemic (M_{pre} = 4.88, SD_{pre} = .86 and M_{intra} = 4.82; SD_{intra} = 0.85; t(78) = -0.770, p = .444). Moving onto attitudes, pre-post-tests revealed a significant decrease in attitudes towards robotic check-in service (M_{pre} = 5.43, SD_{pre} = 1.41 and M_{intra} = 4.98, SD_{intra} = 1.49; t(78) = -2.831, p = .006). However, there was no difference between participants' attitudes towards robotic surgery pre- and intra-pandemic (M_{pre} = 4.63; SD_{pre} = 1.15 and M_{intra} = 4.54; SD_{intra} = 1.1; t(78) = 0.544, p = .588). Preference for robotic (vs. non-robotic) check-in decreased significantly after the COVID-19 pandemic (t(78) = 2.359, p = .021) as well, but not for robotic (vs. non-robotic) surgery (t(78) = -0.799, p = .427). The rest of the results demonstrated that there were no differences in intention to prefer robotic surgery (M_{pre} = 4.27; SD_{pre} = 1.46 and M_{intra} = 4.27; SD_{intra} = 1.55; t(78) = 0.000, p = 1.00) or airport check-in (M_{pre} = 6.20; SD_{pre} = 1.74 and M_{intra} = 6.33; SD_{intra} = 1.56; t(78) = 0.483, p = .630) in case of a necessity before and after the pandemic.

In order to dig deeper into the differences found in consumer attitudes towards low-vs. high-power SR, we next collected open-ended qualitative comments.

5. Qualitative inquiry

We undertook an exploratory study that aided in the discovery of new, relevant issues and where generalizability and scaling were not key concerns (Holloway and Jefferson, 2013). Conveniently, we recruited a convenience sample of 107 (53.3% females, M_{age} = 21.41, SD_{age} = 3.00, range btw. 18–26) participants using Prolific, using an age filter (only ages between 18 and 26) to resemble Gen-Z as in our previous studies. The open-ended answering format allowed us to ask and cover pre-determined questions and topics (Berg and Lune, 2012). In this study, we briefly required the participants to describe their thoughts and feelings about either a hospital check-in robot (high-power condition) or a surgeon robot (low-power condition) via random assignment.

For data analysis, we used an interpretive approach. To shed light on the properties and dimensions of the concepts in the raw data set, we used open coding (Strauss and Corbin, 1998). Two researchers open-coded the transcripts simultaneously and coded them manually using NVivo. We first looked at the valence of expressed sentiments (see Table 1). Even though the negative nodes were slightly more apparent for the surgeon robot compared to the check-in robot, overall consumer comments were positively valenced.

Nevertheless, rather than the valence and the extremity of the attitudes, we mainly wanted to pinpoint specific concepts consumers focused on when formulating their thoughts and feelings on these robots. In the high-power condition (hospital check-in robot), responses mainly touched upon the themes of inevitable scientific progress, automation, empathy, and the COVID-19 pandemic context (related verbatims are illustrated in Fig. 4).

For the surgeon robot, participants' responses touched upon the themes of the aforementioned low-power robot's accuracy, risk, error-making, and threat to the job market (related verbatims are illustrated in Fig. 5).

The overview of the analysis of short consumer comments pointed us towards thorough explanations and directions for the found effects regarding both power and the COVID-19 contexts. For example, the emerging themes intra-pandemic lead us to consider the factors related to the robot threats in the job market (Yu et al., 2022) during a sensitive period. In the literature, SR rise has also been regarded as a double-edged sword for some time, with increased consumer buzz and engagement on the one hand and uncomfortable feelings on the other (Mende et al., 2017).

6. Discussion

We summarize our overall results in Fig. 6 below.

According to the first experimental study, participants' attitudes toward robotic surgery are lower than the airport check-in robots. Overall, the participants found robotic airport check-in more appealing, likable, positive, favorable, better and less irritating than robotic surgery. Based on our theoretical assumptions and pre-test, this difference is attributed to robotic airport check-in as a service encounter where the engaged person feels more powerful (vis-à-vis the SR). In contrast, in robotic surgery, the person feels weaker in power (vis-à-vis the SR). Resonating with the differences in their attitudes, the majority of the participants opted for robotic airport check-in compared to non-robotic check-in, but this was not valid for robotic surgery preference.

Our first set of findings complements previous research, which demonstrates that people are reluctant to use medical technologies (i.e., AI and surgery robots), mainly because people do not understand or believe the medical decisions made by such technologies, even though they outperform human providers (Cadario et al., 2021). In a similar vein, it has been known that people are more disobedient to the advice of robots (vs. humans) (Beckner et al., 2016). One can conclude that individuals show more negative attitudes and less preference towards

Table 1
Content sentiment cross-tabulation.

		CONTENT SENTIMENT			Total
		negative	neutral	positive	
Robot Type	**Check-in**	12	16	26	54
	Surgery	17	14	22	53
Total		29	30	48	107

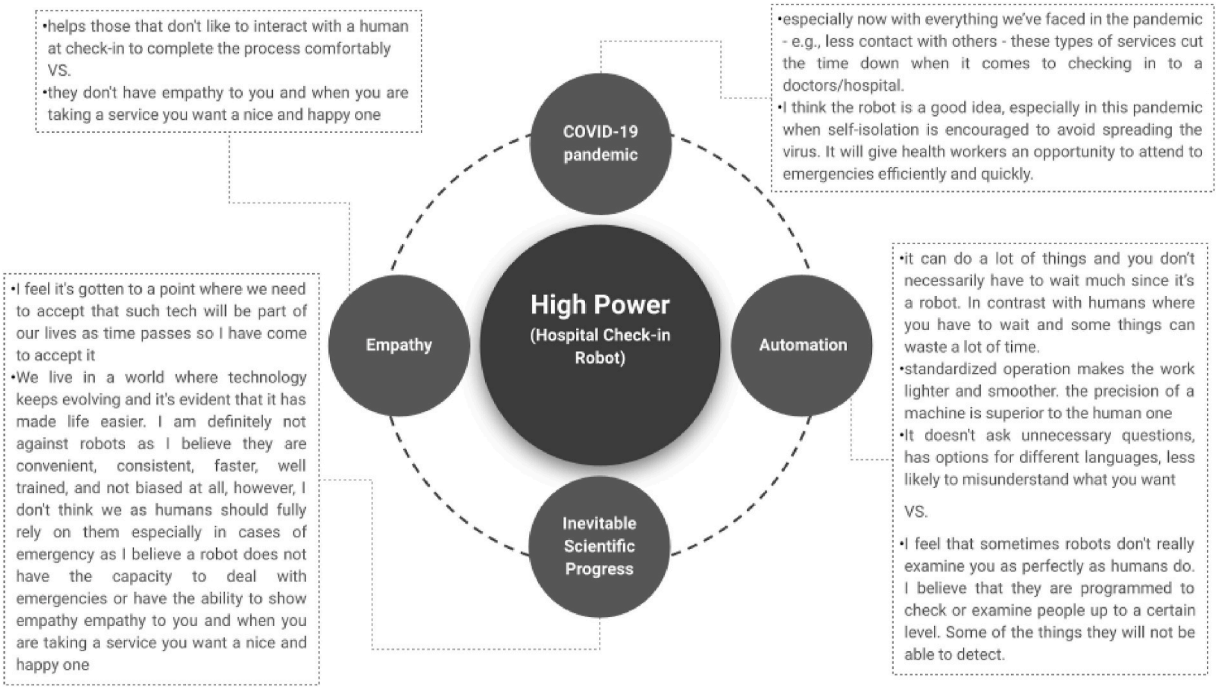

Fig. 4. High Power (robotic hospital check-in) related verbatims.

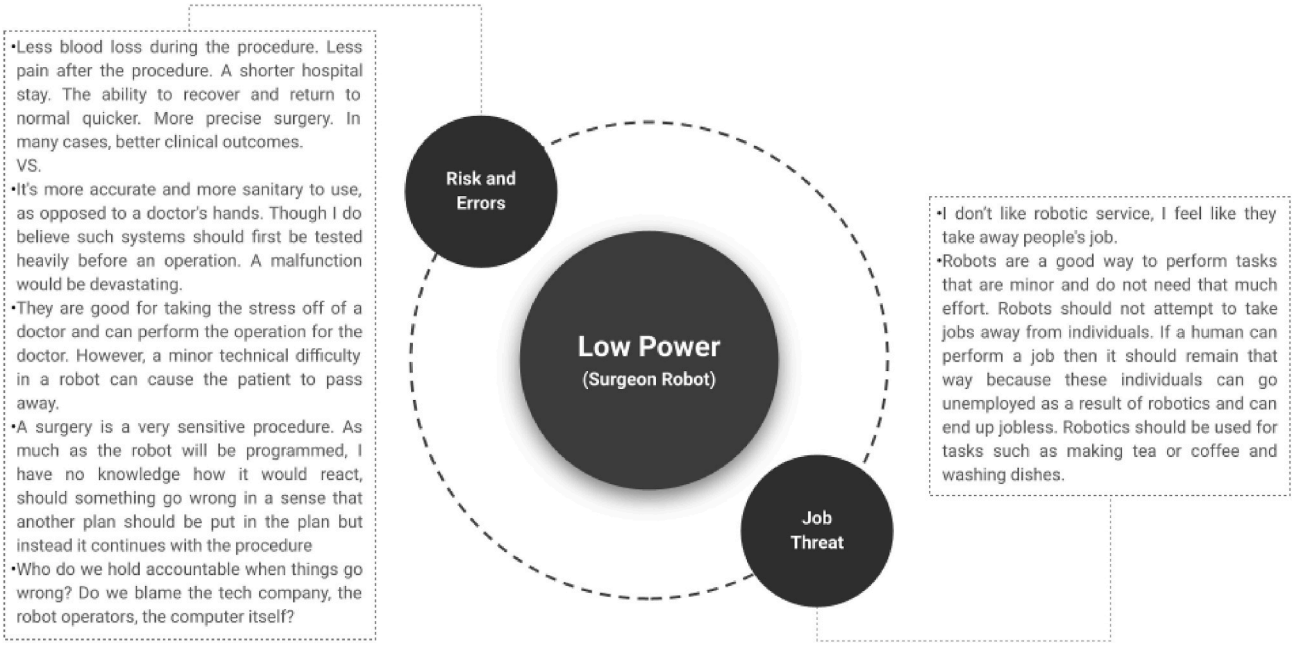

Fig. 5. Low Power (robotic surgeon) related verbatims.

robotic services that put them in a relatively less powerful position. The more positive attitudes towards low-power SR identified in the experimental studies resonated in the qualitative consumer statements as well.

The found effects are irrespective of trait power since there was no relationship between individuals' trait power and their attitudes towards robotic services. Trait power also did not predict their preference for robotic (vs. non-robotic) service choice. Therefore, our findings are conceptually attributed to contextual and relative power but not trait power. This finding paves the way for further opportunities. One may speculate that the negative attitudes of individuals in low-power contexts can be mitigated by empowering people. Yoganathan et al. (2021) mentioned an example from Japan, where severely disabled people are empowered with remote-controlled humanoid robots to work on service frontlines.

A second study was conducted a few months into the spread of COVID-19 as part of an adaptive approach to the swiftly transforming context of the pandemic. Similar to pre-pandemic, participants' attitudes toward the robotic surgery were significantly lower than the airport check-in robots. In a similar vein, the majority of the participants opted for robotic check-in compared to non-robotic check-in, but not in the case of robotic surgery. There was no relationship between power as a trait and attitudes towards robotic surgery. However, power played a

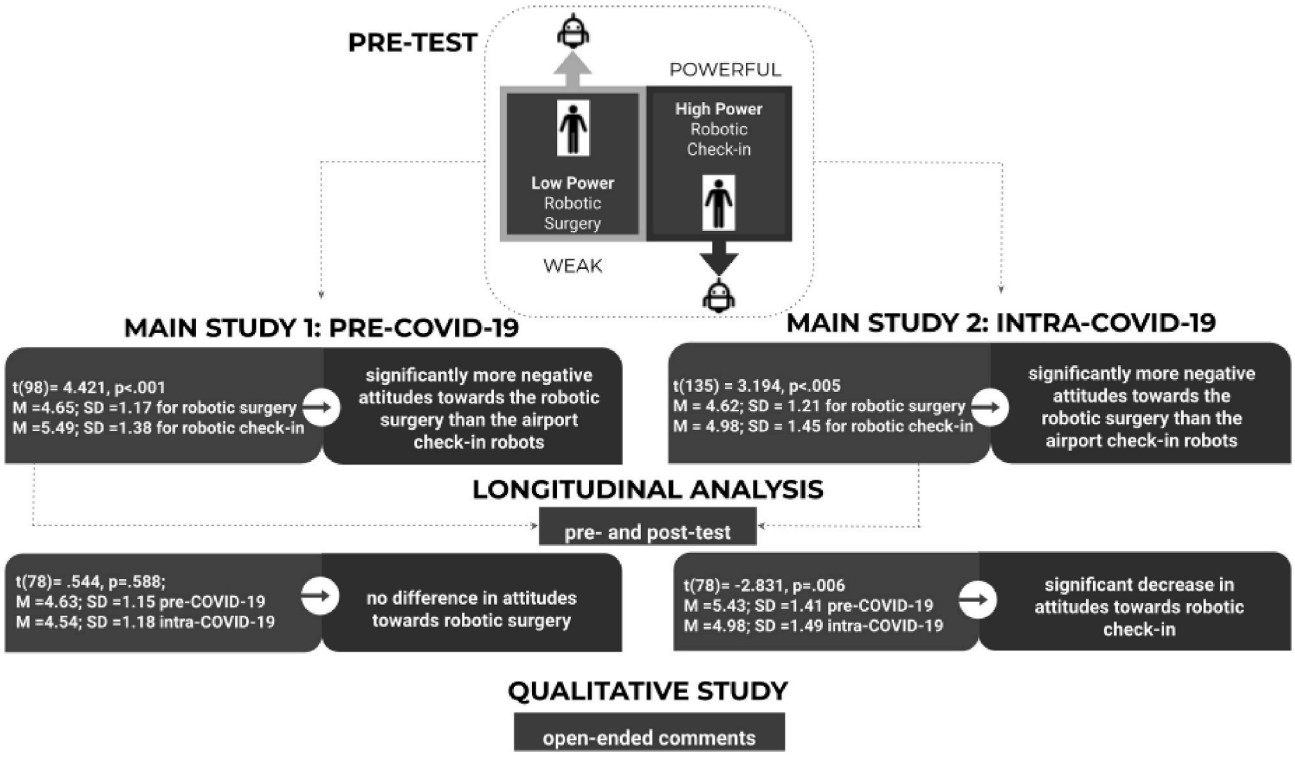

Fig. 6. Overview of research.

marginally significant and positive role in robotic versus non-robotic airport check-in choice in the second study. According to intra-pandemic data, as the power of the participants increased, so did their attitudes towards robotic airport check-in and preference for robotic airport check-in (vs. classical check-in). Since participants' measured sense of power was not different between pre- and intra-pandemic, we speculate that sense of power started to play a positive role in attitudes and preferences of high-power services (and not low-power services) after the COVID-19 crisis.

To sum up, conceptually, Gen-Z consumers held more positive attitudes towards services that they are high in power (compared to low-power) (vis-à-vis the SR) and opted for the robotic version rather than the non-robotic version of services where they are high in power (compared to low-power). However, the attitudes and the preference for only robotic airport check-in decreased intra-pandemic. Longitudinal analysis results demonstrated a significant decrease in participants' attitudes towards airport check-in robots intra-pandemic, but not towards robotic surgery. Here, one may argue that the decline in attitudes towards robotic check-in could be due to refraining from airports.

However, in the context of the COVID-19 pandemic, consumers did not only choose to distance themselves from non-essential travel but also from non-emergency healthcare as well. Individuals refrained from going to hospitals, let alone going under surgery, for less than life-threatening situations. Therefore, we should have seen a related decrease in attitudes towards robotic surgery too. However, there were no observed differences in attitudes towards robotic surgery (a high-power robotic service) pre- and intra-pandemic.

In the COVID-19 context, we contribute by showing the stable attitudes towards SR that are high in power but less stable (and more negative in a crisis time) attitudes towards SR that are low in power. Preliminary qualitative findings lead us to consider the factors related to the need for the human touch in the face of increased automation and technology as well. More than ever, the need for human touch, companionship, and even a hug has been amplified in the COVID-19 pandemic context (Gray, 2021). Travel restrictions, lockdown, and quarantine have resulted in isolation and separation, resulting in social contact deprivation (Banerjee et al., 2021). We speculate that the downside of the pandemic, especially for low-power SR, can be the increased preference to preserve the human touch and a decreased preference to use robotic versions of even simpler consumer services.

Previous research studying the intersection of the consumer individual and the robot service provider, though limited, only aimed to determine the general principles of optimal robotic service delivery and has not paid enough attention to the particular boundary conditions in service delivery contexts (Pitardi et al., 2021). Our findings complement the research on changed consumer behavior intra-crises as well as previous research on traits and relative power. Theoretical and practical implications of these findings are discussed next.

7. Implications

Our results have several empirical, theoretical, and practical implications. First, we connect the literature on social power (Dubois et al., 2012) to the emerging fields of AI and SR (Mende et al., 2019). Our findings contribute to the social power literature by demonstrating that not only do people low in power demonstrate variability across contexts (Kraus et al., 2011), but also attitudes towards robots low in power (vs. high in power) are variable across contexts (i.e., pre- and intra-pandemic contexts).

Previous literature mostly dealt with only a specific type of autonomous robotic services such as home assistants (Schweitzer et al., 2019) or smart heaters (Jörling et al., 2019). We focus on SRs varying in terms of consumers' relative power ratings. In that sense, we also respond to Lu et al.'s (2020) call for studies on customer-robot relationships as power trade-offs.

We also contribute to the literature related to crises by situating our research within the COVID-19 pandemic context. Previous research partly dealt with real-life crises (i.e., the 9/11 terror attack in 2001). As Berry et al. (2020) made clear, the high-contact nature of many services leads to drastic changes in how robotic technology is used, appreciated, or hurt during non-contact health crises (i.e., the COVID-19 pandemic). Post-pandemic, whether the experienced fast-paced diffusion of robotics

in services advanced during the pandemic is to remain, transform or fade out remains to be explored. We agree with scholars (Beane and Brynjolfsson, 2021; Lee and Lee, 2021) predicting that the current predicament of shifting consumer preferences could be lasting - even when the current crisis ends - to lead to significant SR adoption in the future (i.e. human-robot cobotic teams in hospitals and medical services, Shanks et al., 2021).

For service providers, we demonstrated that the attitudes of Gen-Z towards powerful SR (i.e., robotic surgery) are relatively low but more stable over time and crises. High-in-power robotic services are increasing their share amongst services. For example, in terms of value, medical robotics' sales accounted for 47% of overall professional SR turnover in 2019; and robotic surgical systems, the most expensive type in the sector, were primarily responsible for this (International Federation of Robotics, 2020). In the healthcare industry, "cobotic" teams (Peshkin and Colgate, 1999) allow robots to assume leadership roles (Shanks et al., 2021) due to the increasing diagnostic capabilities and accuracy of AI-powered medical robots (i.e., IBM Watson). Combined with our findings, this can be challenging as traditionally, humans desire autonomy and control over technology, commanding all behavior of robots working for them (Isabet et al., 2021). Therefore, healthcare industries serving the option of robotic vs. human care to their patients might look for ways to ease these tensions. One way to do that is to be more transparent in the use and operation of AI, algorithms, and robots, or highlight the various ways that consumers have control (i.e., giving the consumer control over rate, timing, and content; Huang et al., 2009)

Meanwhile, less powerful SR (i.e., robotic check-in) contexts have to deal with negativity in user attitudes and lower preference rates. Therefore, low-power SR providers, such as home and food-ordering assistants, are likely to deal with negative changes in Gen-Z's consumer attitudes intra-crisis. Frontline SRs, such as those in dining or hospitality services, are mainly low in power compared to consumers. Previous findings warned such service providers about risks due to lack of human contact, ethical concerns, or loss in the quality of the received service (Huang and Rust, 2018; Makridakis, 2017; Tussyadiah et al., 2020). Our results speak majorly to assistive technologies such as self-check-in by adding to these warnings and highlight the importance of developing strategies to overcome negative acceptance from Gen-Z consumers.

As the research on optimal designing, placing, and using SR within the store environment is gaining momentum (i.e., Brengman et al., 2021), our finding that points out more negative attitudes towards low-power services during the pandemic (vs. pre-pandemic) paves the way for future research by sorting out alternative functions for such robots in overcoming this negative effect. As high-power services demonstrate less positive but more stable attitudes by consumers during crisis times, robotic service providers may consider these while operating under similar crisis conditions.

At the macro level, several studies discussed the possibility of robots and employees working together in organizational settings (El-Ansary et al., 2016). Our research findings may guide brands, retailers, and even advertising agencies in designing their operations by paying attention to the power of the robots vis-à-vis the human employees for optimal performance.

Last but not least, policymakers should face the contextual gaps in the robotic marketplace, such as the digital divide and the generation gap (Mele et al., 2021). In light of the previous and present findings, policymakers should identify and understand societal challenges accompanying new technologies. Policies should address both the conflicts and tensions (i.e., robots as empowering vs. threat tension) and explore the ethical implications of public and private uses of robots in the future.

8. Limitations and future research

Being amongst the frontiers of longitudinal research covering attitudes towards technology during the pandemic, certain limitations of this study must also be addressed. Due to the importance and extremity of the COVID-19 context, we used a two-stage longitudinal design, complemented with a pre-test as well as a qualitative study. However, more than two legs of data gathering may have been necessary to solidify our findings in the future. Moreover, even though multi-method queries are being seen more prominently in lead marketing journals and promote data-richness to a great extent (Blanchard et al., 2022), further studies may be employed using alternative methodologies, such as lab experiments or field observations involving robotic services.

There are a few limitations related to the generalizability of our research findings. Partly bound by the pandemic context, the sample in this research consisted of university students - belonging to the Gen-Z. The demographic data for all studies presented in Appendix B illustrates that our sample selection resulted in a fairly good representation of Gen-Z. Student samples are typical in social psychology (Pettit and Sivanathan, 2012) and robotics research (Baddoura and Venture, 2013). One of the most significant future challenges awaiting marketers, and consequently retailers, is cited as the Gen-Z (Priporas et al., 2017), as these digital native consumers are known to behave differently towards experiences involving novel technologies, such as robotic services. Still, future research involving a more comprehensive range of ages and occupations is needed. Generational differences in attitudes towards different SR are a promising avenue of research. For example, Xu et al. (2015) demonstrated that compared to younger individuals, older people tolerated the slow speed of robots more while young adults expected robots to move faster for efficiency. Along these lines, one would expect tolerance for robots low-in-power by the older generations but not by younger people.

Next, in all studies, we refrained from using any visuals or images of the robotic technology to control for biases related to branding, size, or visual aesthetics. Even though using SR scenarios instead of real robots can be considered a limitation, service scenarios and online questionnaires are common practices in robotics research (Leo and Huh, 2020). SRs used in our studies were not also specifically anthropomorphic. Research on anthropomorphic robots shows that people contact SRs to replace some social activities and satisfy their need for socialization - especially during the no-touch and social distancing policies of the COVID-19 pandemic (Wu et al., 2021). One may suspect that using highly anthropomorphic robots may elevate consumer attitudes - as long as the anthropomorphic robot is not perceived as having too much power vis-à-vis the human user. Hence, the role of the anthropomorphism level of the SR can be investigated in future studies.

Future research may also re-examine the power context and the attitudinal changes in crisis times from a cross-cultural perspective. National cultures, as well as internalized cultural orientations such as individuals' values and thinking styles, shape their responses and coping strategies to the COVID-19 pandemic (Guan et al., 2020). Future research may take the perspectives of individualism-collectivism or uncertainty avoidance (Hofstede, 2011) and their potential relevance in human-service robot interactions. The rest of our recommendations are summarized in Fig. 7 as an agenda for future researchers.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethical approval

The studies in the manuscript have been approved by the IRB of the main author's university.

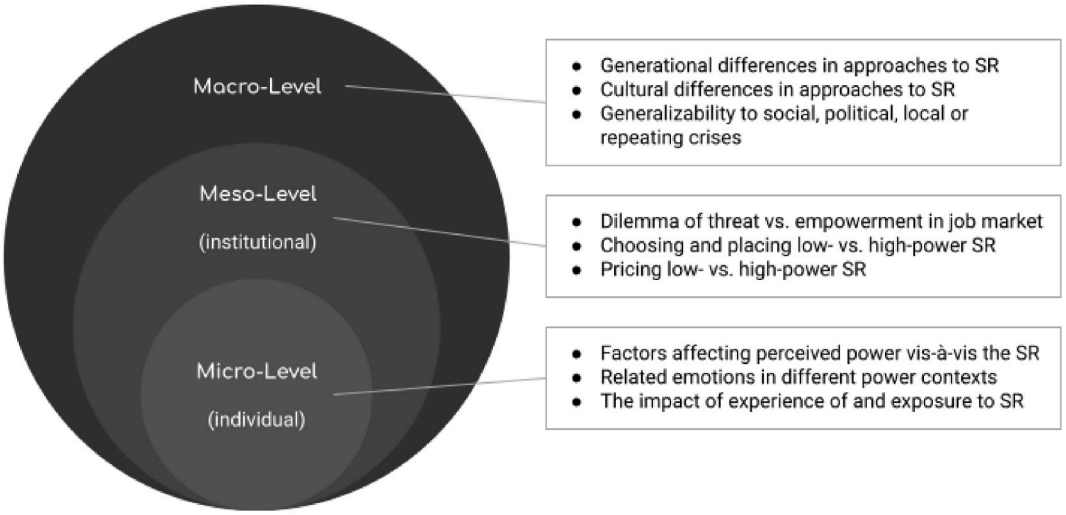

Fig. 7. Agenda for future research.

Declaration of competing interest

None.

A. Full scale items, response formats and Cronbach Alphas of the measures

Scale items, response formats and Cronbach Alphas of the measures used in all studies.

PILOT STUDY	No. of items	Items/Questions	Response Format	Cronbach's Alpha (if available)
Perceived power vis-a-vis SR	Single-item	*"POWER has been defined as the capacity to influence others or the situation. Please indicate how powerful you feel when you are using these services. For example, if you feel extremely powerful during a check-in service, mark "very powerful" in that line."* ● fast-food ordering robots ● self-driving cars ● airport check-in robots ● robotic surgery ● financial stock algorithm robots ● medical diagnosis robots ● daily diet algorithm robots ● virtual home assistants	1 = very weak, 7 = very powerful	
Low-power robotic service	Single-item	*Please indicate in which robotic service the person would feel the weakest*	Single choice	
High-power robotic service	Single-item	*Please indicate in which robotic service the person would feel the most powerful.*	Single choice	
Interest in robotics	Single-item	*How involved/interested are you with/in robotics?"*	1 = not interested at all, 7 = very much interested	
Demographics (gender, income, age)				
STUDY 1				
Chronic sense of power	Eight-item	*I can get people to listen to what I say.* *My wishes do not carry much weight (R).* *I can get others to do what I want* *.Even if I voice them, my views have little sway/influence. (R)* *I think I have a great deal of power.* *My ideas and opinions are often ignored. (R)* *Even when I try, I am not able to get my way. (R)* *If I want to, I get to make the decisions.*	1 = not at all, 7 = very much	.690
Attitudes towards low-power robotic service	Six-item	*"Robotic surgery is a type of surgical procedure that is done using robotic systems. Please rate how you feel about robotic surgery in terms of these dimensions."*	7-point semantic differential scale ● irritating/not irritating, ● not appealing/appealing, ● unlikable/likable, ● bad/good, ● negative/positive, ● unfavorable/favorable	.867
Attitudes towards high-power robotic service	Six-item	*"Robotic airport check-in is a type of check-in procedure done using robotic systems before travel. Please rate how you feel about robotic airport check-in in terms of these dimensions."*	7-point semantic differential scale ● irritating/not irritating, ● not appealing/appealing, ● unlikable/likable, ● bad/good,	.945

(*continued on next page*)

(*continued*)

			● negative/positive, ● unfavorable/favorable	
Likelihood to prefer the robotic versus non-robotic options of low-power service	Single-item	*"In case of a surgery necessity, please rate how likely you are to opt for a robotic surgery out of 7?"*	1 = opt for non-robotic, 7 = opt for robotic	
Choice of the robotic versus non-robotic options of low-power service	Single-item	*"In case of a necessity, which surgery method would you prefer?"*	binary choice 0 = robotic, 1 = non-robotic	
Likelihood to prefer the robotic versus non-robotic options of high-power service	Single-item	"*In case of an airport check-in necessity, please rate how likely you are to opt for a robotic airport check-in out of 7?"*	1 = opt for non-robotic, 7 = opt for robotic	
Choice of the robotic versus non-robotic options of high-power service	Single-item	*"In case of a necessity, which airport check-in method would you prefer?"*	binary choice 0 = robotic, 1 = non-robotic	
Interest in robotics	Single-item		1 = not interested at all, and 7 = very much interested	
Demographics (Gender, income, age)				
STUDY 2				
Change in perceived power due to the pandemic	Single-item	*"As you know, the Coronavirus contagion (known as COVID-19) caused a great number of changes in our economic and social lives at micro and macro levels. Please indicate how you feel because of the pandemic right now."*	7-point bipolar scale 1 = Much powerless compared to pre-Corona, 7 = Much more powerful compared to pre-Corona	
Chronic sense of power	Same as Study 1			.723
Attitudes towards low-power robotic service	Same as Study 1			.893
Attitudes towards high-power robotic service	Same as Study 1			.937
Likelihood to prefer the robotic versus non-robotic options of low-power service	Same as Study 1			
Choice of the robotic versus non-robotic options of low-power service	Same as Study 1			
Likelihood to prefer the robotic versus non-robotic options of high-power service	Same as Study 1			
Choice of the robotic versus non-robotic options of high-power service	Same as Study 1			
Interest in robotics	Same as Study 1			
Demographics (Gender, income, age)				

B. Demographic Characteristics of Participants

Gender and income distribution of the participants.

Baseline characteristics	Pre-test		Study 1		Study 2	
	n	%	*n*	%	*n*	%
Gender			(1 undisclosed)		(3 undisclosed)	
Female	17	44.7	61	61.6	85	62.5
Male	21	55.3	36	36.4	48	35.3
Income						
Low	6	15.8	38	38.4	20	14.7
Low to middle	5	13.2	8	8.1	13	9.6
Middle	23	60.5	33	33.3	62	45.6
Middle to high	4	10.5	15	15.2	37	27.2
High	0	0	4	4.0	4	2.9
	38	100%	99	100%	136	100%

Baseline characteristics	Longitudinal Analysis Sample (Study 1&2)	
	n	%
Gender	(1 undisclosed)	
Female	50	63.3
Male	28	35.4
Income		
Low	16	20.3
Low to middle	7	8.9
Middle	32	40.5
Middle to high	21	26.6
High	3	3.8
	79	100%

Qualitative study

Gender and income distribution of the participants in the qualitative study.

	N	%
Gender		
Female	57	53.3
Male	50	46.7
Income		
Low	46	43
Low to middle	28	26.2
Middle	29	27.1
Middle to high	2	1.9
High	2	1.9
	107	100%

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