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A Systematic Review of the Use of Social Robots in Mental Health Research

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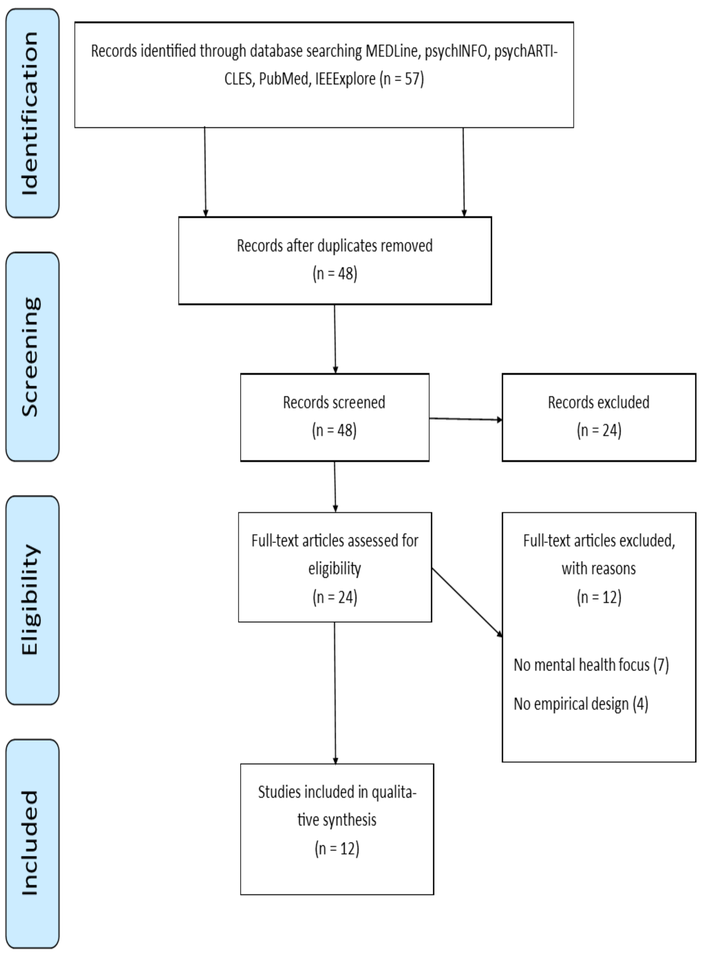
Opportunity Current technology platforms delivering interventions are largely mobile apps and online websites, although efforts have been made to create more personalized and embodied technology experiences. To extend and improve on these platforms, the field of robotics has been increasingly included in conversations of how to deliver technology-assisted, interactive, and responsive mental health interventions. Socially assistive robots (SARs) are clinical tools that can be used in a wide range of healthcare settings to facilitate meaningful engagement in care, better treatment and functional outcomes, and improved social engagement. However, little is known about the utility of using SARs in mental health interventions. This review synthesizes and describes the nascent empirical literature of SARs in mental health research, and identifies gaps and opportunities for improvement in future research and practice.

First Author, Year	Sample Size and Characteristics	Robot	Mental Health Outcome	Intervention	Main Findings
Bemelmans, 2015	71 Nursing home residents	Paro	IPPA[a] score and mood scale	15 minute interaction session with Paro	• Significant positive effect on mood and IPPA score
Galvão Gomes da Silva, 2018	20 Psychology students	NAO	Motivation for exercise	Motivational interviewing session with NAO	• Positive appraisals of robot as non-judgmental • Increased "change talk" in participants • Increased motivation to exercise
Kurashige, 2017	12 Male students aged between 21-23	CRECA	Stress management	Motivational interviewing session with nodding or not nodding CRECA around stress management	• Positive appraisal of nodding CRECA, self-reported reduction in anxiety
Lane, 2016	106 VA community living center elderly patients	Paro	Observed positive and negative behaviors	Interaction sessions with Paro	• More positive and less negative observations after introducing Paro
Loi, 2017	24 Hospital staff	Betty	Perceived benefits to patient well-being and quality of life	Betty present at facility for 12 weeks	• Staff reported that Betty would be helpful to patients and may improve well-being and/or quality of life
Moyle, 2018	20 Elder care staff	Paro	Comfort, well-being	Interactions between Paro and elderly residents	• Staff indicated that there were benefits to using Paro as a companion to elderly patients, although Paro did not comfort all residents.
Šabanović, 2013	10 Nursing home residents with dementia	Paro	Social interaction	Presence of Paro in nursing home	• Paro facilitates and increases social interaction between residents
Sefidgar, 2016	38 women aged 19-45	Haptic Creature	Anxiety reduction	Interaction with Haptic Creature on lap, compared with stuffed animal replica	• Heart and respiration rates significantly decreased relative to stroking a non-breathing replica. Participants reported themselves as calmer and happier.
Valentí Soler, 2015	211 nursing home patients with dementia, 37 at day care facility	Paro, NAO	Apathy, quality of life, irritability	Comparing interactions with Paro, NAO, and live dog	• Apathy and irritability improved for robot groups • Quality of life improved for Paro group
Wada, 2010	4 elderly individual and caregiver dyads	Paro	Aggression, Contentment	Manual-assisted interaction with Paro	• Decrease in aggression after Paro interaction, mixed evidence for increase in contentment
Wada, 2012	12 elderly participants and 9 caregivers	Paro	Aggression, Contentment	Manual-assisted interaction with Paro	• Increase in contentment and social interaction talking after Paro interaction
Wada, 2014	64 elderly individuals in 7 elder-care facilities	Paro	Anxiety, Depression, Aggression	Manual-assisted interaction with Paro	• Symptoms decreased after Paro interaction

Figure 1. PRISMA Flow Diagram



Data/ Results This systematic review of the literature found four distinct SARs used in research to effect mental health outcomes. Research on mental health applications of SARs focuses largely on elderly dementia patients and relies on usability pilot data with methodological limitations. Our review findings suggest that SARs have positive effects on measured mental health outcomes such as stress reduction, aggression, and contentment.

Figure 2. Description of Social Robots Utilized in Reviewed Articles

Robotic Device	Image	Description	Major Features
Paro		Paro is a robotic harp seal. It is referred to as a "therapeutic robot", and meant to provide similar comfort as animal therapy for patients in facilities where live animals may present treatment or logistical difficulties. Paro may be used for comfort, companionship, or stress reduction.	Has five kinds of sensors: tactile, light, audition, temperature, and posture sensors, with which it can perceive people and its environment. He can sense when being touched by its tactile sensor, or being held by a posture sensor. Can also recognize the direction of voice and words such as its name, greetings, and praise with its audio sensor. His voice imitates a harp seal.
Betty		Betty is an individualized, researcher programmed version of the Partner Personal Robot (PaPeRo). Betty may be used for motivation, entertainment, or companionship.	Betty is 39 cm tall and weighs 6.5 kg. Equipped with speakers, camera, and microphone, a touch-pad and voice recognition are used to interact with Betty. The robot can also make human-like gestures, has voice recognition capabilities, is mobile, and can be programmed with a person's preferences (e.g. books or music).
NAO		NAO is brightly colored with large eyes and humanoid appearance. Early in its development, it has been used in research with children who have developmental disorders or disabilities. NAO may be used for motivation or companionship.	NAO stands at 58 cm tall, has speech and movement capabilities and is frequently utilized for its user-friendly software package. It has multiple sensors for touch, sound, speech, and visual recognition. It is a fully programmable platform, and capable of movement.
Haptic Creature		The Haptic Creature is a comfort robot, designed based on human-animal interaction models. Through touch it promotes emotional interaction with the user with the aim to reduce anxiety in the user. It may be used for comfort or stress reduction.	It is characterized as an expressive animatronic lap-pet (size of a large cat). Has sensors to recognize the users touch on any part of its body and responds by stiffening its ears, purring and simulating breathing.
CRECA		CRECA was created for this a particular study and primarily serves as an educational or motivational robot that can converse with the user via computer software and nod its head to validate the user's responses.	This robot is connected to a computer and microphone to perform speech functions. It can also perform nodding movements.

Impact: The current SARs research for mental health usage is limited in generalizability, scope, and measurement of psychological outcomes. Opportunities for expansion of research in this area include diversifying populations studied, SARs utilized, clinical applications, measures used and settings for those applications.

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