Chapter 13
Use of Socially Assistive Robots in Mental Health: Barriers and Facilitators

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ABSTRACT

Access to mental healthcare is faced with many challenges and to address the needs of patients, socially assistive robots (SAR) have been used as an innovative therapeutic tool. The literature highlights a variety of relevant functions and benefits that these robots can serve, be it companion, coach, or play partner. This chapter aims to contribute to the current knowledge about SAR in mental health as a tool that could complement the support provided by professionals, identifying its barriers and facilitators. Despite the presence of certain barriers to their implementation (e.g., technical problems, professionals' resistance), social robot interventions generally show positive effects on patients with mental health conditions.

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BACKGROUND

In mental health, there is a well-documented gap between people in need of support and those who receive care (Lawrence & Kisely, 2010), which may be due to a lack of available professionals, difficulties of transportation, the stigma around engaging in mental health care and financial barriers (Andrade et al., 2014).

To address this treatment disparity, socially assistive robots (SAR) have been used as an innovative therapeutic tool, increasingly explored in recent years to address the growing need for alternative interventions (Guemghar et al., 2022), increasing the use, fairness, and cost-effectiveness of services (Dino et al., 2022).

SAR was developed to provide assistance through social interaction (Scoglio et al., 2019) and to create a friendly and effective interaction with the person, with the additional aim of giving assistance to them and achieving measurable progress in life quality and well-being, often related to motivation, rehabilitation or learning (Feil-Seifer & Matarić, 2005).

According to their function, they can be classified into three primary roles: companion, coach, and play partner.

In terms of design, SAR, often in animal or humanoid forms, have a variety of functionalities to engage a user's attention (Rabbitt et al., 2015). Animal-like robots are created to reproduce the physiological, psychological, cognitive, and socioemotional benefits of animal-assisted therapy without the associated inconveniences (Valentí Soler et al., 2015).

Pet robots are considered a safer choice for therapy in a care setting or even at home as animals may not be allowed inside care settings, to avoid the potential risk of causing injury to patients and professionals, the possibility of causing allergic reactions, and the potential inconvenience related to cleaning and hygiene (Valentí Soler et al., 2015).

Professionals and patients can also show undesirable reactions to animals, both negative (e.g. fear) and overly positive (e.g. becoming too attached). Aggressive patients can also frighten or hurt animals. Less noise, less work requirements and less costs are additional benefits of using pet robots (Valentí Soler et al., 2015).

Other potential advantages of robot therapy include the fact that there are fewer known adverse effects, there is no need for specially trained professionals and the sensors of some robots can respond to environmental changes (movements, sounds...) by simulating interaction with the patient (Valentí Soler et al., 2015).

SAR embodied in a humanoid appearance show the highest levels of acceptability and usability among patients. These robots, with humanlike facial features, communication modalities, and motion patterns, seem to create a more natural interaction (Barrett et al., 2019). Some robots can converse, play music, and display images or videos. Others may even perform movements to demonstrate a set of physical exercises (Guemghar et al., 2022).

SAR are typically fully programmable and can express a variety of different behaviors that might be modified and adapted over time, for example, during the treatment, allowing their customization to patients' needs (Rasouli et al., 2022).

The application and effectiveness of socially assistive robots have been investigated in mental health, along the life cycle, either in housing and/or institutional context, and some barriers and facilitators were identified (Koh et al., 2021).

The barriers refer to the challenges that the implementation and use of these robots can bring not only to the users and caregivers but also to the professionals that implement them, as well as to the environment and space where they are used. Barriers can be classified into several levels, namely organizational, clinical, and technical (Guemghar et al., 2022).

On the other hand, the facilitators are the positive points and the advantages that these robots bring to patients, professionals, and surrounding space, among others and they were also divided into organizational and technical levels (Guemghar et al., 2022).

The barriers should be avoided and for this it is important to understand the feelings (acceptance or denial) that the robot can awaken in the users, making the contact more impactful (Shourmasti et al., 2021).

Even with these noted barriers, SAR research has already been conducted for a variety of mental health conditions and with a diverse group of patients (Rabbitt et al., 2015).

In children and teenagers, studies show that for children with autism spectrum disorder using intervention with robots can improve cognitive and social performance (Lehoux & Grimard, 2018).

In adults, results demonstrate that SAR have been great allies in the rehabilitation of patients with social anxiety, depression, or schizophrenia, occurring as a facilitating tool, in the social mediation of the interaction between two people or between the person and the therapist (Rasouli et al., 2022).

The results of a study carried out with the intervention of the PARO (a baby harp seal robot) in individuals with depression demonstrated a significant decrease in symptomatology and loneliness, contributing to an improvement in quality of life (Chen et al., 2020). A case study with the AIBO (a robotic dog) suggests that it can be a successful tool for diminishing negative symptoms in schizophrenia and general psychopathological symptoms, enhancing socialization, reducing loneliness, and improving general well-being (Narita et al., 2016).

In older adults, studies highlight the importance of the use of SAR as a useful tool with potential benefits in the safety, quality of life, and independence in particular those living in demographic settings where issues of isolation and loneliness are more evident (Lehoux & Grimard, 2018), for example. Intervention conducted with the PARO robot demonstrated significant results in decreasing loneliness in older adults (Robinson et al., 2013). People in this age group who had an intervention with the AIBO robot were able to minimize loneliness to some extent, compared to other groups who were not in contact with it (Banks et al., 2008). In a therapeutic context, with older adults with various degrees of dementia, with whom the PARO robot intervention was performed, it was possible to evidence multidimensional behavioral changes, with potential therapeutic benefits in social, visual, verbal, and physical interactions (Šabanović et al., 2013).

Studies have shown that intervention performed with SAR in individuals with dementia, schizophrenia, depression, autism spectrum disorder, attention deficit hyperactivity disorder, and intellectual disability, positively benefits social interaction, improves the emotional state, decreases agitation, develops more adaptive behaviors and consequently improves their quality of life (Guemghar et al., 2022; Rasouli et al., 2022).

The emerging role of SAR in mental healthcare interventions may create an opportunity to address key gaps in services to people in need of care. The use of SAR in mental health research and interventions is recent and has been restricted to specific populations. We suggest that the application of SAR could be extended to a wide range of mental health domains.

SOCIALLY ASSISTIVE ROBOTS: DEFINITION

SAR refers to a specific type of robotics that focuses on the development of robots capable of assisting individuals through social interaction (Feil-Seifer & Matarić, 2005).

They can provide motivation, coaching, training, and appropriate emotional, cognitive, and social support to users, with the potential of improving access to personalized care in a large spectrum of populations (Feil-Seifer & Matarić, 2005; Scoglio et al., 2019).

These types of robots can have a substantial positive impact on personal challenges such as supporting and maintaining a healthy diet, an active lifestyle, therapeutic programs, and individualized education (Matarić & Scassellati, 2016; Tapus et al., 2007), enhancing user's capabilities and their quality of life and well-being (Clabaugh & Matarić, 2019). The use of these robots allows the performance of a variety of interactions that can fulfill a clinical role without the need for a professional or with a minimal contribution of them, providing education and feedback to the user, while fulfilling the role of coach and monitoring the progress of the treatment (Cho & Ahn, 2016).

SAR are used in combination with professional interventions to increase engagement and offer additional opportunities for social interaction and skills development (Rabbitt et al., 2015), through the use of non-physical strategies, including the use of speech, facial expressions, and communicative gestures, assisting in a particular context, across organizations and/or homes (Clabaugh & Matarić, 2019).

SAR must understand and interact with the patient's environment, exhibit appropriate behavior, and focus its attention and communication on the user, allowing the achievement of specific assistive goals. The robot must do all of this in a safe, ethical, and effective way for the patient (Matarić & Scassellati, 2016).

An intervention through SAR is defined essentially by its desired outcome and application domain. For example, an intervention with an individual suffering from dementia may seek to ensure, through daily reminders, their medication intake whereas an intervention with a patient suffering from anxiety may seek to improve their emotional self-regulation through practices of meditation. Depending on the individual's needs, a SAR intervention could take days, weeks, months, or years and it should be personalized, a priori or during an intervention, modifying or adapting to the unique needs and preferences of each patient (Clabaugh & Matarić, 2019).

SAR FUNCTIONS

According to their function, SAR can be classified, into three primary roles: companion, coach, and play partner. In terms of design, SAR, often in animal or humanoid forms, have a variety of functionalities to engage the user's attention (Rabbitt et al., 2015).

Companionship

One of the most employed functions of SAR in mental health is related to robots with the role of companionship (Rabbitt et al., 2015).

Many of the studies examining SAR in the role of a companion have focused on older adults, many of whom either were identified as having either dementia (Hung et al., 2019) or depression (Berridge et al., 2023). Studies show that an intervention with the PARO robot shows benefits that include the reduction of negative emotions, and behavioral symptoms, improving social engagement, mood improvements, and a better quality of care experience (Hung et al., 2019; Wang et al., 2022).

Play Partners

A second application of SAR has focused on robots as play partners who support children in practicing or building skills, most often in children with autism spectrum disorder (Scassellati et al., 2012). Autism is a neurodevelopmental disorder characterized by persistent deficits in the ability to communicate and interact socially across multiple contexts, along with identifiable patterns of restricted and repetitive behaviors, interests, and activities (APA, 2014). SAR can be programmed to help the child learn socially interactions and appropriated and desirable behavior and also provide stimulus for interactions with people (Cho & Ahn, 2016).

Coach

Finally, a third role that SAR has occupied in mental health research is that of a coach. These robots can describe and serve as a model for the performance of tasks, they can also monitor patient's performance, provide corrective feedback, and offer encouragement and support (Rabbitt et al., 2015).

An example to illustrate this type of robot is robot Baxter, which demonstrates a set of physical exercises, monitors and evaluates the user's performance, providing feedback to encourage further exercise. The robot also motivates and assesses the performance while presenting audiovisual feedback (facial expressions and nonverbal behaviors such as blinking) (Fitter et al., 2020).

The relationship between these types of robots lies in the fact that they are all designed to interact with human beings and provide some kind of support, be it emotional, educational, or training. However, their specific functions and objectives vary. Companion robots aim to create emotional connections and provide companionship, play partners focus on play and educational activities with children, while coach robots aim to help people achieve specific goals through guidance and training. Each of these types of robots plays a different role in human interaction and can be applied in different contexts.

ROBOT DESIGN CONSIDERATIONS

The main design characteristics to consider when developing SAR are robot appearance and interaction modes (Robinson & Nejat, 2022).

SAR appearance may be classified as human-like, character-like, machine-like, or animal-like, depending on the body and facial features (Robinson & Nejat, 2022).

It also includes attributes that can be classified as expressiveness (focusing on non-verbal visual expressiveness), size (small, medium, and large), and material composition (including hard plastic, metal, or soft materials used to prevent robot damage from external factors and allow the customization of the appearance and texture in order to promote physical touch) (Robinson & Nejat, 2022).

Interaction modes describe the interfaces that SAR use to communicate with users including speech (the ability to speak, detect spoken keywords, and detect word associations, sounds (to express robot states such as sleep), visual displays (to provide task-specific instructions, show pictures, videos, or for teleconferencing), gestures (include illustrators that add emotional expression and emphasis to speech, such as body language) and physical touch (to show appreciation, to achieve a specific task, to get attention and for greetings or departures such as handshakes) (Pandey & Gelin, 2018; Paterson, 2023; Robinson & Nejat, 2022; Tellex et al., 2020).

Furthermore, in terms of autonomy, SAR can be teleoperated (remote-controlled), semi-autonomous, or fully autonomous. Remote-controlled robots can adapt to the participants' capabilities and social circumstances. However, this form of operation is challenging as it requires human assistance (Elbeleidy et al., 2022; van den Berghe et al., 2018).

In contrast, an autonomous robot does not require manual operation and reacts to a current situation based on its perception and analysis of social circumstances (Elbeleidy et al., 2022; van den Berghe et al., 2018). Currently, researchers are mainly developing autonomous robots, decreasing third-party support (Elbeleidy et al., 2022).

ACCEPTANCE AND ATTITUDES TOWARD SAR

SAR has the potential to increase a user's engagement in physical, cognitive, and social activities (Beuscher et al., 2017).

As identified in the literature some factors affect the attitudes and acceptance of individuals toward SAR: individual characteristics (age, sex, education, culture, and technical experience), assistive technology characteristics (effectiveness, image appearance, and matching technical efficiency with user expectations) and social factors (fear of use/anxiety, fear of becoming lonely/stigmatization and influence of the family and community) (Broadbent et al., 2009; Wu et al., 2014).

Regarding individual characteristics, in terms of age, younger people are more willing to accept SAR compared to older people (Wu et al., 2014).

Nevertheless, a study conducted by Łukasik et al. (2021) showed that older adults demonstrate a similar acceptance of psychosocial interventions by the robot as that as younger people. Concerning sex, the research indicates a similar high acceptance.

Regarding education, individuals with a high level of education were more willing to interact with robots, which can be justified by the fact that educated older adults can better recognize the ability of SAR (Louie et al., 2014).

In what concerns technical experience, people with previous contact with robots, evidence lower levels of anxiety and understand its use better (Salichs et al., 2019). Also, specific personality traits might be indicators of attitude changes associated with specific domains of social interactions (He et al., 2022). More agreeable, extroverted, and open individuals are more likely to accept a robot (Esterwood et al., 2021).

It is also agreed that technology characteristics have an impact on the patient's acceptance and studies show that matching a robot's appearance to its functions can improve its acceptance and its use over time. The same happens when there's an involvement in the design process (Beer et al., 2017; Liberman-Pincu et al., 2023; Louie et al., 2014; Sinnema & Alimardani, 2019). The design of a SAR must also account for technical performance, the expected user experience, and the environment where it will be used (Beer et al., 2017; Goetz et al., 2003).

An example, in the study of Natarajan et al. (2022), the authors evaluated the acceptability of SAR in individuals with dementia in India. They found that while participants found the humanoid appearance pleasing, making subtle adaptations such as changing the robot's eye color to black (to reflect the most common eye color in the Indian population) would make it easier to interact with them.

Social factors mainly reported are related to the feelings that the use of SAR is associated with negative aspects of aging (loneliness, dependence, disability) increasing feelings of stigmatization (Wu et al., 2014).

Some individuals expressed worries that robots will weaken their living abilities and limit their connections with family members and thus opposed the use of robots (Wu et al., 2014; Ziefle & Calero Valdez, 2017).

Other concerns are related to the patient's safety namely the malfunction, closely followed by misgivings concerning depersonalized and dehumanized care (Broadbent et al., 2009; Papadopoulos et al., 2023).

BARRIERS AND FACILITATORS

Facilitators are factors that contribute to encouraging the initiation or continuation of the practice of some activity, while barriers are factors that hinder or prevent this practice (Guemghar et al., 2022).

Thus, barriers and facilitators are a variable that is part of any activity, and the use of robots is no different (Koh et al., 2021).

In this chapter, the robots were selected by consulting recent systematic review articles in mental health with different populations.

The barriers and facilitators are separated into three distinct areas, namely children and adolescents, adults, and older adults. This division was made based on the literature used, that is, on the relationship between the sample used in the consulted study and the barriers and facilitators identified in it, and these are also divided into three levels: the organizational, which refers to the characteristics of the implementing organization; the technical, which refers to the characteristics of the intervention; and the clinical, which is related to the characteristics of the individuals involved in the implementation (Damschroder et al., 2022).

Later in Tables (2,3 and 4), we'll present the relationship between the robots described and the respective barrier and/or facilitator identified, so it is important to briefly explain each of the robots mentioned (Table 1).

After the schematization of the robots present in the articles used for the identification of barriers and facilitators, we will then proceed to their presentation, divided by life cycle: children and teenagers, adults, and older adults.

First, regarding children and teenagers (Table 2), a barrier at the clinical level, the fact that participants feared the robot (Kumazaki et al., 2018) was identified as a barrier at the clinical level; and at the organizational level, the presence of a technician during the sessions (Moyle et al., 2016), was identified as a facilitator.

Second, regarding adults, (Table 3) only barriers at the technical level were recognized namely the cost (Brecher, 2020); and at the clinical level, the barrier was associated with hearing impairment of patients (Chen et al., 2020).

Third, about older adults (Table 4), it was already possible to verify barriers and facilitators at all three levels - organizational, technical, and clinical (Guemghar et al., 2022).

Table 1. Identification of the robots use and their description and purpose

ROBOT	DESCRIPTION	PURPOSE
CommU (Kumazaki et al., 2018)	Type: humanoid robot Height: 30.4 cm Features: Clear eyes that can move them, shows a variety of simplified expressions, resembles a child.	Through its clear eyes, it allows children to recognize and interpret communication signals and is expected to facilitate attention retention, since eye contact is a basic social skill.
MARIO (Casey et al., 2020)	Type: humanoid robot Height: 1.5 m Features: face consists of large, animated eyes that move on wheels and can be activated by voice or touchscreen.	This robot addresses the difficult challenges of loneliness, isolation, and dementia in older adults through innovative and multifaceted inventions provided by it.
Joy for All (LLC, 2018)	Type: Animal robot (cat and dog) Features: soft, realistic fur and sensors that respond to touch, movement, and sound, allowing them to react and interact. Cat: growls, meows, and moves its paw, ears, head, and trunk in reaction to touch. Dog: barks when spoken to, wags his tail, turns his head toward the sound, and his heart beats when petted. This robot addresses the difficult challenges of loneliness, isolation, and dementia in older adults through innovative and multifaceted inventions provided by it.	The main goal is for people with dementia to achieve their well-being, which is generally considered to be a feeling of comfort, health, or happiness, and pets help to create that feeling and maintain their abilities throughout the illness.
Telenoid (Sorbello et al., 2014)	Type: humanoid robot Height: 80 cm (the size of a small child), Weight: 5 kg Features: soft skin, bald head, doll face, and stumps in place of limbs, making the body look male or female, old or young. The connection with the robot is made through the Internet, transmitting the voice and imitating the movements of the face and head.	The goal was to design a telepresence robot that could reproduce the voice and movements of a remote operator.
PARO (Hung et al., 2019)	Type: Animal robot (seal) Length: 16 cm Features: moves head and whole body, including head, tail, and flipper shaking movements.	Designed to provide emotional and social support, since interaction with the robot can improve mood, motivation, anxiety, loneliness, depression, and pain as psychological effects, improve stress and blood pressure as physiological effects, and stimulate communication and improve sociability as social effects.
Sophia (Chu et al., 2017)	Type: Humanoid robot Characteristics: able to reproduce varied facial expressions, very similar to a human person, and was the first robot to receive citizenship of a country.	It is designed to learn, adapt to human behavior and work with humans, help people in real-life uses such as medicine and education, and serve research in Artificial Intelligence.
JustoCat (Koh et al., 2022)	Type: Animal robot (cat) Features: breathes, purrs, and meows just like a real cat, its fur is replaceable and easily washable.	The aim is to enrich the daily lives of people suffering from dementia by providing them with greater psychological, physical, and social well-being, derived from the calming effect that cats have on patients.
LiveNature (Feng et al., 2019)	Features: an interactive system that takes a novel combined system approach, using an environment tracking unit and an interactive robotic sheep, to provide long-term access and engage in rewarding experiences for people with dementia in long-term care facilities.	This environment provides a holistic multi-sensory engagement, triggering positive emotions, increasing social bonding, and also restoring attention and communication.

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Table 1. Continued

ROBOT	DESCRIPTION	PURPOSE
Chapit (Goda et al., 2020)	Weight: 3 kg Characteristics: speaks while making the gesture of swinging its neck, body, and both legs, with LED eyes glowing. It can communicate not only through language (as it has voice recognition and some language and vocabulary built in), but also through nonverbal communication, such as gestures and facial expressions. It keeps you company without questions, helps around the house (e.g. by turning TVs and lights on and off), and also has an infrared sensor between its legs that detects when a person passes in front of it and wakes it up automatically if it is asleep.	The main purpose of this robot, besides keeping you company, is to help combat loneliness by stimulating feelings namely care, concern, and affection for others.
CuDDler (Moyle et al., 2016)	Type: Animal robot (bear) Height: 40 cm, Width: 20 cm, Weight: 4 kg Features: ability to recognize verbal and non-verbal communication acts that are linked to a person's emotional state, can move its neck, arms and eyelids, and interacts vocally with a low-level growl like a bear. Through a device placed inside it, it can analyze the touch pattern of each participant as they interact and touch the robot, controlling the movement, gestures and voice allowing CuDDler to respond appropriately to the pattern and type of touch. It is also possible, via an external device, to send instructions to the internal device by manually controlling the robot's response, movement and voice.	The main purpose is to have a positive impact on the emotional well-being and quality of life of its users, ultimately leading to improved general health and reduced healthcare costs.

Table 2. Barriers and facilitators identified in the children and teenagers, by levels, and the respective robot

CHILDREN AND TEENAGERS				
	Barriers	**Robot**	**Facilitators**	**Robot**
Organizational	-	-	Presence of a technician during the sessions	CuDDler
Technical	-	-	-	-
Clinical	The participants feared the robot	CommU	-	-

Table 3. Barriers and facilitators identified in the adults, by levels, and the respective robot

ADULTS				
	Barriers	**Robot**	**Facilitators**	**Robot**
Organizational	-	-	-	-
Technical	Cost	Joy for All	-	-
Clinical	Participants with hearing impairment	Telenoid	-	-

Table 4. Barriers and facilitators identified in the older adults, by levels, and the respective robot

OLDER ADULTS				
	Barriers	**Robot**	**Facilitators**	**Robot**
Organizational	Noisy environment during interaction	MARIO	Robot was easily available	Joy for All
	Storage area	PARO	Easy hygiene measures	JustoCat
	Billing required	PARO	The robot's name was given by the participants	PARO
	Hygienic measures	PARO	Robot intervention does not replace the usual activities	LiveNature
	Staff resistant to implementation	PARO	Possibility to organize activities with the robot	PARO
	Increased workload for professionals	PARO	Session duration is flexible	LiveNature
	Session frequency not adapted to patient's needs	PARO	-	-
Technical	The robot was difficult to understand	Sophia	Nice robot appearance	MARIO
	The touch screen was difficult to use	Sophia	Possibility to add accessories (e.g. pen) to make the touch screen easier to use	MARIO
	The robot's voice recognition system was poor	MARIO	Use involves little need for training	JustoCat
	Limited visibility of the robot's screen	Sophia	Respond to patient touch	JustoCat
	The robot was too noisy, too fragile, too heavy, and/or too big	CuDDler	Appropriate speech modalities	Sophia
	Spoke a limited number of languages	PARO	Voice and face activation/ recognition of the robot	Sophia
	Connection between devices was unstable	PARO	Entertainment features (e.g. applications, pictures, music)	MARIO
	-	-	Contextual interaction (e.g. the ability to intervene on the augmented reality screen allowing for greater interactivity)	Live Nature
Clinical	Participants with advanced cognitive decline	PARO	-	-
	Difficulty in disengaging after removal from the robot	PARO	-	-
	Risk of disillusionment	Live Nature	-	-
	Participants with language problems	Chapit	-	-
	Interaction with the robot seems childish and uninteresting	JustoCat	-	-

At the organizational level, the barriers identified were: noisy environment during interaction (Barrett et al., 2019), storage area, billing required, hygiene measures (Bemelmans et al., 2015), professionals resistant to implementation, increased workload of professionals (Hung et al., 2021) and frequency of sessions not adapted to the needs of patients (Pu et al., 2020); in turn, the facilitators were: the fact that the robot is easily available (Hammarlund et al., 2021), easy hygiene measures (Gustafsson et al., 2015), robot name was given by the participants (Chen et al., 2020), robot intervention does not replace usual activities, session duration is flexible (Feng et al., 2020) and the possibility to organize activities with the robot (Jøranson et al., 2015).

At a technical level, the recognized barriers were: the robot was difficult to understand, difficulty using the touch screen (Chu et al., 2017), the robot's voice recognition system was poor (D'Onofrio et al., 2019), limited visibility of the robot's screen (Chu et al., 2017), the robot was too noisy, fragile, heavy, too big (Moyle et al., 2016), the fact that the robot speaks a limited number of languages and the connection between devices was unstable (Chen et al., 2020); in contrast, the enablers were: the fact that it is possible to add accessories (e.g. pen) to facilitate touchscreen use (Barrett et al., 2019), use involves little need for training, respond to patient touch (Brecher, 2020), has appropriate speech modalities, and also robot voice and face activation/recognition (Chu et al., 2017), entertainment features (e.g. apps, images, music) (Casey et al., 2020), and contextual interaction (e.g. the ability to intervene on the augmented reality screen allowing for greater interactivity) (Feng et al., 2020).

At the clinical level, the barriers named were: the fact that some participants have severe cognitive decline (Hung et al., 2021), difficulty in disengaging after removal from the robot (Chen et al., 2020), risk of disillusionment (Feng et al., 2020), participants with language problems (Goda et al., 2020) and the fact that interaction with the robot seems childish and uninteresting (Gustafsson et al., 2015).

Some topics are common in two areas, more specifically, in children and teenagers and older adults. Particularly at the technical level, the identified barrier is related to the robot's speaking speed (too fast, long pauses, etc.) (Chu et al., 2017) whereas the facilitators refer to the pleasant appearance of the robot (Barrett et al., 2019) and its clear and audible sound (Chu et al., 2017). Finally, at the organizational level, the facilitator refers to the fact that caregivers are trained to work with the robot, with a demonstration before the intervention begins (Bemelmans et al., 2015).

According to the data presented by the collected studies, in Tables 2, 3, and 4, it was possible to identify the barriers and facilitators, relating to the organizational, technical, and clinical aspects of robots throughout the life cycle. Therefore, a higher number of clinical and technical barriers and facilitators were found in all age groups, but mainly in older adults. The studies show more facilitating aspects in the organizational and technical areas and fewer facilitating aspects at the clinical level, in the group of older adults, which is the age group with the highest number of research evidence. According to the data presented, there is also a scarcity of results that may show facilitating aspects both in the context of children and adolescents and in adults. There is also little evidence of organizational barriers both in adults and children and young people, at a technical or clinical level.

SOCIALLY ASSISTIVE ROBOTS IN MENTAL HEALTHCARE: OUTCOMES

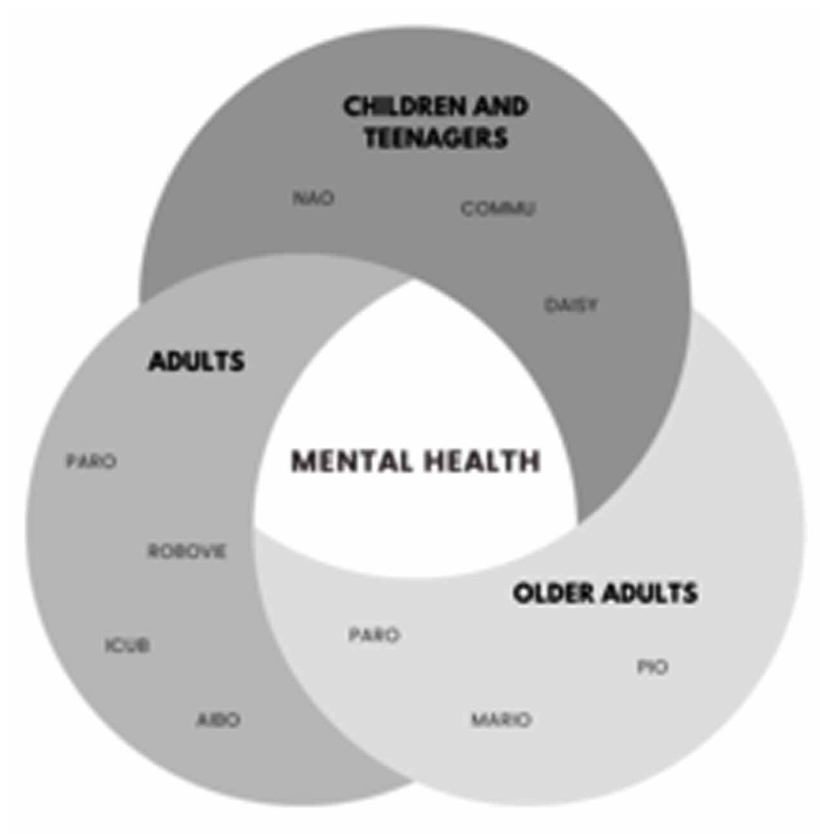
The use of SAR is a promising area, which has been boosted by the covid-19 pandemic and has several applications in the field of mental health (Kulpa et al., 2021). The literature has been highlighting the various clinical aspects of robots in this area, from companion to therapeutic partner. SAR are not a proposed replacement for healthcare professionals, nor should they be seen as solving all needs in mental health. Instead, they can be a promising clinical tool in a wide range of interventions (Rabbitt et al., 2015).

Through audio, visual, and motion resources, SAR can interact with patients and has proven to be an excellent help in improvising physical and psychological well-being (Scoglio et al., 2019).

In this sense, studies have shown that SAR has positive benefits in social interaction, improves the emotional state, develops more adaptive behaviors, and consequently improves the quality of life (Guemghar et al., 2022; Rasouli et al., 2022).

It is pertinent to point out some evidence that the literature reports on the effectiveness of SAR in mental health throughout the life cycle (Figure 1), described below.

Figure 1. Robots distribution by life cycle



Children and Teenagers

In what concerns children and teenagers diagnosed with Autism Spectrum Disorder studies show that intervention can improve cognitive and social performance (Scassellati et al., 2012), highlighting more involvement in tasks through interaction with robots than through interaction with humans (Kumazaki et al., 2020).

In a study conducted by Kumazaki et al. (2018), the authors compared the behavior of children with Autism Spectrum Disorder with that of children with typical development, with 5-6 years old, during a joint attention task in which children interacted with either a human or a robotic agent. The robot used was CommU, a humanoid robot.

The results showed that joint attention in children with Autism was better during the robotic intervention than during the human agent intervention.

These children exhibited improved performance in the joint attention task with humans after interacting with the robot CommU. Joint attention was differentially facilitated by the human and robotic agents between children with autism and the ones with typical development.

Another study, conducted with the Daisy robot, a non-humanoid, and addressed to children with Autism (7-12 years old), investigated the outcomes of the interaction between four elementary schools and this robot.

During structured and prepared activities, which were conducted by the social robot as well as by a human partner, the intervention indicated positive outcomes, specifically there was more eye contact, proximity, and verbal interaction during sessions with the robot than during those with the teacher, additionally, behaviors such as increased attention and ability to follow instructions improved during interaction with the robot. There was also noted a reduction in fidgeting (Fachantidis et al., 2018).

Although there are many studies on children with autism, there is also evidence of its use in other health conditions.

In a longitudinal single-case study design with a 10-year-old child diagnosed with Attention Deficit Hyperactivity Disorder, coordination deficits, and severe dysgraphia, it was possible to show that intervention in dysgraphia using child-robot interaction, combining learning by teaching and games is feasible and can improve writing (Gargot et al., 2021). The robot used in this study was Nao, which is a humanoid type (Amirova et al., 2021).

In the study, the child was encouraged to teach the robot to write by the demonstration on a tablet, with a series of games that were designed to specifically train pressure, pitch, speed, and letter binding. This training occurred during 20 consecutive weekly occupational therapy sessions. The results indicated that his motivation increased, avoidance behaviors decreased, and handwriting and posture improved very significantly (Gargot et al., 2021).

In a systematic review conducted by Kouroupa et al. (2022), the authors summarize the evidence about the use of SAR in children and young people with autism, aged up to 18 years old.

Results show that most interventions used humanoid robots, mainly in clinical setting, followed by home, schools, and laboratory environments, with the aim to improve social and communication skills. The most common outcomes showed that robot-mediated interventions significantly improved social functioning. By contrast, robots did not improve emotional or motor outcomes, but the numbers of trials were very small.

Although there is abundant literature focused on interventions using robots for children with autism, there is a gap to be filled in other different educational needs.

A study conducted with children followed in speech therapy, using a robot as an assistant in the sessions, provoked a positive response from the children as there was an increase in their motivation and involvement in the tasks.

The interventions were implemented using the NAO robot (humanoid robot) in a therapeutic center.

The results suggest that the use of social humanoid robots in therapy is promising and may open many possibilities for further work on introducing robots to improve interventions (Egido-García et al., 2020).

Adults

Results show that SAR have been great allies in the rehabilitation process of individuals with social anxiety, depression, intellectual deficit, or schizophrenia, being a facilitating tool in the social mediation of the interaction between two people or between the patient and the health professional (Rasouli et al., 2022).

A study conducted by Wagemaker et al. (2017) aimed to explore the effectiveness of the therapeutic robot PARO on the alertness and mood of adults (59-70 years) with moderate to severe intellectual impairment.

During the control phase, participants interacted with a stuffed seal (named Tobi, similar to PARO), which was later replaced by the Paro robot. Results show that in one of the participants, alertness and mood improved during the intervention phase with PARO when compared to Tobi. The other four participants did not experience improvement in any of the outcome measures.

It was not possible to conclude that robot-based animal-assisted therapy interventions have clear beneficial effects on alertness and mood in adults with moderate to severe intellectual deficit (Wagemaker et al., 2017).

A study conducted with ten patients with an average age of approximately 23 years with social anxiety aimed to see if there would be less actual and anticipatory anxiety when interacting with a robot than when interacting with a person. The robot used was Robovie, with a humanoid appearance. The results indicated that participants with higher social anxiety tended to feel less "anticipatory anxiety" and tension when they knew they would interact with a robot than when they knew they would interact with a person. Furthermore, interaction with a robot proved to cause less strain than interacting with a person, no matter the level of social anxiety (Nomura et al., 2020).

Another study involved 21 participants diagnosed with schizophrenia, in an outpatient setting, aimed to evaluate how patients diagnosed with schizophrenia recognize positive (happiness) and negative (anger) facial emotions displayed by a humanoid robot (Raffard et al., 2016).

The results of this study concluded that the patients were faster to perceive positive facial expressions in humans compared to positive expressions in robots. On the other hand, they were slower to perceive negative facial expressions in humans and faster to perceive them in the robot (Raffard et al., 2016).

A case study was conducted with a 54-year-old patient diagnosed with schizophrenia, 18 years of hospitalization, depression, and general psychopathological symptoms such as anxiety. This patient underwent an intervention with the AIBO robot (Narita et al., 2016).

The robot sessions included playing ball and performing caresses through touch.

The study suggested that AIBO-assisted therapy proved to be a successful tool for reducing negative symptoms, enhancing socialization, and reducing loneliness and promoting general well-being (Narita et al., 2016).

Older Adults

Soon, the number of older adults with dementia will tend to increase significantly, the result of which is likely to affect both the quality of life of the elderly and of their caregivers. It is therefore becoming increasingly urgent to find options that can minimize the effects of this problem and it is important to provide support for the aging person and their caregivers (Amabili et al., 2022).

In dementia, studies highlight the importance of using SAR as a useful tool with potential benefits for the safety, quality of life, and independence of older adults living in demographic settings where issues of isolation and loneliness are more evident (Lehoux & Grimard, 2018).

A study conducted, with 20 older adults diagnosed with depression, residing in four different institutions, aimed to evaluate the effects of the PARO robot seal intervention on depression, loneliness, and quality of life in institutionalized older adults, and to explore experiences and perceptions of its use after the intervention. Each patient was given a PARO robot that they kept for 24h, during one week. Four assessment moments were conducted during the intervention using assessment scales and an interview. The results of this study indicated that significant improvements were identified in the depression, isolation, and quality of life of older adults (Chen et al., 2020).

According to Casey et al. (2020), loneliness in people with dementia often results in increased cognitive decline, negatively impacting quality of life.

A study conducted by this author aimed to explore the use of the social robot, MARIO, with older people living with dementia as a way of addressing these issues, exploring their perceptions and experiences of contact with this robot.

This study was conducted in the United States, Italy, and Ireland, with the participation of 38 older adults with dementia, 28 family caregivers, and 28 informal caregivers from different healthcare settings.

The results of this study indicated that contact with the MARIO robot was generally positive, despite some of the more challenging aspects, such as voice recognition. Older adult participants achieved better social engagement and improved cognitive function.

Some formal and informal carers initially reported some pessimism regarding engagement with the MARIO robot, but over time their views changed when they saw the impact the robot had on the older adults, reporting positives such as increased cognitive engagement, autonomy, and reduced loneliness and isolation, which led to some improvement in their quality of life (Casey et al., 2020).

Robots can also be used in different settings either in institutions, clinics or at home.

A study conducted in Korea aimed to investigate the effectiveness of the PIO social robot intervention on cognitive function, depression, loneliness, and quality of life in older adults living alone. The social robot PIO was designed to deliver intervention programs to older adults with and without dementia.

This study was conducted in three wellness centers for older adults, and 64 individuals aged 65 who were living alone. In the experimental group were included 31 participants and 33 participants were included in the control group. The intervention was carried out twice a week in twelve 50-minute sessions for 6 weeks.

The results showed an improvement in cognitive function, depression, quality of life, and decreased loneliness in the experimental group compared to the control group, with depression and loneliness showing significantly more improvement in the experimental group (Lim, 2023).

Interacting with social robots, such as PARO, has been shown to improve mood but also literature showed that it can be used for example, in acute pain.

A study using PARO robot intervention with institutionalized older adults with dementia and chronic pain found that there was an improvement in their mood and alleviation of chronic pain after daily intervention for 30 minutes, five days a week for six weeks (Pu et al., 2020).

CONSIDERATIONS FOR THE USE OF SAR: FROM CONCEPTION TO IMPLEMENTATION

After consulting the current literature about the design and implementation recommendations of SAR in different populations, we summarize below the information that we consider relevant. Below we describe some key steps that we consider important when designing SAR:

Designing SAR requires a balance between technological capabilities, human needs, and ethical considerations. Collaboration with experts from various disciplines and involving end-users throughout the design process is crucial to creating effective and socially beneficial robots.

Table 5. Considerations for the use of SAR– from conception to implementation

1. Identify the target population: Determine the specific group of people your robot will assist, that could be older adults, children with autism, individuals with mental health conditions, or any other population that could benefit from social support.
2. Understand user needs and requirements: Conduct thorough research to understand the needs, preferences, and challenges of the target population. Consider conducting interviews, surveys, and observations to gather insights from potential users, caregivers, and experts in the field. It is also necessary to understand the contextual factors that may influence the motivation and success of interaction by users, professionals, and/or caregivers: individual characteristics, assistive technology characteristics of robots, and social factors.
3. Define robot capabilities: Based on the user needs, identify the capabilities and functionalities your socially assistive robot should possess. Consider aspects such as communication skills, emotional intelligence, physical assistance, and adaptability to different user contexts.
4. Human-robot interaction design: Design the robot's appearance, behavior, and interaction modalities in a way that promotes engagement, trust, and a positive user experience. Pay attention to factors such as facial expressions, body language, voice tone, and appropriate responses to user cues.
5. Personalization and adaptation: Incorporate machine learning and artificial intelligence techniques to enable the robot to personalize its interactions and adapt to each patient needs. This could involve learning user preferences, tracking progress, and dynamically adjusting its behavior over time.
6. Ethical considerations: Ensure that the design and use of the robot is consistent to ethical guidelines. Consider issues such as privacy, consent, data security, and potential impact on human relationships. Implement mechanisms to protect user information and maintain confidentiality.
7. Iterative design and evaluation: Continuously iterate and refine the robot's design based on user feedback and evaluation. Conduct user studies and usability tests to assess the effectiveness and acceptance of the robot in real-world scenarios.
8. Collaborative design: A user-centered design approach should be used to ensure that the design is focused on users' needs and preferences, increasing motivation for the robot's use.
9. Consider deployment context: Consider the specific context in which the robot will be deployed. Factors such as the physical environment, social norms, and cultural sensitivities should be considered to ensure that the robot's design aligns with the context of use.
10. Long-term support and maintenance: Plan for ongoing support and maintenance of the robot once it is deployed. This includes regular updates, bug fixes, and addressing user feedback to continuously improve the robot's performance and user satisfaction.

CONCLUSION

There is a well-documented gap in access to mental health care services, resulting in incalculable costs in terms of human suffering and social burden.

Evidence shows that the application of SAR can be a great ally in care delivery and its use can be extended to more mental health care to support current needs. SAR can be integrated into intervention protocols along with professionals, allowing a clinical reach, to better serve people with mental health conditions.

In clinical practice, the use of SAR can be well accepted by patients and professionals due to several factors, including greater efficiency of care, reduced waiting times, automation of repetitive tasks, and assistance in monitoring and collecting clinical data, which can result in a better overall experience of care.

Reducing geographical barriers, the shortage of healthcare professionals, personalizing SAR, and adapting them to the individual needs of each patient, can also increase patient satisfaction and motivation to use them, thus increasing the possibility of access to quality, personalized care, and services.

However, it is recognized that there are real barriers to overcome (e.g., physical design, and user perceptions). But it is also true that the use of SAR can help those who do not receive care and/or those whose care can be improved through some help in daily living, to deliver an intervention, to promote adherence to another type of intervention, or to provide some form of interaction.

While writing this chapter, it was particularly evident that there are few studies on the adult population, but the results of the use of SAR in the recovery process are promising and we believe that given the prevalence of mental health conditions its use can be a good ally.

It's worth noting that SAR are still an emerging technology, and their effectiveness and acceptance in various contexts are still being researched and evaluated. Ethical considerations, privacy concerns, and the need for clear guidelines and regulations surrounding their use are also important factors to consider as SARs continue to evolve.

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KEY TERMS AND DEFINITIONS

Barriers: Barriers are factors that hinder or prevent the initiation of the practice of a certain activity.

Facilitators: Facilitators are factors that contribute to encouraging the initiation or continuation of the practice of a certain activity.

Mental Health: Mental health is a state of mental well-being that enables people to cope with the stresses of life, realize their abilities, learn well and work well, and contribute to their community.

Quality of Life: Level of satisfaction and comfort that a person is relative to in life, taking into account context, culture, values, goals, and expectations.

Recovery: An individual process, not focusing on symptoms but focusing on the person's autonomy and self-determination, being able to create and live a meaningful life and contribute to the community.

Socially Assistive Robots: Refers to a specific type of robotics that focuses on the development of robots capable of assisting individuals through social interaction.

User-Centered Approach: A collaborative approach focused on the users´ needs and preferences.