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A Review on Current and Potential Applications of Robotics In Mental Health Care

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Introduction

Robotics technology is most commonly associated with robots, that are physically embodied systems capable of causing physical change in the world. Robots execute this transformation via effectors that either move the robot itself (locomotion) or move items in the environment (manipulation), and they frequently make judgments based on data from sensors. Robot autonomy can range from totally teleoperated to fully autonomous (the robot is entirely independent). The word robotics technology also encompasses related technologies, such as sensor systems, data processing algorithms, and so forth. While in recent years this has evolved outward, with an emphasis on difficulties connected to dealing with actual people in the real world. This transition has been referred to as human-centered robotics in the literature, and a developing topic in the last decade focused on difficulties in this arena is known as human robot interaction (HRI). The application of robotics technology in mental health treatment is still in its early stages, but it offers a potentially beneficial tool in the professional's arsenal.

According to Goodrich and Schultz [1], [2], the HRI challenge is about "understanding and shaping the interactions between one or more people and one or more robots." They divide the problem into five major components: (1) the level and behavior of a robot's autonomy, (2) the nature of information exchange between humans and robots, (3) the structure of the human robot team, (4) how people and robots adapt and learn from one another, and (5) how the task shapes interaction.

All of these aspects influence how a mental healthcare practitioner thinks about using robots technology in their practice. However, there are two additional aspects that practitioners should be aware of. The first is the morphology, or shape, of the robot. Robots might have a very mechanical aspect or a very human one. Morphology is a hotly disputed issue in the scientific world, with several studies demonstrating that humans will anthropomorphize and establish attachments to practically anything that conveys animacy. Some experts are concerned that this not only misleads people about a robot's capabilities, but may also be immoral when handling vulnerable groups. Individuals with cognitive limitations, for example, or youngsters, may be more vulnerable to deceit and manipulation by robots.[1], [3]

Individual variations between persons can also have an influence on the HRI problem. People have a variety of cognitive and physical characteristics that can dramatically impact how people perceive, interact with, and accept robots. These considerations may be especially essential when contemplating the employment of robots technology for clients in mental healthcare facilities, who may have additional special requirements. [4]

Morphology of Robots

Figure 1 displays a variety of consumer and research robots utilized in mental health applications, several of which will be described more in the next section. The robots in this picture represent the cutting-edge of socially interacting robot technology. Other applications have utilized robots with more mechanical looks, but relatively few in mental health care.

Figure 1. Robots employed in mental healthcare nowadays have a wide range of morphologies, including zoomorphic, mechanical, cartoon-like, and humanoid representations. These robots have been used to help treat persons with dementia, autism, and cognitive impairments; to give companionship for lonely people; to teach children with developmental disabilities; and to assist improve how people with visible disabilities are treated.

While the most frequent morphologies are zoomorphic, anthropomorphic, and cartoon-like, some robot designers have experimented with various unusual representations. Actuating "ordinary items" such as balls, drawers, and ottomans, for example. Because of people's intrinsic inclination to anthropomorphize anything with animacy, these robots are highly entertaining. They may be beneficial in medical strategies with customers who are less familiar with anthropomorphic or zoomorphic depictions, such as autistic persons.

A robot's morphology is frequently tied to its functional capacity requirements; for example, a grasper is likely to be present in a robot that needs to move items, and legs are likely to be present in a robot that needs to climb stairs. Consumer robots, on the other hand, frequently have looks that resemble science fiction images in terms of color (grey) and form (boxy). They also communicate exaggerated feminine images at times (i.e., fembots), Figure 1, Robots employed in mental healthcare nowadays have a wide range of morphologies, including zoomorphic, mechanical, cartoon-like, and humanoid representations. These robots have been used to help treat persons with dementia, autism, and cognitive impairments; to give companionship for lonely people; to teach children with developmental disabilities; and to assist improve how people with visible disabilities are treated. Robotics Technology in Mental Health Care, which has sparked ethical debate in certain scientific circles. [5]–[8]

While customers have little control over the look of the robot they buy, they routinely dress, name, and otherwise customize it. Extensive, long-term in-home tests of the Roomba vacuum cleaning robot, for example, illustrate this customer personalisation.

As will be described in the "Ethical Issues" part of this chapter, mental healthcare providers must exercise caution when choosing a robot morphology to utilize in treatment. Many individuals have a lingering dread of robots as a result of 60 years of heinous science fiction images, and these worries may be compounded in a mental healthcare setting. Some morphologies, on the other hand, may limit

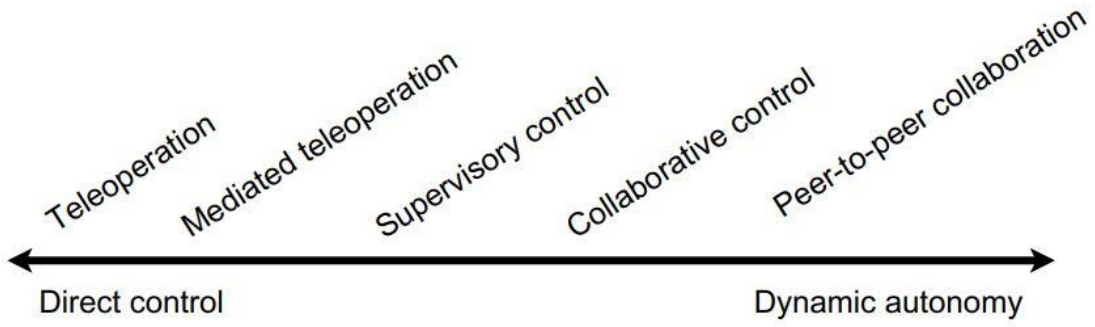
or postpone the transfer of learnt abilities from the treatment context to normal life. In general, while choosing a platform, mental healthcare providers must carefully balance the robot's capabilities against the patient's therapeutic requirements. [9]–[11]

Capabilities of Robots

Current robots have a wide range of physical capabilities, and as the service robotics sector grows, these capabilities will only expand. Robots of diverse morphologies can display limb-like action, such as walking, running, climbing, turning, gripping, shaking, and pointing; face-like motion, such as facial expressions, gazing, and nodding; and other types of biological motion, such as flipping, flying, and undulating. However, the technology that will allow these platforms to behave independently and securely in the presence of humans is still in its infancy. While the research community has achieved great advances in recent years, it still confronts a number of problems, notably at home. As a result, the vast majority of modern-day robots utilized in mental health treatment are either entirely controlled by an operator or totally preprogrammed and hence rather limited in their capabilities [12]–[15].

Robot Autonomy

Figure 2 demonstrates the many levels of autonomy that a robot can use in an HRI situation. Many advanced robotic systems feature customizable autonomy, allowing humans to adapt how they interact with robots in real time.



This is especially beneficial in mental healthcare contexts, where a practitioner may want to direct some robot actions while leaving others autonomous. A therapist dealing with an autistic kid, for example, would want the robot to play a game independently and change how the robot gives prizes based on the child's development.

Recent Implementations

Robotics technology has been used in a number of contexts in mental healthcare. Interventions for illnesses ranging from autism spectrum disorder to cognitive impairments, as well as strategies to stimulate physical activity and give companionship to persons living alone, are examples of such uses.

It is worth mentioning that few randomized controlled clinical trials (RCTs) have been documented in the literature due to the nascency of consumer robotics technology and its tendency to develop fast. Many published studies have limited sample numbers, inadequate controls, and are difficult to duplicate

owing to hardware and software heterogeneity. As a result, while assessing the efficacy of these therapies, one should proceed with caution. However, there is also importance in learning from qualitative and case-based research, therefore some of these findings are also given here. [16], [17]

Autism Spectrum Disorders

One of the most common applications of robotics technology in mental health care is in the diagnosis and treatment of autism spectrum disorders (ASD). As Diehl et al. (2014) reported in a recent review article, robotics technology holds great potential for people with ASD, as they are very responsive to treatment involving robotics technology, possibly more so than treatment with human therapists. Thus, there are many recent Direct control Dynamic autonomy Teleoperation Mediated teleoperation Supervisory control Collaborative control Peer-to-peer collaboration (Figure 2). The scale of autonomy which a robot may employ during an HRI scenario [18], [19]. Scale from Goodrich and Schultz (2007), used with permission. Robotics Technology in Mental Health Care 189 studies in the literature reporting the use of robots in this fashion. [8], [20], [21]

However, advise caution in deploying this technology clinically, as few RCTs have been conducted, and the majority of reported research in the literature has been more technology-focused rather than client-focused. Thus, the authors argue that using robots clinically for ASD diagnosis and treatment should be considered as an experimental approach, and suggest “clinical innovation should parallel technological innovation” if robots are to be fully realized in the ASD clinical space.

Physical Activity and Physical Exercise

Studies by Lancioni [22], [23] report multiple robot-based intervention experiments aimed at increasing activity engagement and ambulation in a small group of individuals (n 5 6) with significant physical and cognitive difficulties . The mobile robots employed in the experiments significantly improved participants' involvement with the physical environment, enhancing both their independence and their "social image." herapy post-stroke. However, a large-scale RCT done recently found no significant difference between using a robot versus more traditional treatment. Furthermore, anecdotal data shows that many of these upper-limb rehabilitative robots are so difficult to operate that they sit in closets after being purchased. [24], [25]

Mataric [26]–[28] present the notion of socially assistive robots (SAR), which give social or cognitive aid to individuals without physically engaging with them, in a distinct field of post-stroke rehabilitation.

1 SAR "targets particular convalescence, rehabilitation, training, or education goals." The authors discovered good results from the use of a SAR for post-stroke exercise encouragement in numerous modest (n 5 2) non-RCT pilot experiments.

Weight reduction is another application for deploying robots to encourage exercise participation, according to Kidd and Breazeal. The authors created Autom, a robotic weight loss coach that was demonstrated to be more successful than a paper-based or computer-based system in maintaining long-term weight reduction (i.e., encouraging diet adherence and activity) in a controlled research (n 5 45).

Dementia and Cognitive Decline with Age

Mordoch et al. conduct a thorough analysis of the literature on robot usage in dementia care and describe findings from about 21 research including dementia patients from 2004 to 2011. It should be emphasized that none of these research contained a randomized controlled trial, that the majority had small sample sizes, that the majority lacked proper controls, and that the majority will be difficult to reproduce owing to a lack of standardized hardware/software. There are number of investigations on individuals with cognitive impairments who were given Paro as a therapeutic innovation. Paro is a zoomorphic system that resembles a seal that has been utilized in care facilities across the world as an alternative to physical animal therapy. Patients usually hold, hug, stroke, or chat to Paro like they would

a live animal or infant during therapy. Shibata's dementia-related investigations include both short-term and long-term studies, with both quantitative and qualitative information collected. As a result, it is impossible to make any conclusions about Paro's overall success in dementia therapy. [29], [30]

There was one well-designed RCT in the literature that suggested the usefulness of a robot intervention for age-related cognitive decline. A study with 34 (n 5 34) healthy Japanese women living alone between the ages of 66 and 84. The research lasted eight weeks. Participants in the intervention group engaged with the Kabochan Nodding Communication ROBOT, a cartoon-like platform that talked and nodded at them participants in the control group received a robot with the same morphology but did not communicate or nod. At the end of the trial, individuals in the intervention group had lower cortisol levels , better judgment and verbal memory performance (as measured by the Mini-Mental State Examination), and better nocturnal sleep (self-report). [31], [32]

Robot Companions to Improve Psychosocial Outcomes

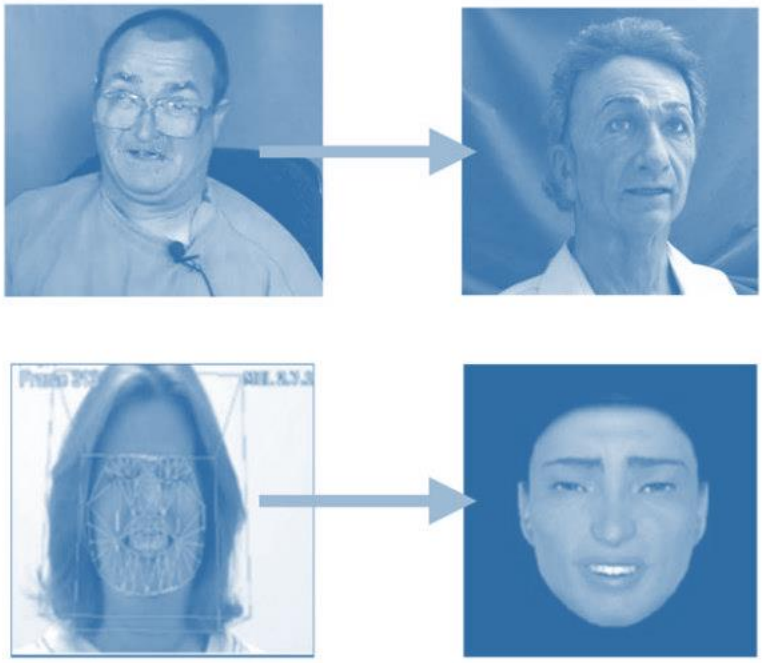
Several controlled research have revealed that companion-like robots might be an effective therapy for loneliness and high blood pressure. For example, Robinson et al. conducted a recent randomized controlled experiment in a New Zealand care facility in 2013. (n 5 40) [33], [34]. Those in the intervention group interacted with Paro for 12 weeks, while participants in the control group engaged in conventional care home activities. When compared to the control group, those who interacted with Paro saw a substantial decrease in loneliness during the course of the experiment.

This impact of loneliness reduction from a pet-like robot has also been demonstrated in other RCTs in the United States with AIBO, a robotic dog (n 5 25). This effect was also seen in various between-subject and within-group trials conducted in Japan (n 5 13, n 5 5, respectively). Bemelmans et al. conduct a thorough systematic evaluation of the literature Robinson reported a pilot research in both a nursing home and a hospital environment in 2014 using a repeated measures design with participants briefly engaging with Paro (n 5 21). Blood pressure was recorded before, during, and after participants interacted with the robot. The researchers discovered a substantial drop in systolic and diastolic blood pressure while subjects used Paro, as well as a significant increase in diastolic blood pressure after the robot was removed [32], [35].

Clinician Education in Interaction with People Disabilities

We've been looking at new approaches to employ humanoid robots to train physicians to better engage with patients in person. This research was driven by the fact that physicians have been demonstrated to be biased towards patients with obvious and invisible impairments, making this a topic of interest in mental health treatment.

We invented realistic, patient-based facial expression synthesis for simulated patients and have synthesized diseases such as cerebral palsy, dystonia, and pain. Medical simulation technology, such as life-sized human-patient simulators, which are effectively humanoid robots, is already used in mental healthcare training. We intend to do an RCT with nurses to investigate the usefulness of realistic facial expressions in critical care situations, and we may also look into mental care settings. [36], [37]



Schizophrenia Diagnosis and Research

Robotics technology has also been applied in unique ways to research persons suffering from schizophrenia. Lavelle, Healey, and McCabe [38], [39] conducted a series of tests in which patients with schizophrenia were put in triads with undiagnosed control volunteers. A Vicon motion capture device was used to track each group, and their body motion was assessed in terms of social rapport and group engagement, the interaction of 20 mixed triads was compared to the interaction of 20 control triads (total n 5 120), when compared to controls, the findings confirmed the hypothesis that persons with schizophrenia have worse rapport during first-time contacts. Medication therapy is critical for those suffering from schizophrenia, but nurses who visit patients at home and other human care are few. When a patient's motivation is low, they reduce their nodding and replying, which interferes with their social ties [40]–[43].

Lavelle's study was the first to quantitatively investigate the natural interaction between patients with schizophrenia and matched controls on such a fine scale [38], [39]. Since the publication of this study, new sensors that are a quarter of the cost of a Vicon motion capture system and give much more information have hit the market. As a result, this technology provides academics and practitioners with a whole new approach to examine interpersonal interactions. [44], [45] A recent study, for example, employs non-linear analytic approaches and motion modeling to investigate how teams synchronize with one another during psychomotor entrainment tasks. Because synchronization with others is a vital sign of brain health and social development, the approaches we're creating might be valuable for therapists and researchers dealing with people who have autism, post-traumatic stress disorder, or traumatic brain injury.

Design Problems

Potential Barriers to Adoption of Provider Technology

Robot designers should be aware that mental healthcare providers may be cautious to include robotics technology into their practice for a variety of reasons. For starters, it may interfere with or be viewed as interfering with face-to-face communication between the clinician and the patient. This has been a rising issue in treatment and safety across other healthcare fields, and there is every reason to believe it will be exacerbated in a profession based on face-to-face connection.

Second, providers may be concerned that robots technology would interfere with or hamper their practice, as has been shown in several trials using telepresence psychiatric treatment delivery systems. The mere appearance of robotics technology may be regarded as a danger to care delivery by clinicians, and this impact may be exacerbated in the absence of long-term, rigorous RCTs demonstrating the usefulness of the new technology. [8], [46]

Finally, as with any new technology introduced into a profession, there are several hidden hurdles to acceptance. Several researchers have established models for forecasting technology adoption among a variety of professionals, including mental health practitioners, that may be valuable to deploy. Because of its shady cultural past in science fiction, robotics technology offers a particular adoption obstacle. To relieve any fears, robots must be well-designed in order to swiftly express their genuine capabilities to end-users.

There is a need for evidence-based robotics in mental health care.

As previously noted in this chapter, thorough RCTs are required before robots may be effectively employed in mental healthcare practice. These research should investigate not just patient benefit and technology acceptability difficulties, but also caregivers' socio-technological demands. While most robots are unlikely to cause actual harm to clients or practitioners, using this technology before an evidence foundation is established risks replacing related to cognitive with less effective or ineffective ones.

Thus, robot designers who want to investigate the application of robotics technology in mental health care should try to conduct thorough studies in collaboration with practitioners and academics from the start [47]–[51]. This is critical for a number of reasons. First and foremost, appropriate controls must be chosen. Instead of the treatment group getting the robot and the control group getting an alternate therapy, the control group may get a non-actuated analog. Despite being located in a society known for anti-iconography, such a robot was found to be well-accepted when employed for hospital care and household activities such as housekeeping. Artificial Intelligence in Mental and Behavioral Health Care This method worked well for the aforementioned Kobachan intervention for age-related cognitive loss, and it may be effective for other therapies as well.

Second, by collaborating with practitioners, robot developers are more likely to gain access to desirable patient groups and be able to participate in long-term research. Clinical efficacy is related to treatment length in many mental healthcare applications, i.e., the dosage response connection. As a result, given the high chance of novelty effects, a single contact with a robot is not as helpful a statistic.

People with disabilities and their families are susceptible to treatment fads and pseudoscience, some of which can be seriously harmful. Regardless of the temptation of new technology, it is important to tread carefully and conduct rigorous RCTs before adopting new treatment techniques. [52], [53]

Particular Principles

Considerations for Human Dignity

• Humans' emotional needs must always be acknowledged.

• The right to privacy of humans must always be respected to the maximum degree possible in accordance with legitimate design aims.

• Human fragility, both physical and psychological, must always be recognized.

Considerations for Design

• Maximum, acceptable transparency in robotic system programming is necessary.

• Robotic behavior should be predictable.

• Trustworthy system design concepts must be applied to all areas of a robot's functioning, including hardware and software design, as well as any data processing on or off the platform.

• Users should be given with real-time status indications to the maximum degree possible in accordance with realistic design objectives.

• To the maximum extent possible in accordance with realistic design objectives, obvious opt-out procedures (kill switches) are necessary.

Considerations Legal

• All applicable laws and regulations pertaining to persons' rights and safeguards (e.g., FDA, HIPPA, and FTC) must be followed.

• The decision routes of a robot must be re-constructible for litigation and conflict settlement.

• Human informed consent to HRI should be enabled to the maximum degree practicable in accordance with legitimate design goals.

Considerations of a Social Nature

• The Wizard of Oz should be used as little and carefully as possible, with the goal of avoiding Turing deceptions.

• Human connection to and anthropomorphization of robots should be carefully studied throughout design.

• Humanoid shape and functionality are authorized only to the extent required to fulfill realistic design goals.

• In robot design, avoid racist, sexist, and ableist morphologies and behaviors.

Since the publication of this original study, we have held a workshop titled "The Emerging Policy and Ethics of Human Robot Interaction." 198 Artificial Intelligence in Behavioral and Mental Health Care The workshop has expanded on these concerns, and we will soon make a consensus paper available to the community.

Conclusion

The personal robotics market is fast increasing, with new firms starting, products being created, and commercial applications arising in ways inconceivable a decade ago. While exact forecasts are unattainable, the present trend in research and development points to a future in which robots can aid us in a range of daily jobs. Robots, in particular, are well positioned to be a tremendously enabling technology, providing an enhanced quality of life and an increase in independence.

Robots may also aid those with invisible health issues, such as mental health illnesses, as well as their caretakers. According to one participant at our HRI Policy and Ethics Workshop, many individuals just want a "robot that can change the oil." In other words, a robot that can assist with household duties or everyday life responsibilities. Simple things may be quite valuable.

Robots may be effective in training for caregivers. For example, much as researchers in the virtual agent community have utilized virtual patients and coaches to instruct clinical students, robots may be used in the same role. For example, to educate conversation and listening skills, as well as to facilitate destigmatization.

However, clinicians should exercise caution when deploying autonomous robots to directly deliver therapy to those suffering from mental illnesses. It is critical to first develop a solid evidence basis through the use of rigorous RCTs. Despite the attractiveness of "Sigfrid von Shrink," the robotic psychotherapist in Fredrick Pohl's novel Gateway, genuine AI realization has yet to catch up to robots' extraordinary physical skills. Having said that, this is an exciting time for robotics technology. As computer processors and storage get faster and less expensive, and as new developments in machine learning and multimodal processing emerge, there is a world of opportunity for robots to become more adept and nimble in human social contexts.

References

[1] M. A. Goodrich and A. C. Schultz, "Human–Robot Interaction: A Survey," *Foundations and Trends® in Human–Computer Interaction*, vol. 1, no. 3, pp. 203–275, 2008.

[2] M. A. Goodrich and A. C. Schultz, "A Survey, Found. Trends® Human–Computer Interact," *Hum.-comput. interact.*, 2007.

[3] T. B. Sheridan, "Human–Robot Interaction: Status and Challenges," *Hum. Factors*, vol. 58, no. 4, pp. 525–532, Jun. 2016.

[4] P. A. Hancock, D. R. Billings, K. E. Schaefer, J. Y. C. Chen, E. J. de Visser, and R. Parasuraman, "A meta-analysis of factors affecting trust in human-robot interaction," *Hum. Factors*, vol. 53, no. 5, pp. 517–527, Oct. 2011.

[5] F. Iida and C. Laschi, "Soft Robotics: Challenges and Perspectives," *Procedia Comput. Sci.*, vol. 7, pp. 99–102, Jan. 2011.

[6] H. H. Lund, J. Hallam, and W.-P. Lee, "Evolving robot morphology," in *Proceedings of 1997 IEEE International Conference on Evolutionary Computation (ICEC '97)*, 1997, pp. 197–202.

[7] S. Jahandari, A. Kalhor, and B. N. Araabi, "Online forecasting of synchronous time series based on evolving linear models," *IEEE Transactions on*, 2018.

[8] L. D. Riek, "Robotics technology in mental health care," *Artificial intelligence in behavioral and mental health*, 2016.

[9] R. Van Patten *et al.*, "Home-Based Cognitively Assistive Robots: Maximizing Cognitive Functioning and Maintaining Independence in Older Adults Without Dementia," *Clin. Interv. Aging*, vol. 15, pp. 1129–1139, Jul. 2020.

[10] A. Krishnaraj, "Designing Social Robots for Early Detection of Mental Heath Conditions," 2019.

[11] S. Ansari-Rad, S. Jahandari, and A. Kalhor, "Identification and control of mimo linear systems under sufficient and insufficient excitation," *2018 Annual American*, 2018.

[12] A. M. Okamura, M. J. Matarić, and H. I. Christensen, "Medical and Health-Care Robotics," *IEEE Robot. Autom. Mag.*, vol. 17, no. 3, pp. 26–37, Sep. 2010.

[13] L. D. Riek, "Healthcare robotics," *Commun. ACM*, 2017.

[14] S. Jahandari, A. Kalhor, and B. N. Araabi, "A self tuning regulator design for nonlinear time varying systems based on evolving linear models," *Evolving Systems*, 2016.

[15] S. Jahandari, A. Kalhor, and B. N. Araabi, "Order determination and robust adaptive control of unknown deterministic input-affine systems: An operational controller," in *2016 IEEE 55th Conference on Decision and Control (CDC)*, 2016, pp. 3831–3836.

[16] J. Dawe, C. Sutherland, and A. Barco, "Can social robots help children in healthcare contexts? A scoping review," *BMJ paediatrics open*, 2019.

[17] F. Lattanzio *et al.*, "Advanced technology care innovation for older people in Italy: necessity and opportunity to promote health and wellbeing," *J. Am. Med. Dir. Assoc.*, vol. 15, no. 7, pp. 457–466, Jul. 2014.

[18] S. Jahandari, F. F. Beyglou, and A. Kalhor, "A robust adaptive linear control for a ball handling mechanism," *2014 Second RSI/ISM*, 2014.

[19] S. Jahandari, F. F. Beyglou, A. Kalhor, and M. T. Masouleh, “A robust adaptive linear control for a ball handling mechanism,” in *2014 Second RSI/ISM International Conference on Robotics and Mechatronics (ICRoM)*, 2014, pp. 376–381.
[20] H. Kumazaki, T. Muramatsu, and Y. Yoshikawa, “Optimal robot for intervention for individuals with autism spectrum disorders,” *Psychiatry*, 2020.
[21] C. Huijnen, M. A. S. Lexis, and R. Jansens, “Mapping robots to therapy and educational objectives for children with autism spectrum disorder,” *developmental disorders*, 2016.
[22] G. E. Lancioni, D. Bellini, and D. Oliva, “A robot to provide multihandicapped blind persons with physical guidance and activity choices,” *J. Dev. Phys. Disabil.*, vol. 5, no. 4, pp. 337–348, Dec. 1993.
[23] G. E. Lancioni, D. Bellini, and D. Oliva, “Brief report: Building choice opportunities within a robot-assisted occupational program: A case study,” *Behav. Interv.*, vol. 8, no. 3, pp. 219–226, Jul. 1993.
[24] O. Avioz-Sarig, S. Olatunji, V. Sarne-Fleischmann, and Y. Edan, “Robotic System for Physical Training of Older Adults,” *Adv. Robot.*, vol. 13, no. 5, pp. 1109–1124, 2021.
[25] S. M. Rabbitt, A. E. Kazdin, and B. Scassellati, “Integrating socially assistive robotics into mental healthcare interventions: applications and recommendations for expanded use,” *Clin. Psychol. Rev.*, vol. 35, pp. 35–46, Feb. 2015.
[26] B. Scassellati, H. Admoni, and M. Matarić, “Robots for use in autism research,” *Annu. Rev. Biomed. Eng.*, vol. 14, no. 1, pp. 275–294, May 2012.
[27] E. Deng, B. Mutlu, and M. J. Mataric, “Embodiment in Socially Interactive Robots,” *Foundations and Trends® in Robotics*, vol. 7, no. 4, pp. 251–356, 2019.
[28] M. J. Matarić, “Behavior-based robotics as a tool for synthesis of artificial behavior and analysis of natural behavior,” *Trends Cogn. Sci.*, vol. 2, no. 3, pp. 82–86, Mar. 1998.
[29] M. Law *et al.*, “Developing assistive robots for people with mild cognitive impairment and mild dementia: a qualitative study with older adults and experts in aged care,” *BMJ Open*, vol. 9, no. 9, p. e031937, Sep. 2019.
[30] V. Faucounau, Y. H. Wu, and M. Boulay, “Caregivers’ requirements for in-home robotic agent for supporting community-living elderly subjects with cognitive impairment,” *Technology*, 2009.
[31] M. Darragh, H. S. Ahn, B. MacDonald, and A. Liang, “Homecare robots to improve health and well-being in mild cognitive impairment and early stage dementia: results from a scoping study,” *Journal of the American*, 2017.
[32] N. Fields, L. Xu, J. Greer, and E. Murphy, “Shall I compare thee… to a robot? An exploratory pilot study using participatory arts and social robotics to improve psychological well-being in later life,” *Aging Ment. Health*, 2021.
[33] K. L. Narayanan *et al.*, “Fuzzy Guided Autonomous Nursing Robot through Wireless Beacon Network,” *Multimed. Tools Appl.*, vol. 81, no. 3, pp. 3297–3325, Jan. 2022.
[34] P. H. Robinson, M. Clarke, and J. Barrett, “Determinants of delayed gastric emptying in anorexia nervosa and bulimia nervosa,” *Gut*, vol. 29, no. 4, pp. 458–464, Apr. 1988.
[35] A. A. Scoglio, E. D. Reilly, J. A. Gorman, and C. E. Drebing, “Use of Social Robots in Mental Health and Well-Being Research: Systematic Review,” *J. Med. Internet Res.*, vol. 21, no. 7, p. e13322, Jul. 2019.
[36] T. Shibata and K. Wada, “Robot therapy: a new approach for mental healthcare of the elderly–a mini-review,” *Gerontology*, 2011.
[37] A. Fiske, P. Henningsen, and A. Buyx, “Your Robot Therapist Will See You Now: Ethical Implications of Embodied Artificial Intelligence in Psychiatry, Psychology, and Psychotherapy,” *J. Med. Internet Res.*, vol. 21, no. 5, p. e13216, May 2019.
[38] C. Howes, M. Lavelle, P. G. T. Healey, J. Hough, and R. McCabe, “Disfluencies in dialogues with patients with schizophrenia,” in *CogSci*, 2017.
[39] M. Lavelle, P. G. T. Healey, and R. McCabe, “Nonverbal behavior during face-to-face social interaction in schizophrenia: a review,” *J. Nerv. Ment. Dis.*, vol. 202, no. 1, pp. 47–54, Jan. 2014.
[40] K. Kollias *et al.*, “The development of the Early Intervention in Psychosis (EIP) outpatient unit of Eginition University Hospital into an EIP Network,” *Psychiatrike*, vol. 31, no. 2, pp. 177–182, Apr. 2020.

[41] S. P. Stefanatou Pentagiotissa, G. K. George Konstantakopoulos, E. G. Eleni Giannouli, S. V. Silia Vitoratou, and V. M. Venetsanos Mavreas, “The relationship between patients’ needs and psychopathology in schizophrenia: Do patients and therapists agree?,” *Eur. Psychiatry*, vol. 30, p. 1376, Mar. 2015.
[42] S. Dimitrakopoulos, A. Hatzimanolis, P. Stefanatou, L.-A. Xenaki, and N. Stefanis, “S125. The role of dup, DUI and polygenic score for schizophrenia on cognition in Athens fep study sample,” *Schizophr. Bull.*, vol. 46, no. Supplement_1, pp. S82–S83, May 2020.
[43] P. Stefanatou, G. Konstantakopoulos, E. Giannouli, N. Ioannidi, and V. Mavreas, “Patients’ needs as an outcome measure in schizophrenia,” *Eur. Psychiatry*, vol. 33, no. S1, pp. S453–S453, Mar. 2016.
[44] S. Ujike *et al.*, “Encounter of Pepper-CPGE for the elderly and patients with schizophrenia: an innovative strategy to improve patient’s recreation, rehabilitation, and communication,” *J. Med. Invest.*, vol. 66, no. 1.2, pp. 50–53, 2019.
[45] K. L. Fortuna *et al.*, “A Future Research Agenda for Digital Geriatric Mental Healthcare,” *Am. J. Geriatr. Psychiatry*, vol. 27, no. 11, pp. 1277–1285, Nov. 2019.
[46] K. Kabacińska, T. J. Prescott, and J. M. Robillard, “Socially Assistive Robots as Mental Health Interventions for Children: A Scoping Review,” *International Journal of Social Robotics*, vol. 13, no. 5, pp. 919–935, Aug. 2021.
[47] E. Miller and D. Polson, “Apps, avatars, and robots: The future of mental healthcare,” *Issues Ment. Health Nurs.*, 2019.
[48] D. David, S. A. Matu, and O. A. David, “Robot-based psychotherapy: Concepts development, state of the art, and new directions,” *International Journal of Cognitive*, 2014.
[49] P. Stefanatou, E. Giannouli, Z. Antonopoulou, P. Tsellos, G. Vaslamatzis, and M. Typaldou, “The Concept of Time Perspective Within a Psychiatric Context,” *Eur. Psychiatry*, vol. 33, no. S1, pp. S507–S508, Mar. 2016.
[50] P. Stefanatou *et al.*, “Patient-reported needs predict perceived psychosocial disability and quality of life beyond symptom severity in schizophrenia,” *Disabil. Rehabil.*, pp. 1–9, Feb. 2022.
[51] P. Stefanatou *et al.*, “Fear of COVID-19 impact on professional quality of life among mental health workers,” *Int. J. Environ. Res. Public Health*, vol. 19, no. 16, p. 9949, Aug. 2022.
[52] T. Kolling, J. Haberstroh, R. Kaspar, and J. Pantel, “Evidence and deployment-based research into care for the elderly using emotional robots: Psychological, methodological and cross-cultural facets,” *geriatric psychiatry*, 2013.
[53] E. Mordoch, A. Osterreicher, L. Guse, K. Roger, and G. Thompson, “Use of social commitment robots in the care of elderly people with dementia: a literature review,” *Maturitas*, vol. 74, no. 1, pp. 14–20, Jan. 2013.