Huijnen et al., Int J Neurorehabilitation Eng 2017, 4:4
DOI: 10.4172/2376-0281.1000278

International Journal of Neurorehabilitation
ISSN: 2376-0281

Commentary OMICS International

Robots as New Tools in Therapy and Education for Children with Autism

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Abstract

Robots are increasingly considered as a promising tool in therapeutic and educational interventions for children with autism spectrum disorder (ASD). International literature indicates that robots can potentially be applied to a wide range of objectives. The aim of this article is to present an overview of robots that are currently used in therapy and educational for children with ASD and to indicate what objectives they address. Focus group sessions (N=9) with ASD professionals (N=53) from nine organisations were conducted which identified potential objectives for children with ASD. A systematic literature study delivered an overview of the state of the art of robots under study. Professionals reported to work on 74 ASD objectives in 9 different domains (based on the International Classification of Functioning - Child and Youth, ICF-CY). The robots (N=14) found in the literature addressed 24 of these objectives in 8 of the 9 domains, indicating the potential contribution of these robots to therapy and education of children with ASD. Domains that are targeted most often by robots currently are 'social or interpersonal interactions and relations', 'play' and 'communication'. Results indicate that robot mediated interventions are considered to be a possible valuable tool in the education or therapy for children with autism. In order to unlock the potential of robots, it is advised that technical developers use knowledge from ASD practice so that meaningful applications can be developed.

Keywords: Autism spectrum disorder (ASD); Children; Therapy and education objectives; Robots

Introduction

More and more children, about 0.66% or 1 child in 152 children, have the diagnosis of Autism Spectrum Disorder (ASD) [1-5]. Autism spectrum disorder is characterised by persistent deficits in social communication and social interaction across multiple contexts, as well as restricted, repetitive patterns of behaviour, interests, or activities [6]. It is a disorder which affects multiple areas of daily living throughout a person's life. People (children) benefit from early and on-going intervention that is tailored to their specific individual needs [5]. Technology is an accepted and efficient support tool in the therapy and education of individuals with ASD and their (informal) carers [7-10]. More, specifically, robot-assisted therapy (RAT) or robot-mediated intervention (RMI) is considered promising for children with ASD [11-16]. Although it might sound contradictory to use a robot to teach children skills in areas such as communication and social interaction, the use of robots has a number of advantages for these children. Interacting with a robot can be easier for them than interacting with a person, but also less complex, more predictable, simpler and more appealing; robots can be applied in a controlled manner which decreases the risk of stressful situations; robots are better in endless repetitions and variations can be made in a conscious and controlled way [8,17]. The aim of this short commentary is to provide a short overview of robots for use in ASD interventions as presented in the literature.

Methods

A mixed method approach, including focus groups and a systematic literature study was used to create this overview. This short commentary is based on previous research [14]. Professionals (N=53) working in care organisations or special needs schools for children with ASD participated in 9 focus group sessions to provide insight into the objectives that are important for these children [14]. This resulted in an overview of 9 domains including 74 objectives, as presented in Figure 1. These domains, based on the ICF-CY, were: communication, social/interpersonal interactions and relations, self-care/independent living, play, emotional wellbeing, sensory experiences and coping, motor experiences and skills, preschool skills and functioning in daily reality. Each of these domains includes a number of specific objectives (Figure 1). A systematic literature study was conducted based on principles of the Cochrane Handbook [18] to learn more about the state of the art of robotics for this target group. The consulted databases were PubMed, CINAHL, EMBASE, ERIC, IEEE Xplore digital library, Science Direct, Springer Link and Taylor & Francis. Furthermore, a Google Scholar search was carried out.

Results

Peer reviewed articles discussed 14 different robot platforms that focus on 24 different objectives of the 74 ASD objectives identified by the professionals. Figure 2 provides an overview of these robots and the objectives that they addressed. Some robots (e.g. NAO, Robota, Probo, Keepon, Isobot, Tito, GIPY-1, KASPAR, Ifbot, Labo-1) have been applied for multiple objectives, and other robots have been reported in the context of one ASD objective only (e.g. cat robot, HOAP 3, Robot arm and Pleo). Objectives that were studied most often were: 'imitation in social interaction', 'turn-taking', 'imitation in play', 'collaboration/joint attention', 'playing together – collaborative play' and 'attention'. The most commonly addressed domains are: 'Social/Interpersonal interactions and relations', 'Play' and 'Communication'. The domain of 'Self-care, independent living' is left unaddressed by all robots. 'Preschool skills' is the domain for which the ASD professionals identified most objectives (n=14). However, only 1 of these 14 objectives was targeted, by the robot Nao ('pose a question/ask for help').

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Received July 10, 2017; **Accepted** June 28, 2017; **Published** August 04, 2017

Citation: Huijnen CAGJ, Lexis MAS, de Witte LP (2017) Robots as New Tools in Therapy and Education for Children with Autism. Int J Neurorehabilitation 4: 278. doi: 10.4172/2376-0281.1000278

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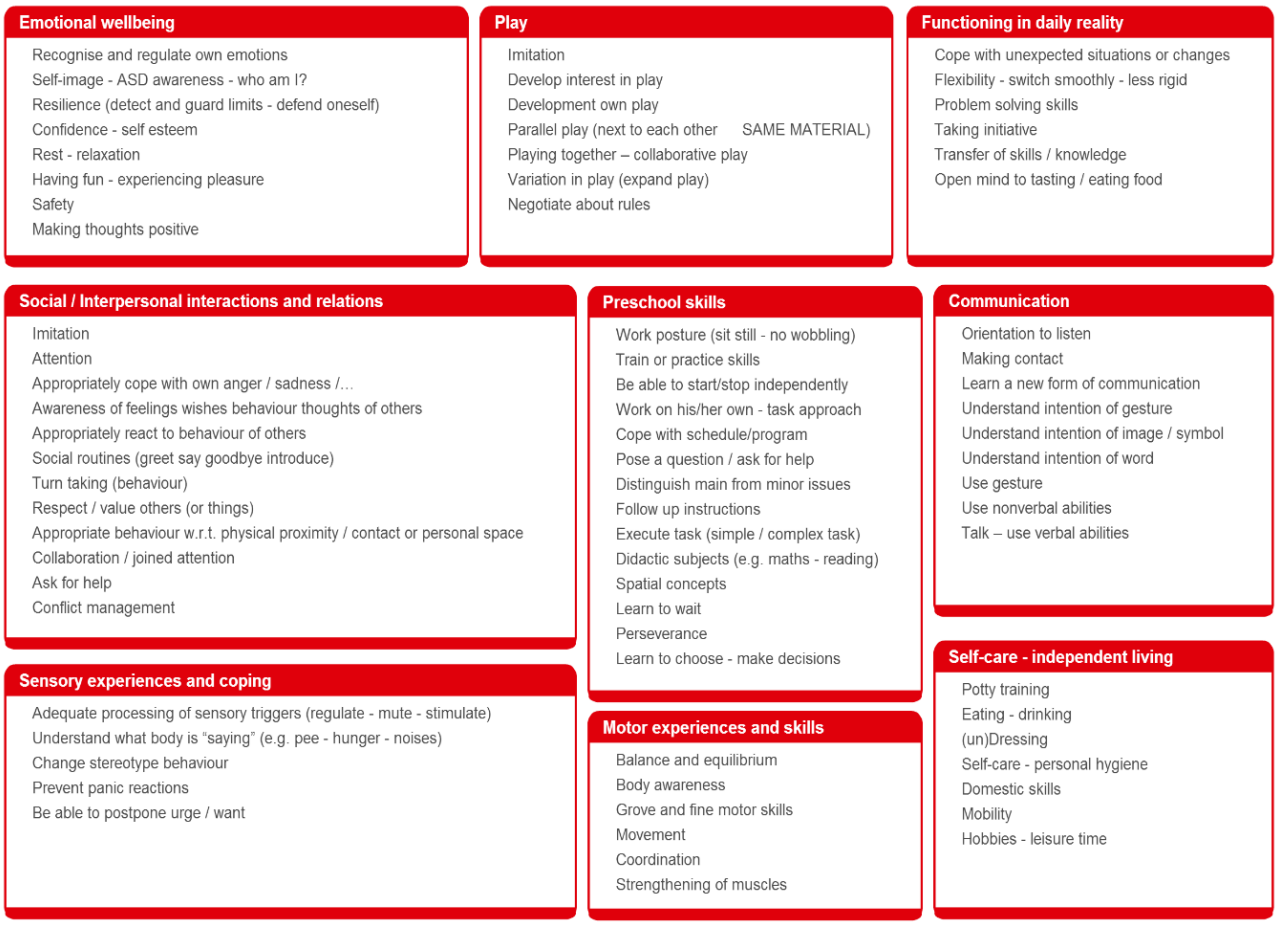

Figure 1: Overview of therapy and education objectives for children with autism spectrum disorder.

Robot	Therapy or educational objectives	References	Robot	Therapy or educational objectives	References
Nao	Imitation; Attention; Collaboration/joint attention; Playing together–collaborative play; pose a question/ask for help	[21-28]	**GIPY**	Development own play; Parallel play (next to each other, same material)	[29] [30]
Robota	Imitation; Turn taking (behaviour); Imitation; Coordination	[31-33]	**Hoap 3**	Development own play; Parallel play (next to each other, same material); Taking initiative	[34]
Probo	Awareness of feelings, wishes, behaviour, thoughts of others; social routines (greet, say goodbye, introduce); parallel play (next to each other, same material)	[35,36]	**KASPAR**	Making contact; Attention; Appropriately react to behaviour of others; Turn taking (behaviour); Appropriate behaviour w.r.t. physical proximity; Playing together – collaborative play; Self-image, ASD awareness; Adequate processing sensory triggers, regulate, stimulate; Understand what body is "saying"; Be able to postpone urge; Taking initiative	[37] [38] [39] [40] [37]
Keepon	Making contact; appropriately react to behaviour of others; Development own play; Flexibility, switch smoothly, less rigid	[41-43]	**Robot arm**	Imitation	[44]
Cat robot	Awareness of feelings, wishes, behaviour, thoughts of others	[45]	**Pleo**	Talk – Use verbal abilities	[46]
I-sobot	Imitation	[47,48]	**Labo-1**	Turn taking (behaviour); Imitation	[49,50]
Tito	Collaboration / joint attention; Imitation	[51]	**ifbot**	Orientation to listen; Use nonverbal abilities; Talk, use verbal abilities	[52]

Figure 2: Overview of robots and objectives they may address.

For the domain of 'Emotional wellbeing' also one robot (KASPAR) could be identified in one article addressing one objective ('self-image, ASD awareness, who am I').

Recent research aimed to study the expectations of professionals of what contribution robot KASPAR can have for children with autism. Professionals expect that KASPAR can contribute mostly to working on objectives in the domains of communication, social interaction, and play [19]. Examples of objectives in these domains are: 'imitation in play', 'making contact', 'orientation to listen', 'imitation in social interaction and relations', 'turn taking', 'social routines', 'attention', 'learn a new form of communication' and 'talk – use verbal abilities'. Professionals also expect KASPAR to contribute to objectives in other domains such as emotional wellbeing and preschool skills: 'having fun, experiencing pleasure', 'develop interest in play' or 'train or practice skills', 'pose a question or ask for help' and 'follow up instructions' [19].

These results indicate that robot mediated interventions may address a larger scope of objectives for these children than they currently do. Although more and more studies highlight the potential of robots for this target group, robots have not made their way into (many) classrooms or therapy sessions yet. Many of the robots found in the literature are still in a prototype stage and not commercially available. It is highly recommended that knowledge from ASD practice reaches technical robot developers to guide robot development so that studies can be conducted with robot interventions that are carefully designed to meet the specific needs of this target group and that utilise the potential power of robots [20].

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