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Ph.D. THESIS RESUME

ENHANCING SOCIAL AND EMOTIONAL ABILITIES OF CHILDREN WITH AUTISM SPECTRUM DISORDER BY USING ROBOT ENHANCED PSYCHOTHERAPY

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Key words: robot-enhanced therapy, autism spectrum disorder, socio-emotional skills, cognitive flexibility, parental distress, cognitive-behavioral therapy

CHAPTER I THEORETICAL BACKGROUND

1. Introduction and research topic

1.1 Autism Spectrum disorder – general information

Autism Spectrum Disorder (ASD) is one of the most common childhood developmental disorders (Fombonne, 2009). ASD is characterized by restricted patterns of behavior and interests and qualitative impairments in communication and social interaction (American Psychiatric Association, 2000). These are known collectively as the core symptoms (American Psychiatric Association, 2000) for ASD. In the most recent version of the DSM (DSM-V: American Psychiatric Association, 2014), the whole spectrum of Pervasive Developmental Disorders was replaced with one disorder named "autism spectrum disorder" described by two defining dimensions of behavior: 1) deficits in social communication and social interaction, and 2) presence of restrictive and repetitive patterns of behavior, interests and activities.

The prevalence of ASD is continuously rising and some recent publications estimate the prevalence of ASD as being close are close to 7 in 1,000 (Fombonne 2009, Leyy et al. 2009, Mahjouri & Lord 2012). Results vary markedly in different studies depending on methods, sample sizes, procedures involving administrative databases or national registers, or a two-stage or multistage approach in underlying populations, sources of information, diagnostic instruments used, diagnostic criteria, and the period of time when the study was conducted (Fombonne 2009).

1.1.1 Social skills: Implications for play

As we have mentioned before, Memari et al., 2013 showed that perseveration is negatively connected to appropriate daily social play in a child with ASD. This represents an important issue for ASD children due to the fact that since 1967, Vygotsky that stated that social play has a crucial developmental role and may increase the intelligence. Continuing with more recent work (Smith, 2010; Ginsburg, 2007), play has been shown to be an integral part of the child development. Play it is argued to be linked with a number of important developmental achievements such as social skills, emotion regulation and language abilities (Casby, 2003; Lindsey & Cowell, 2003).

1.1.2 Restricted and repetitive behaviors and the relation with cognitive flexibility

Several studies associate these restricted and repetitive behaviors and interests with executive dysfunctioning and most clearly with the domain of cognitive flexibility (e.g., Lopez, Lincoln, Ozonoff, & Lai, 2005; South, Ozonoff, & McMahon, 2007). Cognitive flexibility is a central part of children cognitive development and several studies showed that individuals with ASD engage in highly perseverative and inflexible strategies compared to both clinical (e.g., children with Attention Deficit Hyperactivity Disorder) and typically developing control groups (TD) (Geurts, Verte´, Oosterlaan, Roeyers, & Sergeant, 2004; Ozonoff, Pennington, & Rogers, 1991). Cognitive flexibility is defined as "the ability to adapt thoughts or actions in response to situational changes" (Geurts, Corbett, & Solomon, 2009).

1.1.3 Emotional symptoms in children with ASD

Autism spectrum disorder (ASD) is associated with amplified emotional responses and poor emotional control (Mazefsky et al., 2013). Difficulties in recognizing,

identifying and expressing emotions, lack of emotional empathy and the deficits in theory of mind and lack of effective strategies of self-regulation, can also be connected to high rates of psychiatric co-morbidities in ASD. Psychiatric co-morbidities are prevalent, with secondary psychopathology occurring in as many as 72% of children with ASD (Klin et al., 2005; Mazzone et al., 2012; Leyfer et al., 2006). Previous reports have shown the presence of different types of psychiatric disorders in persons with ASD and important associations have been found with both internalizing, such as depression, bipolar disorder, anxiety disorder, obsessive compulsive disorders, and externalizing disorders including attention deficit and hyperactivity disorder, disruptive behaviour and conduct disorder (Green et al., 2000; Hedley & Young, 2006; Howlin, 1997; Kuusikko et al., 2008; Mazzone et al., 2012; Meyer et al., 2006; Mukaddes & Fateh, 2010; Munesue et al., 2008; Newman & Ghaziuddin, 2008; Pineet al., 2008; Simonoff et al., 2008; Tani et al., 2006; Volker et al., 2010; Ruta, Mugno, D'Arrigo, Vitiello, and Mazzone 2010).

Despite the fact that comorbidity with mood disorders has been widely studied, several issues remain unsolved in order to understand the manifestation of symptoms in these patients. In fact, in the clinical practice, it remains difficult to identify psychiatric symptoms and the underlying mechanism especially because typical autistic problems, such as the lack of emotional empathy and the deficits in theory of mind, can mask the psychiatric disorders (Klin et al., 2005; Mazzone et al., 2012).

Underlying mechanisms of emotional symptoms

An area of research particularly relevant to psychopathology and dysfunctional emotions and its underlying mechanisms relates to the distinction between rational and irrational beliefs. Irrational beliefs, as defined by Albert Ellis (1962, 1994) in the framework of Rational Emotive Behavior Therapy (REBT), are evaluative beliefs which have no logical, empirical and/or pragmatic support. That is, they are illogical, they are not supported by evidence and/or they do not serve the purposes of the individual. By contrast, rational beliefs are logical, and/or have empirical support, and/or are pragmatic. For a belief to be considered rational, it has to meet at least one of these criteria, but it is not required to meet all three. Therefore, the terms rational and irrational have a rather psychological meaning, and not necessarily a philosophical or a logical definition (Ellis, David, & Lynn, 2010).

According to REBT, dysfunctional emotions like anxiety or depression are triggered and maintained by irrational beliefs, whereas functional emotions, either positive or negative (e.g., concern, sadness), are primed by rational beliefs. In this sense, the "ABC" model (Ellis, 1994) states that people experience undesirable activating events (A), about which they have either rational or irrational beliefs (B). In interaction with the activating events (A), rational and irrational beliefs (B) further lead to emotional, behavioral, and cognitive consequences (C). Rational beliefs lead to functional, adaptive consequences, while irrational beliefs lead to maladaptive, dysfunctional consequences.

1.2 Psychological interventions in ASD

1.2.1 Early Intensive Behavioral Intervention for core symptoms in ASD

A number of studies provide evidence for the use of behavioral and psychosocial interventions as a first line treatment for the core symptoms of ASD in children (Ospina et al., 2008). For example, several studies on early intensive behavioral intervention

(EIBI) have yielded encouraging results in improving children's cognitive, adaptive, and social functioning (e.g., Lovaas, 1987; Sallows & Graupner, 2005). Meta-analyses and systematic reviews have generally concluded that EIBIs based on the principles of applied behavior analysis appears to be the most effective treatment for ASD to date (Eikeseth, 2009; Makrygianni & Reed, 2010; Matson & Smith, 2008; Reichow, 2012; Reichow & Wolery, 2009; Rogers & Vismara, 2008; Spreckley & Boyd, 2009; Virués-Ortega, 2010; Warren et al., 2011).

However, the heterogeneity and developmental nature of ASD make it unlikely that one specific treatment model or its specific implementation strategy will work for any one child throughout his cognitive and social development. A variety of other factors should also be considered; therapist burnout would be an example of this. Gibson, Grey, and Hastings (2009) rightly point out that most EIBI is delivered in a repetitive, intensive manner, usually the bulk of which is one-to-one since children with autism require an excessive amount of one-to-one instruction. In order to reduce the workload of the therapist, to increase the engagement in therapy and to increase the effectiveness of therapy for some specific skills (social skills for example) new advances in ASD intervention are recommended.

1.2.2 Effectiveness of CBT on emotional problems of Children with ASD

As mentioned above many children with ASD experience clinically or subclinical elevated anxiety symptoms, a characteristic associated with disrupted functioning across multiple domains. Although considerable work has been done addressing the core symptoms of children with ASD (e.g., Dawson et al., 2010; Kasari, 2002), limited attention has been given to treatments for reducing emotional problems of children with ASD.

Despite the fact that Cognitive behavioral therapy (CBT) has been shown to be an effective empirically supported treatment for typical children, there has been debate in the literature as to whether or not it can be used with other populations. Specifically, with the recent recognition of the high comorbidity of anxiety with ASDs, the use of CBT with children who have ASD has been highly debated. For instance, Sturmey (2005) argues against using a cognitive component to treat this population and is in favor of strict applied behavioral analysis. Lindsay (2005), on the other hand, argues that a cognitive component can actually be beneficial in therapy with children with ASDs. In the midst of this debate, the literature in the area is consistently growing and there seems to be a general consensus that with certain specific modifications, CBT can be used to treat anxiety in higher functioning children who have Asperger's syndrome, PDD-NOS, or autism. We believe that CBT has the potential to be used for reducing emotional problems of children with ASD, but a series of adaptations need to be developed: increasing the structure and predictability, including visual supports and verbal labeling, explicitly drawing attention to important social cues and greater parent involvement (Beebe & Risi, 2003).

1.3 Association between child characteristics and parental distress

1.3.1 Parental distress

Parents of children with autism spectrum disorder (ASD) are at a heightened risk for mental health problems (DeMyer, 1979; Koegel et al., 1992). They report greater stress

and depression and a lower quality of life than parents of children with other developmental disabilities, physical disabilities, or chronic health conditions (Mugno et al., 2007; Olsson and Hwang, 2001). This is also because of the communication impairments, stereotyped interests, and many other problem behaviors associated with the disorder (APA, 2004).

Predictors of parenting distress have been researched quite extensively in autism and other developmental disabilities (e.g., Hastings & Johnson, 2001; Perry, 2004b). Links between high parenting stress and concurrent problems in child and parent functioning have been demonstrated among children with ASD, and there is recent evidence of the negative effects of cumulative stress on children's behavior. In our research project parental distress, among being considered an independent variable is also seen as a potential factor influencing parent involvement. Clinical experience suggests that parents experiencing high stress levels may be less able to be involved effectively with their children's therapy. Furthermore, some research suggests that high parental stress can negatively impact the child's progress in behavioral or cognitive interventions (e.g., Plienis et al., 1988; Robbins et al., 1991).

1.3.2 Parent's involvement in therapy

Parental involvement increases generalization of therapy via practice at home and better understanding of the program. For instance, Chalfant et al. (2007) also emphasized parental involvement but via a different approach. Instead of having parents directly participate in each session, a separate parent group program was set up to coincide with each of the child's group therapy sessions. In these sessions parents discussed (with the aid of separate therapist) what the child was learning in his/ her session and how to help the child practice his/her new skills outside of the therapy sessions. This group also provided a parental support network, parenting skills, and parental management training. This approach allowed a tailored parent component of therapy to occur simultaneously with the CBT for the child.

In our research project we have created three components of treatment, a child only component, a parent child dyad, and a parent only component. By doing so, parents could be involved directly in the treatment process while at the same time receiving separate, more intensive therapy. Several studies adapted before similar approaches (Sze & Wood, 2008, Reaven et al. 2009, Wood et al. (2009) by involving parents directly in therapy as well as providing separate parent training sessions.

1.3.3 Reducing distress in parents of children with ASD

The central idea of Rational Emotive Behavior Therapy (REBT, Ellis, 1962, 1994) is that rational beliefs trigger functional emotions while irrational beliefs trigger dysfunctional emotions. Rational and irrational beliefs may be distinguished in terms of their logical, empirical, and pragmatic support. As defined by Albert Ellis (Ellis, 1962, 1994), rational beliefs are evaluative beliefs with logical, empirical and/or pragmatic support, while irrational beliefs are illogical, not supported by evidence, and/or do not serve the purposes of the individual. Rational beliefs are considered to be associated with functional emotions, while irrational beliefs are thought to lead to dysfunctional emotions.

The "ABCDE" model is the cornerstone of REBT (Ellis, 1994). The initial ABC assessment framework was later expanded into the ABCDE model (Ellis, 1962; Ellis, & Dryden, 1997), in recognition of the importance of disputation and replacing irrational beliefs with rational ones. In the ABCDE framework, A stands for undesirable life events "activating events" that can be (1) internal or external, (2) past, present or future, (3) real or imagined. About activating events people uphold rational or irrational beliefs (B) that result into affective, psycho-physiological and behavioral consequences (C).

1.4 Robot-enhanced interventions

1.4.1 Attitudes toward robots

In psychology, an attitude is known as a relatively stable and enduring predisposition to behave or react in a certain manner towards persons, objects, institutions, or issues (Chaplin, 1991). In regard to robotics, attitude towards use is defined as the user's positive or negative evaluation of the use of the robot (Heerink, Krose, Evers, & Wielinga, 2010). Attitude towards a certain behavior has a strong, direct and positive effect on the intention to perform that behavior (Fishbein, & Ajzen, 1975). In reference to robotics, intention to use is defined as the indication of the user's readiness to use the robot (Moon & Kim, 2001) Together, both of these variables are acknowledged predictors of actual behavior, making them relevant for studying the user acceptance of social robots. Past research has shown that barriers to the use of assistive technologies include feelings of embarrassment and lack of knowledge (Broadbent, et al., 2012).

In addition, perceived benefit has been found to have positive effects on the adoption of and attitudes toward new technologies (Lee, 2009; Wang, Dacko, & Gad, 2008), while perceived risk has negative effects on public acceptance of and trust towards technology (Eiser, Miles, & Frewer, 2002).

1.4.2 Social robots – application for psychotherapy in general

In recent years it has been possible to identify a clear trend in the design and development of new technologies regarding psychotherapeutic approaches in order to reduce the symptoms and to improve the quality of life of the clients. Psychotherapy is defined as a psychological intervention which has the aim to stimulate human optimization, to prevent mental disorders and to provide treatment for mental disorders and other disorders that involve psychological factors in their etiopathogenetic mechanisms (David, Lynn, & Ellis, 2010).

Rapid progress in the development of interactive technologies and their accessibility offer the possibility for innovation in psychotherapy for individuals with mental health disorders. Some of the technological tools used have already undergone systematic testing and their efficacy/effectiveness are synthesized in meta-analytical studies; see the case of online delivered cognitive-behavioural therapy (CBT) and computer based CBT (Mureşan, Montgomery, & David, 2012; Reger & Gahm, 2009) and also of virtual reality based CBT (Opriş et al., 2012; Powers & Emmelkamp, 2008). Also the advances in recent years in robotics have enabled social robots to fulfil a variety of functions in the psychotherapeutic process.

David, Matu, & David (2014) defined robot-assisted/enhanced therapy the use of robots in a personalized evidence-based psychotherapy framework, where the robot

should be seen as a technological tool that can help the psychotherapists to accomplish their clinical roles and aims. Social robots may have different roles in in psychotherapy (David, Matu & David, in press): mediator; therapist or assistant.

1.4.3 Robot - enhanced therapy for children with ASD

Many research groups have studied in detail how social robots positively affect social interaction in children with ASD. Different theories try to explain why children with autism prefer to live in a predictable world. One of them, the Theory of Mind (Baron-Cohen, 1997) explains that children with autism tend to have difficulties in identifying mental states of others, i.e. in having a representation of what others may think. Consequently, it can be very hard for them to understand social interactions. In addition to this theory, they often lack the capability to generalize (Baron-Cohen, 1997) and, as a consequence, to classify entities. Moreover, since human beings are very complex with all their essential expressiveness, they tend to prefer interacting with objects which are simpler. This could be partly explained by a theory focusing on the Based on the empathizing–systemizing theory of Baron-Cohen (Baron-Cohen, 2009), robots can be described as predictable and lawful systems, very easy for children with ASD to cope with.

Robots might have the potential to be used in ASD therapies due to several advantages: 1) The anthropomorphic embodiment of the robot is offering human like social cues and is keeping at the same time object-like simplicity; 2) Robots can be programmed to gradually increase the complexity of the tasks, by solely presenting relevant information; moreover, information can be repeated in the same format, without trainer fatigue; 3) Robots are predictable and, therefore, controllable, enable errors to be made safely and give possibilities to train a wide range of social and communication behaviors to prepare for real life exposition; 4) Children with ASD are more responsive to feedback, even social feedback, when administered via technology rather than a human (Ozonoff, 1995).

Yet, most of the support to date for the use of social robots in therapy is based on study cases and designs with major limitations and thus lacks support for the generalization of the improved skills (Ricks & Colton, 2010; Diehl, Schmitt, Villano, & Crowell, 2012).

2. Relevance and impact of the research topic

The prevalence of ASD is continuously rising and the impairments emerge early and persist in development even though their manifestation changes over the course of development. The disorder is a complex one and it is characterized by a large variability in behavioral and cognitive characteristics between individuals. Currently, no biological marker exists and ASD is diagnosed based on the behavioral phenotype and there are no interventions that can cure the disorder. Most individuals with ASD require professional care throughout their lives (Mordre et al., 2012; Seltzer et al., 2003).

Considering all the characteristics mentioned above, researchers have been focused on developing complex interventions that can assist the individuals with ASD along their lives. However, the heterogeneity and developmental nature of ASD make it unlikely that one specific treatment model or its specific implementation strategy will work for any one child throughout his cognitive and social development. Recent studies have shown using technological tools, such as social robots, are potentially viable

approach to teaching different skills to students with ASD for several reasons (Diehl et al, 2012). First, research has shown that students with ASD often respond well to teaching techniques that involve feedback provided by a technological instrument (Whalen et al., 2010; Ozonoff, 1995). Second, technology could be used to minimize the impact of social deficits inherent in ASD by reducing the quantity and complexity of child-therapist interactions. Third, research has suggested that students with ASD tend to be highly responsive to using social robots, which could make academic demands delivered via social robots less aversive or more palatable. Finally, social robots can be used to individualize instruction by selecting difficulty settings appropriate for a particular student's ability level.

In this sense, this research project starts from several studies that have investigated the use of social robots in therapy for children with ASD (Robins, Dautenhahn, Boekhorst & Billard, 2005; Vanderborght et al., 2012, Kim et al., 2012) and offers new hypothesis to be investigated in this domain.

CHAPTER II. RESEARCH OBJECTIVES AND OVERALL METODOLOGY

The general goal of this research project was to investigate the potential of using robot-enhanced tasks/techniques for children with ASD in order to improve their social, play and emotional performances. More specifically, we wish to investigate whether if using the active presence of a social robot in different types of tasks can improve the performances of children with ASD compared with typically developing children (TD) on several levels: behavioral, cognitive and subjective.

The first major objective of our research was to quantitatively review the data available in the literature regarding the psychological applications designed to improve the performance of the participants regarding the behavioral, subjective or cognitive outcomes. We have decided to orient our research efforts in this direction as 1) no other previous systematic review looked at this specific matter; 2) we needed to establish a state of the art regarding the use of social robots for psychological outcomes. This objective aimed to contribute to the empirical evidence regarding the effectiveness of robot-enhanced techniques and was pursued by means of a quantitative meta-analysis (Study 1).

The second major objective of our research was to investigate the attitude towards using robots in mental health services and to pilot the use of robot-enhanced therapy for children with ASD. We have selected to investigate the effects of social robots in play skills, social skills and engagement in the task since several research papers suggested that robot-enhanced task can represent an added value on the behavioral outcomes. As research on social skills and engagement has benefited from a great attention in specialized literature, we were able to easily integrate our research with the current findings in this domain. This objective was pursued in Study 2 and Study 3.

The third major objective of our research was to extend previously reported results by investigating robot-enhanced therapy for other types of outcomes (e.g, cognitive performance) and also to compare the performances of TD children with ASD children. The objective had conceptual and methodological implications. In order to accomplish this objective we have developed a task that measured cognitive flexibility in children. We investigated the role of the social robot in the task and we have compared

the performances between the two types of population (children with ASD and TD children) (Study 4).

The fourth major objective of our research was to extend previously results regarding child variables that may be linked to heightened levels of parental distress, as well as underlying mechanisms for elevated symptoms of anxiety, depression and dysfunctional emotions. In order to accomplish this objective we have ran an exploratory correlational predictive study. Data are collected on several variables (i.e., cognitive functioning, adaptive behavior, emotional problems, autism severity, behavioral flexibility, communication and behavioral problems), and an attempt is made to provide a comprehensive view of child characteristics and their relative contribution to parental distress. We have investigated also the role of child characteristics as a potential predictor of parental distress (Study 6).

Finally, our fifth major objective was to investigate the emotional problems of children with ASD and to integrate robot-enhanced intervention in a classical CBT protocol designed for increasing awareness of emotions and cognitions and to reduce maladaptive behaviors. More specifically we compared a robot-enhanced CBT protocol for children with treatment as usual for children with ASD. Considering previous research which emphasizes the importance of level of distress in parents for children's outcome we have also introduced a module of REBT for parents (Study 5 and Study 7)

CHAPTER III. ORIGINAL RESEARCH

Study 1. The effects of robot-enhanced psychotherapy. A meta-analysis.

Introduction[1]

In recent years it has been possible to identify a clear trend in the design and development of new technologies regarding psychotherapeutic approaches in order to reduce the symptoms and to improve the quality of life of the clients. Psychotherapy is defined as a psychological intervention which has the aim to stimulate human optimization, to prevent mental disorders and to provide treatment for mental disorders and other disorders that involve psychological factors in their etiopathogenetic mechanisms (David, Lynn, & Ellis, 2010).

Rapid progress in technology and its' accessibility, offers the possibility for innovation in psychotherapy for individuals with mental health disorders. A part of the technological tools used have already undergone systematic testing and their efficacy/effectiveness are synthesized in meta-analytical studies; see the case of online delivered cognitive-behavioural therapy (CBT) and computer based CBT (Mureşan, Montgomery, & David, 2012; Reger & Gahm, 2009) and also of virtual reality based CBT (Opriş et al., 2012; Powers & Emmelkamp, 2008). Also the advances in recent years in robotics have enabled social robots to fulfil a variety of functions in the psychotherapeutic process.

The technological progress has focused on the development of special characteristics of embodied agents in order to be able to interact with children, adults or elderly people with cognitive, physical or social disabilities. The specific needs of these categories of people become a trigger point for new research techniques that focus on

[1] This study was accepted for publication.
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studying the benefits of human-robot interactions (Libin & Libin, 2004)

Meta-analysis objectives

Through this meta-analysis we aim to (a) provide an estimation of overall effect of robot-enhanced therapy on psychological outcome for different types of population, (b) provide average effect sizes on different outcomes, such as cognitive, behavioral and subjective, and (c) test possible moderators of effect size. Also, in the context of the current modalities in which social robots are being used to address different types of clinical problems, there are still some questioned that might be answered through our study, e.g., what type of tasks should we use in human robot interactions? or what type of outcomes does the use of social robot in psychotherapy impact more?

Method

Inclusion – exclusion criteria

We have included in our meta-analysis studies that report quantitative data regarding the use of social robots in specific tasks that have as an outcome psychological measures. We have also compared the use of this type of agents with another type of interventions which did not include a social robot. The dependent variables that we have focused on were: a. the cognitive performance (e.g. anagrams, puzzles): b. a behavioural level (e.g. prosocial behaviours) c. the subjective level (e.g. mood, perceived pain).

There are a number of potential moderators of the robot-enhanced therapy effect on the psychological outcomes as we have identified through our search in the literature and how previous studies have suggested (David, Matu & David, 2014). After analyzing the potential studies for our meta-analysis, we have decided (post priori) to consider the following mediators:

a. *function of the robot in the session* - possible roles of robotic agents in psychotherapy mediator, assistant, therapist (David, Matu & David, 2014)
b. *the type of the control condition*: a computer; a human; no help; a toy;
c. *robot type*: humanoid; non-humanoid;
d. *design*: experimental; quasi-experimental;
e. *population*: clinical; non-clinical.

Literature Search

The data collection process consisted of a systematic search of PubMED, PsycINFO, and IEEExplore (http://ieeexplore.ieee.org) for records from 1990 until June 2013 to identify all the studies that aimed to assess the effects of robot-enhanced therapy. These databases were searched using the following terms*: robot psychology, robotherapy, robot psychotherapy, robot autism, robot elderly, robot assisted learning, robot assisted therapy*. We also systematically searched the references from recent studies and reviews on the topic (Diehl, Schmitt, Villano & Crowell, 2012; Broekens, Heerink & Rosendal, 2009).

The inclusion criteria were: (a) to report psychological outcomes that resulted from a comparison between the effects of robot – enhanced therapy and interaction with a human or a non-robotic object; (b) to have multiple participants – in order to form a group; (c) to report quantitative data and to allow us to calculate the effect size; (d) to be written in English. We did not include studies that were reporting case studies or single case experiments, that used robots in both conditions (experimental and control) or

studies which only applied pretest and posttest measurements for a single group of subjects.

After the initial search we have identified a total of 955 records from databases and we have added 17 more records, which we have considered to be relevant from other sources, including references of other relevant papers. We have removed 111 duplicates and then we have screened through their abstracts a number of 861 records. A total of 103 articles were retained in order to be assessed for eligibility. Only 12 studies were included in the meta-analysis.

Procedure

The studies selected for this meta-analysis were originally conducted using different types of control groups, different types of interventions and different types of outcome measures. Taking into consideration these differences, we cannot assume a single true effect size for all studies selected. Therefore, we decided to use a random effects model to analyze the data (e.g., Borenstein, Hedges, Higgins, & Rothstein, 2009; Hunter & Schmidt, 2004). To test the assumption that the effect sizes included in each data sets estimate the same population mean, we tested for homogeneity of effect sizes using the Q statistic and the I^2 statistic (Borenstein, 2005). In order to address the publication bias, we calculated a fail-safe N for all effect size subsets (Rosenthal, 1991).

Results

The robot-enhanced therapy overall effect

The overall effect of robot-enhanced therapy, including the three levels (cognitive, behavioral and subjective) was calculated from 12 studies, including 581 participants. The results showed a medium significant effect of the robot-enhanced therapy Cohen's D= 0.523, VarD=0.022, p = 0.00, 95% CI = [0.233; 0.814] when compared to non-robotic condition (e.g., human condition).

The effects of robot-enhanced therapy on the behavioural level

The effect of robot-enhanced therapy on behavioral level was calculated from 9 studies, including 247 participants. The results showed a medium significant effect of the robot-enhanced therapy Cohen's D= 0.543, VarD=0.014, p = 0.00, 95% CI = [0.314; 0.722] when compared to non-robotic condition (e.g., human condition) and there was no evidence of heterogeneity, Q (8) = 7.579, p = 0.476, I^2 = 0.000.

The effects of robot-enhanced therapy on the subjective level

The effect of robot-enhanced therapy on subjective level was calculated from 3 studies, including 79 participants. The results showed a non-significant effect of the robot-enhanced therapy Cohen's D= 0.446, VarD=0.319, p = 0.162, 95% CI = [-0.179; 1.072] when compared to non-robotic condition (e.g., human condition) and there was no evidence of heterogeneity, Q (2) =3.506, p = 0.173, I^2 = 42.952.

The effects of robot-enhanced therapy on cognitive performance

The effect of robot-enhanced therapy on the cognitive level was calculated from 5 studies, including 387 participants. The results showed a small non-significant effect of robot-enhanced therapy on the cognitive performance, Cohen's D= 0.373, VarD=0.087, p

= 0.207, 95% CI = [-0.206; 0.952], and there was evidence of heterogeneity, Q (4) = 17.155, p = 0.002, I^2 = 76.683, and in this case we have analyzed whether one of the potential moderator variables could explain the heterogeneity found on the cognitive level. We found no significant moderator for the effect of robot-enhanced therapy on the cognitive outcome.

Conclusions and discussions

The results of this meta-analysis show that there is a medium significant effect of the robot-enhanced therapy on improving the performances on the three levels (behavioural, cognitive and subjective) taken together. Our findings are in line with other studies and reviews that emphasize the effectiveness of robot-enhanced therapy on specific populations or outcomes (e.g. Wada, Shibata, Saito, & Tanie, 2004; Ricks & Colton, 2010; Diehl, Schmitt, Villano & Crowell, 2012).

When analyzing the dates separately on the three levels which were considered in our study we found a significant effect of the robot-enhanced therapy on improving the performances on the behavioural level D= 0.543, VarD=0.014, p = 0.00, 95% CI = [0.314; 0.722]. We didn't find significant effect of the robot-enhanced therapy on improving the performances on the cognitive level (D= 0.373, VarD=0.087, p = 0.207, 95% CI = [-0.206; 0.952]) when compared to non-robotic condition (e.g., human condition). We found no significant effect of the robot-enhanced therapy on improving the performances on the subjective level (D= 0.373, VarD=0.087, p = 0.207, 95% CI = [-0.206; 0.952]).

Our results showed a significant heterogeneity in the case of the investigated outcomes and therefore we have conducted moderation analyses. We found no significant moderator for the effect of robot-enhanced therapy on any level. However, we could identify a trend regarding the role of the robot in therapy both on the overall effect and also on the behavioural level. We found that the most efficient interventions are those in which the robot is used as a mediator in therapy and afterwards as a therapist compared with when the robot is used as an assistant.

Limits and future directions

The most important limit of our study is that we could not identify any significant source of heterogeneity of the overall effect. There seem to be additional variables, excepting the ones considered by us, which have an influence on the robot-enhanced therapy on the overall effect. Further investigations are needed in order to identify these moderators. The small number of articles and participants included in the meta-analysis could be explained by the lack of studies that report quantitative data in this area. In future studies researchers should include quantitative measures and they should compare the efficacy of the robot-enhanced therapy with evidence-based treatments.

Future research should also focus on other types of pathologies (e.g. anxiety, depression) in order to test the effects of robot-enhanced therapy on reducing the symptoms, since the current studies considered mostly autism spectrum disorders and dementia in elderly. Until now, the majority of studies investigated the outcomes in therapy; future studies should investigate the mechanisms of change and should elaborate some cost-effectiveness analysis regarding robot-enhanced therapy.

Study 2. Attitudes toward using social robots in psychotherapy

Introduction[2]

Broadbent, Stafford, and MacDonald (2009) found that there are two aspects that impact users' acceptance of healthcare robots: characteristics of the robot (e.g., size, adaptability) and of the person (e.g., age, attitudes). In reference to robotics, intention to use is defined as the indication of the user's readiness to use the robot (Moon & Kim, 2001). These variables are acknowledged predictors of actual behavior, making them relevant for studying the user acceptance of social robots. Past research has shown that barriers to the use of assistive technologies include feelings of embarrassment and lack of knowledge. (Broadbent, et al., 2012). In addition, perceived benefit has been found to have positive effects on the adoption of and attitudes toward new technologies (Lee, 2009; Wang, Dacko, & Gad, 2008), while perceived risk has negative effects on public acceptance of and trust towards technology (Eiser, Miles, & Frewer, 2002).

Considering all these the aims of the current study are to investigate the attitudes toward using social robots in mental health care of three different populations: parents, adolescents and children. We also aim to investigate the impact of perceived benefits of using social robots in psychotherapy and if the level of information that participants have influence their attitudes towards robots. Also we wanted to reveal if the perceived benefits of using social robots in psychotherapy may influence their decision to participate on a robot-enhanced sessions.

Method

Participants

We had 336 participants that completed the questionnaires. Their age ranged from 14 to 58 (M = 29.54, SD = 13.27), 208 were women and 128 were men. This group was composed by 163 adolescents, their age ranged from 14 to 19 (M = 16.55, SD = 1.04), 128 were girls and 35 were boys and 173 adults, their age ranged from 31 to 58 (M = 41.97, SD = 5.22), 80 were women and 93 were men. Among that we also had a group of children, 61 that completed a different version of the questionnaire (customized for their level of understanding), their age ranged from 6 to 9 (M = 7.26, SD = 1.06), 28 were girls and 33 were boys.

Procedure

Participants were randomized into two groups (both adults/adolescents and children): the informed group or non-informed group. The informed group received information regarding the benefits of social robots in mental health care services: The therapy based on social robots is referring to the use of robots in psychotherapy. The non-informed group completed the questionnaires without having any type of information about social robots.

Instruments for adults

The questionnaire for adults has of 18 items and the items consisted in: a. general questions regarding the use of social robots in society, b. questions regarding the

[2] This study was accepted for publication.
Costescu, C., & David, D. (in press). Attitudes toward using social robots in psychotherapy. Transylvanian Journal of Psychology.

effectiveness of the use of social robots in the psychological counseling or psychotherapy; and c. questions regarding the use of robots in the therapy for children. The questionnaire for children has of 10 items and the items were addressing issues regarding: a. general attitude of the use of social robots in society; b. questions regarding the effectiveness of the use of social robots in the psychological counseling or psychotherapy. Among measuring their attitude toward using social robots in mental health services, and not only, we have also investigated their openness for participating to some robot-enhanced therapy sessions. They had to mark their option by yes or no, and if they agreed to participate some contact details and a signature were required.

Results

Attitudes towards social robots in adults

Our findings illustrate that when people are asked in general about the utility of the social robots, 73.2% of the people consider robots as being good for the society and only 7.8% disagree with that. Moreover, 51.5% believe that social robots represent no danger for the society and 34% nor disagree or agree regarding this question. 63.4% consider that social robots could be useful for mental health services, but only 50% consider them good partners for elderly and 20.4% consider that social robots are not appropriate for caring of elderly.

When it comes to using robots in psychotherapy, people seem to maintain their positive attitudes towards robots, and so 74.1% of them consider that social robots could make psychotherapy sessions more interesting and only 8% disagree. The majority of the participants believe that including a robot in the psychological counseling process could increase the effectiveness of the treatment (52.%) and help the clients with the homework (55.3%), but they do not believe that they can reduce costs (37.2%) or shorten the number of psychotherapy sessions (43.1%). Also we have asked some questions about the use of robots for children and interestingly we found that 37.4% of the participants disagree with robots taking care of their children, 33% nor disagree, nor agree and only 29.2% agree.

Attitudes towards social robots in children

Children that participated to this survey also had positive attitudes toward the usefulness of the social robots in society (83.7%) and felt positively to participate into some interaction sessions with social robots (75.4%). They also believe that the robots can help them (72.6%) when they are feeling stressed or that social robots can became good partners for elderly (71.7%). Interestingly when it comes to caring for children our young participants also were more cautious and 32.8% of them disagree to this issues

This section of the questionnaire had the highest scores from both children and adults' answers; apparently the majority of children, unlike adults, would feel comfortable in a robot-enhanced psychotherapy session (78.7%) and also the same percentage of participants declared that they find sessions with the social robots to be interesting. Only 15% of the children that participated at this survey consider that social robots aren't useful in psychotherapy.

Differences in attitudes towards social robots when considering the age of the participants

An exploratory objective of this study was also to see how robots are perceived at different ages by the community. The results revealed a significant difference, with small effect size between young adults and middle age adults, *(t (334) = 3.024, p = .003, d = .33),* meaning that younger participants had a better opinion regarding the use of social robots than middle age participants, regardless whether they were or not informed (Figure 6). Also we found a significant differences, with a small effect size between young adults and middle age adults, regarding their openness to participate to some robot-enhanced sessions t (330) = 2.755, p = .006, d = .30. That means that 62% respondents from the adults group had a more negative attitude toward the use of social robots, than the average attitudes from the adolescents group.

Informed vs. no informed participants

When testing our second hypothesis that stated that the participants on this who were informed will have more positively attitudes toward robots, we found that there was no significant differences between the two groups neither in adult's responses t (334) = 1.659, p = .09, d = .18, nor in children's' responses , t (59) = 1.298, p = .199, d = .33.

Openness to participate to a research project that involves interaction with the robots

We did not find any differences between informed participants and those who weren't informed regarding the benefits of robot-enhanced therapy, neither in adult's responses t (334) =0.613, p = .541, d = .06, nor in children's' responses , t (59) = 0.555 p = .581, d = .13.

Conclusion and discussion

The aim of the current study is to investigate the attitudes toward using social robots in mental health care of three different populations: parents, adolescents and children and to investigate the impact of information regarding the benefits of robots on psychological outcomes. Our findings illustrate that the majority of people have positive attitudes as concerning the use of robots for psychotherapy, considering them useful tools and that they can increase the effectiveness of psychological treatments.

Some of the results seem to be contradictory, for example although 74.1% of participants consider that social robots could make psychotherapy sessions more interesting, but only 39.9% of them would feel comfortable in a robot-enhanced session. The same interesting findings can be observed when it comes to the use of robots for children, the majority of the participants agree that social robots can increase the effectiveness of psychotherapy for children but on the other hand, only 29.2 % of the respondents consider that social robots should take care of children; 37.4 % disagree and 33% nor agree, nor disagree.

Contrarily to other studies which have shown that the perceived benefits of social robots can increase the positive attitudes, our results show that there is no significant differences between the two groups, meaning that the information provided in this study in regards to the benefits of social robots, makes no difference in terms of attitudes or openness to participate to several robot-enhanced sessions. When interpreting these results we have to consider also the fact the level of positive attitudes was high even if the respondents were not informed, and this could represents a bias in the data interpretation.

When analyzing the differences between the group of adolescents and the group of adults, we have realized that adolescents have significantly more positive attitudes toward using robots in psychotherapy than adults. Moreover, the results revealed significant differences also when it comes to participating to robot-enhanced sessions between adults and adolescents. These findings are in line with other studies that show that age influences how people attitudes toward robots and how they interacted with robots (Broadbent, Stafford, & MacDonald, 2009; Heerink, Kröse, Evers, & Wielinga, 2010; Nomura, Kanda, Suzuki, & Kato, 2008; Stafford et al., 2010).

Limits and future directions

The strengths of this article are that it combined an exploratory design and an experimental design. However, one of the major limits of this study is that we have asked some of the people to complete the questionnaires while they were systematically invited to visit our laboratory, considering that people with more positive attitudes toward robots may have been more likely to participate. The study had a relatively small sample size, although it is larger compared to many sample sizes in other user studies of robots, considering that it is a survey, a larger number of participants could have strengthen the results. Another possible limit of this study could be that the prior experience that the participants had with robots, such as a personal interaction with a robot, was not assessed by the questionnaire. This experience might have an influence on the results.

Study 3: Enhancing play skills, engagement and social skills in a play task in ASD children by using robot-based interventions. A pilot study.

Introduction[3]

Children with ASD have deficient play skills relative to typical peers (Jarrold 2003; Williams, Reddy & Costall, 2001), in particular, they lack the ability to engage in symbolic or pretend play (Rutherford & Rogers, 2003). Their play contains fewer novel play acts (Charman & Baron-Cohen, 1997) and is less elaborated and diverse than that of typically developing peers (Ungerer & Sigman, 1981). Given the marked impairments in symbolic and functional play among children with autism, the theories explaining cognitive impairments in autism should be able to account for the difficulties in pretend play, such as ‘‘theory of mind’’ (Astington & Jenkins, 1999) and weak central coherence (Frith, 1989). Children with ASD have pretend play deficits because they are unable to derive high-level meaning and therefore process faces or toys as fragments regardless of the play contexts (Lam, & Yeung, 2012).

The hypotheses of this study are: a. children with ASD will perform better in a functional play task when interacting with the robot compared with children interacting with the adult; b. children that will interact with the robot will be more engaged in the play task than when interacting with the adult; c. children that will interact with the robot will elicit more social behaviors compared with children interacting with the adult. Also we assume that children interacting with the robot will have a better performance regarding play skills, engagement in play and social behavior during the interaction with

[3] This study was accepted for publication.
Costescu, C., Pintea, S., Vanderborght, B. & David, D. (2014) Enhancing play skills, engagement and social skills in a play task in ASD children by using robot-based interventions. A pilot study. Interaction Studies, 15(2), 292-320.

the robot (the children's performance measured during the intervention) compared to their performance from baseline (the children's performance before implementing the experimental task – using an equivalent form of the experimental task).

Method

Participants

For this study, the children were recruited from several Romanian associations for children with ASD from Bucharest. In our screening process we considered the following aspects: a. previous diagnosis of autism spectrum disorder based on the criteria outlined in the DSM-IV-TR; b. minimal verbal abilities (e.g. the ability to combine 2-3 words in a phrase); c. biological age between 4 – 7 years old. From 64 registered children only 30 children met the criteria (see Figure 1). These children had to meet the following criteria: (a) diagnose confirmation using the Autism Diagnostic Observation Schedule – Generic ADOS-G, (Lord et al., 2000); (c) IQ>70, we have used SON-R 2.5-7 (Tellegen & Laros, 1993) in order to asses the intellectual ability; (d) minimal ability of functional play and (d) recognizing basic facial expression from photographs.

Procedure

The task consisted in a doctor role play task where the robot or the adult was the patient (depending on the condition), the child was the doctor and the child was supposed to help the robot/adult to feel better. Several aches/needs were expressed by the robot/adult in order to encourage the child to use the correct tools needed in order to recover (e.g. Coughing! Offf I feel a pain in my neck; Auch! it hurts where I got the injection).

Setting

The experimental sessions were implemented in a room therapy (i.e., surface about 40 m^2) from "Together Step by Step Association", Bucharest, Romania. The sessions were conducted by a clinical psychologist trained by the experimenter. The room was divided in two: in one part of the room, either the robot was installed or the adult sat on the ground (depending on the experimental condition). (see Figure 2)..

Figure 2. The child, the robot/the adult and the therapist sitting in a triangle.

Behavior measurements

Play performance: correctly using the objects (the targeted objects) from the play task – putting the correct object in any place of the robot/adult (e.g., bringing syrup close to robot's/adult's mouth; bringing stethoscope close to robot's/adult's chest).

Collaborative play: the child develops a cooperative play with his/her play partner, interacts with him/her by sharing the objects (others than the targeted one – which are specified in the scenario) and paying attention to his actions (measured in duration).

Engagement scale (this scale was developed based on the coding schema developed by Kim, et.al., 2012) and included 5 steps: intense noncompliance, non-compliance, neutral, slight interest, engagement, intense engagement.

*Stereotypical behaviors***:** a repetitive or ritualistic movement, posture, or utterance (measured in frequency – the number of stereotype behaviors performed by the child during the play task).

Positive emotions: the child laughed or smiled while interacting with the adult/robot (measured in frequency - the number of smiles or laughs performed by the child during the play task).

Contingent utterances: verbal utterances (one word or a couple of words) that are in context, congruous with the interaction with the play partner (e.g. yes-no responses, responses to the question) (measured in frequency – the number of contingent utterances said by the child during the play task).

Verbal initiations: verbal utterances (one word or a couple of words) that are in context, congruous with the interaction with the play partner and adds a new information, including expansion, adding to the content of the play partner utterance or introducing new related topics.

Eye contact: looking at the upper region (not necessary at the eyes) of the play partner for more than 2 seconds (measured in duration – the number of seconds in which the child made eye-contact with the play partner).

The social robot Probo

The social robot Probo, in contrast with many robots that have stiff actuators and are covered with hard plastic shells, Probo is powered with compliant actuators, makes use of flexible materials and is covered by a soft fur. This makes that when the children touch the robot they feel a soft and huggable robot, which is a pleasant feeling. The robot has a fully expressive and anthropomorphic head with 20 degrees of freedom capable of showing facial expressions and making eye-contact (Saldien, Goris, Vanderborght, Vanderfaeillie & Lefeber, 2010).A user friendly Robot Control Center (RCC) enables the operator to control the robot in a Wizard of Oz setup (Landauer, 1986; Wilson & Rosenberg, 1988).

Results

Play performance

The adult condition group (Mdn=6) and the robot condition group (Mdn=12) started from similar levels of performance (U=11.00, Z=-.73, p=.464), with also non-significant differences (Mdn=5.50) for the adult condition and Mdn=254 for the robot condition) in the intervention phase (U=10.00, Z=-.91, p=.360) (see Figure 3a).

Collaborative play

The between-group analysis proved similar performances recorded by the two groups (Mdn=19.50 for the adult condition and Mdn=25.00 for the robot condition) in baseline (U=12.50, Z=-.45, p=.647), while in the intervention phase, the group in the robot condition recorded better performance (Mdn=107.00) than the group in the adult condition (Mdn=42.00) with a statistically significant difference (U=1.00, Z=-2.55, p=.011) (see Figure 3b). The between-groups effect size measured by Cohen's *d*, proved a large effect size (d=1.89). This means that 96% participants from the adult group had a poorer performance than the average performance of the participants from the robot group. The within-subjects analysis proved a statistically significant change for both adult condition group (Z=-2.20, p=.027) and robot condition group (Z=-2.02, p=.043), with a large effect size for both the robot condition (d=3.06) and the adult condition (d=2.32) but with a better performance for the robot.

Engagement scale

The statistical analysis proved that the group in the robot condition started from a performance on the engagement scale (Mdn=2.00) similar to the one recorded for the adult condition group (Mdn=2.00), the Mann-Whitney test for independent samples proving no significant differences (U=14.50, Z=-.09, p=.922). In the intervention phase, the group in the robot condition recorded a better perfomance (Mdn=5.00) than the adult condition group (Mdn=2.50), which was statistically significant (U=4.00, Z=-2.08, p=.037). The magnitude of this effect, quantified the Cohen's *d* between groups in the ntervention phase, proved to be a large one (d=1.59). This means that 95% participants from the adult group had a poorer performance than the average performance of the participants from the robot group. Also, from a within-subjects perspective, the analysis using the Wilcoxon test for repeated measures proved a significant change for the robot condition group (Z=-2.06, p=.039) while the group in the adult condition recorded no significant change (Z=-1.00, p=.317). As a consequence we can conclude that the robot condition proved its superiority in enhancing the engagement behavior of ASD children (see Figure 4a).

Stereotype behavior

The statistical analysis proved that the group in the robot condition started from a frequency of stereotype behavior (Mdn=3.00) similar to the one recorded for the adult condition group (Mdn=3.50), the Mann-Whitney test for independent samples proving no significant differences (U=13.00, Z=-.037, p=.711). In the intervention phase, the group in the robot condition recorded a lower frequency (Mdn=2.00) than the adult condition group (Mdn=4.50), with a statistically significant difference (U=4.00, Z=-2.05, p=.040) (see Figure 4b). The calculation of effect size between groups in the intervention phase proved to small effect (d=0.12). This means that 54% participants from the adult group had a poorer performance than the average performance of the participants from the robot group.

Positive emotions

The between group analysis for positive emotions shows that the two groups (Mdn=4.50, for the adult condition and Mdn=10.00 for the robot condition) recorded in the baseline show non-significant differences (U=10, Z=-.92, p=.357). Also in the intervention phase, we could not identify significant differences (U=11.00, Z=-.73,

p=.462) between groups (Mdn=8.50 for the adult condition and Mdn=16.00 for the robot condition).

Contingent utterances

The adult condition group started from a level (Mdn=6.00) that proved to be similar (U=9.50, Z=-1.00, p=.313) to the one recorded in the robot condition (Mdn=8.00). Also in the intervention phase, the performance of the two groups (Mdn=7.00 for the adult condition and Mdn=12.00 for the robot condition) proved non-significant difference (U=7.00, Z=-1.47, p=.140) (see Figure 5a). The between-groups effect size measured by Cohen's *d*, proved a large size effect (d=0.67).

Verbal initiations

The adult condition group (Mdn=6.50) and the robot condition group (Mdn=7.00) started from similar frequencies of initiations (U=14.00, Z=-.18, p=.855), recording also non-significant differences (Mdn=10.50 for the adult condition and Mdn=3.00 for the robot condition) in the intervention phase (U=9.50, Z=-1.01, p=.09)..

Eye contact

The between-group revealed non-significant differences (U=14.00, Z=-.18, p=.855) between the adult condition (Mdn=48.50) and the robot condition (Mdn=58.00) in the baseline. Also, in the intervention phase, the two groups (Mdn=72.50 for the adult condition and Mdn=106.00 for the robot condition) proved a non-significant difference (U=5.00, Z=-1.82, p=.068) but very close to the significance cut-off. The within-subjects analysis revealed a significant change both for the adult condition (Z=-1.99, p=.046) and for the robot condition (Z=-2.03, p=.042). As the effect size of the two condition is concerned, the Cohen's *d* calculated for the within-subjects change proved a larger effect for the robot condition (d=3.59) than for the adult condition (d=1.01).

Conclusions and discussions

Our results are in line with these findings, and indicate that children with ASD exhibit more collaborative play when they have the robot as a play partner compared with the situation in which they play with a human partner. Moreover, when the comparison between the two groups was made the results were in favor of the group of children who interacted with the robot, even if the difference did not reach statistical significance. The within-subjects analysis proved a statistically significant change for both adult condition group and robot condition group, but with a better performance for the robot.

When analyzing the engagement in play, our results show that regarding their engagement behaviors in the play task the children who interacted with the robot there was a statistically significant difference in the intervention phase when comparing with the adult group. Regarding the other variable: stereotypic behaviors, which also represents a measurement of the engagement in the task, our results point out that, the children in the robot group recorded a lower frequency of stereotype behaviors than the children from the adult group with a statistically significant difference. Another outcome of our study was social skills and we have measured contingent utterances, verbal initiations and eye contact. Regarding the eye contact variable, our results are in line with other studies investigating the use of robots in therapy for children with ASD which state that important improvements in eye contact were identified when using the robot.

As a conclusion we may say that our findings can be added to the amount of studies that highlight that robots can be a component of intervention for children with

ASD; they can mediate the interaction between the child and the human therapist. However, it is important to mention the limits of our study: first we had some methodological limitations taking into account the small sample; secondly the children had only one session of interaction with the robot/adult and this could explain the variability of the data.

Study 4. Cognitive flexibility in autism spectrum disorder: A robot-based approach

Introduction[4]

Cognitive flexibility is a central part of children cognitive development (Geurts, Corbett, & Solomon, 2009). Cognitive flexibility is defined as "the ability to adapt thoughts or actions in response to situational changes" (Geurts, Corbett, & Solomon, 2009, p. 74). Thus, cognitive flexibility is expressed as flexible choice behaviour. Several studies showed that individuals with autism spectrum disorder (ASD) engage in highly perseverative and inflexible strategies compared to both clinical (e.g., children with Attention Deficit Hyperactivity Disorder/ADHD) and typically developing control groups (e.g., Panerai, Tasca, Ferri, Genitori D'Arrigo, & Elia, 2014; Geurts, Verte´, Oosterlaan, Roeyers, & Sergeant, 2004; Ozonoff, Pennington, & Rogers, 1991). Indeed, studies have shown that children with ASD have some difficulties in learning to shift cognitive sets to new perceptual categories, especially in studies using the Wisconsin Card Sort Test (WCST) and the Cambridge Automated Neuropsychological Test (Corbett, Constantine, Hendren, Rocke, & Ozonoff, 2009). Several studies thus hypothesize that children with ASD engage more successfully in different types of tasks if the information is presented in an attractable manner (i.e. that is easily understood and clearly identifies the expected behaviours) (Quirmbach, Lincoln, Feinberg, Gizzo, Ingersoll, & Andrews, 2009; Goldsmith, & LeBlanc, 2004). Also they are more attentive, motivated, have better performance and they enjoy more the task when a technological tool is implemented in the session (Moore, & Calvert, 2000).

Objectives of the current study

The main objective of the present study was to investigate the cognitive flexibility in ASD children as compared to typically developing children in two experimental conditions: robot-based versus adult-oriented tasks. In our study we have tried to rectify many of the previous limitations in the field, by using a rigorous methodology, a large sample of children (n=81) and well-defined and more ecological measures. The specific hypotheses were: a) children with ASD will have a better performance in the acquisition phase of the reversal learning task in the robot condition (i.e. when interacting with the robot) compared with adult condition (i.e. when interacting with the adult); b) children with ASD will have a better performance in the reversal phase of the reversal learning task in the robot condition compared with adult condition; c) children with ASD will have more attentional engagement episodes and positive affects in the robot condition compared to the adult condition; and d) children with ASD will have more attentional engagement episodes and positive affects compared to typically developing children in the robot condition.

[4] This study was submitted for publication.
Costescu, C., Vanderborght, B. & David, D. (submitted) Cognitive flexibility in autism spectrum disorder: A robot-based approach. Journal of Autism and Developmental Disorders

The robotic toy Keepon. Keepon has a yellow snowman-like body that is 120 mm tall. The upper part (the "head") has two eyes and a nose.. Keepon's head and belly deform whenever it changes posture or someone touches it. The simple body has four degrees of freedom: nodding ±40◦, turning ±180◦, rocking ±25◦, and bobbing with a 15 mm stroke. For our study we have used a hacked version of the robot, which was controlled by an operator through a computer by using the Arduino microcontroller (Hoang-Cao et al., 2014).

Figure 1 The robot Keepon

Method

Participants

The number of participants included in this study was 83 children, 40 typical developing children aged between 4 and 7 (M =5.4, SD = 0.4) and 43 children with ASD aged between 4 and 13 (M =8.4, SD = 2.2). ASD children were diagnosed using DSM-IV criteria by a psychiatrist and their diagnosed was confirmed by using the Autism Diagnostic Observation Scale (ADOS) (Lord et al., 2000), adapted into Romanian by our group (David, Anton, Stefan, Mogoase, & Matu, 2010).

Setting

The experimental sessions were implemented in a room therapy (i.e., surface about 42 m^2). The sessions were conducted by a licensed clinical psychologist trained by the experimenter and certified by our National Board of PsychologistsThe child was sitting in front of the robot/adult and in between a printed version of each item was placed (see Figure 2).

Figure 2. The therapist, the child and the robot in the robot condition

Procedure

Probabilistic Reversal Learning Task (the task was adapted from D'Cruz et al., 2013)

In order to increase the ecological validity of the task, the items were presented in a printed version, and the feedback received by the participants was either from the robot (in the robot condition) or from the adult (in the adult condition). Participants were presented with two identical stimuli (animal pictures) and were required to select the picture that was in the correct location in order to receive positive feedback and to make the robot Keepon or the adult happy, if the item chosen was not correct they receive negative feedback. The rules concerning the correct position of the item was pre-established by the experimenter. Positive feedback was illustrated by robot Keepon through a winning sound and by two popping movements and by the adult through showing a happy face and saying "Well done". Negative feedback was illustrated by robot Keepon through a losing sound and by bending the head twice and by the adult through showing a sad face and saying "Your answer is not good".

Measured outcomes

Primary outcomes: Firstly, we have considered the errors from the acquisition phase of the task, learning errors/learning performance: the total number of incorrect trials from the learning phase. Secondly, following classification of errors on reversal learning tasks used in other studies, errors in the reversal phase were considered as either perseverative or regressive (see D'Cruz et al., 2013; Ragozzino, Jih, & Tzavos, 2002). Perseverative errors occurred when participants chose the previously reinforced response before choosing the new correct response. Regressive errors occurred when participants chose the previously reinforced response after having already selected the new correct choice at least once. Thus, this distinction allowed the number of perseverative errors to provide an index of how quickly a participant shifted their response after reversal, and the number of regressive errors provided a measure of how well the new correct choice pattern was maintained.

Secondary outcomes. They are focused on the engagement and interest in the task. We have measured attentional engagement with the interactional partner, meaning the looking sequences that the child has with the interactional partner (robot or adult) with the purpose of sharing the chosen item from both phases of the task and it was measured in frequency. Another measurement which showed how much children enjoyed the interactions was positive affect; a positive affect episode was scored if the smiling appears 3 seconds before or after indicating an item, in both phases of the task.

Results

Probabilistic Reversal Learning Task Performance: Learning phase performance

The ANOVA analysis of *the learning performance* showed significant main effect of the within factor (robot vs. adult) - $F(1, 79) = 15.35$, $p = .000$, and also a significant main effect for the between factor (children with ASD vs. typical developing children) - $F(1, 79) = 18.75$, $p = .000$. The interaction effect was also significant - $F(1, 79) = 12.66$,

p = .001. We performed pairwise analysis using Bonferroni correction for four comparisons (p=0.012). The analysis revealed a significant higher number of errors in the robot condition compared to adult condition in the ASD group (t (40) = -3.842, p=.000). In the robot condition the analysis revealed a significant higher number of errors in the children with ASD group compared to typically developing children group (t (79) = 4.111, p=.000).

Probabilistic Reversal Learning Task Performance: Perseverative errors

The ANOVA analysis of *the perseverative errors showed* no significant main effect of the within factor (robot vs. adult) - F (1, 79) = 1.94, p = .167 and also no significant main effect of the between factor (children with ASD vs. typically developing children) - F (1, 79) = 0.887, p = .349. The interaction effect was significant - F (1, 79) = 5.962, p = .017. We performed pairwise analysis using Bonferroni correction for four comparisons (p=0.012).

Probabilistic Reversal Learning Task Performance: Regressive errors

Since age of the children correlated with *regressive errors* we have used analysis of covariance (ANCOVA) with age as a covariate. The analysis of *the regressive errors* showed no significant main effect of the within factor (robot or adult) F (1, 79) = 1.23, p = .270, and also no significant main effect of the between factor (children with ASD vs. typically developing children) F (1, 79) = 2.504, p = .118. The interaction effect was also not significant F (1, 79) = 1.980, p = .163.

Probabilistic Reversal Learning Task Performance: lose: Shift errors

The ANOVA analysis of *lose: shift errors* showed no significant main effect of the within factor (robot or adult) - F (1, 0) =0.006, p = .939, and also no significant main effect of the between factor (children with ASD vs. typically developing children) - F (1, 0) = 0.150, p = .699. The interaction effect was also not significant - F (1, 0) = 0.16, p = .900.

Attentional engagement

The ANOVA analysis for *attentional engagement* showed significant main effect of the within factor (robot vs. adult) - F (1, 79) =12.918 p = .001, but no significant main effect of the between factor (children with ASD vs. typically developing children) - F (1, 79) = 0.552, p = .460. The interaction effect was significant - F (1, 79) = 31.956, p = .000. We performed pairwise analysis using Bonferroni correction for four comparisons (p=0.012). The analysis revealed a significant higher number of attentional engagement episodes in the robot condition compared to adult condition in the ASD group (t (40) = -6.563, p=.000), and Cohen's d=0.79, indicating a large effect size.

The between group comparison (ASD vs. typical developing children) for the *attentional engagement* in the adult condition was significant (t(79)= -4.317, p=.000), showing that in the adult condition children with ASD had fewer attentional engagement episodes than typically developing children. In the robot condition there was no significant differences between the two groups (t (79) =1,948 p=.054).

Positive affect

The ANOVA analysis for *positive affect* showed significant main effect of the within factor (robot vs. adult) - F (1, 79) =6.530, p = .013, and also significant main effect of the between factor (children with ASD vs. typically developing children) - F(1,79) = 33.670, p = .000. The interaction effect was also significant - F (1, 79) = 7.604, p = .007. The analysis revealed a significant higher number of positive affect episodes in the robot condition compared to adult condition in the ASD group (t (40) = -3.057, p=.004. When comparing children with ASD with typically developing children the analysis revealed a significant higher number of positive affects in the children with ASD group compared to typically developing children group in the adult condition (t(79)= 3, 492 p=.001); Cohen's d=0.78, indicating a large effect size. Also, in the robot condition there was significant difference between the two groups (t (79) =6.368, p=.000); Cohen's d=1.4, indicating a large effect size.

Conclusions and Discussion

The present study used a probabilistic reversal learning task to investigate the differences between cognitive flexibility deficits in ASD compared to typically developing children in two conditions: interacting with the robotic toy Keepon and interacting with an adult. We have tried to improve the reversal learning task by making it more suitable for younger children, in a printed version and increasing the engagement in task by including a robotic toy in the task.

Our first hypothesis was that children with ASD will have a better performance in the acquisition phase of the reversal learning task when interacting with the robot compared with adult condition. However, we found that children with ASD learned the rules better in the adult condition; indeed, 82% children with ASD had a poorer performance in the robot condition than the average performance of the children with ASD in the adult condition. Our second hypothesis was that children with ASD will have a better performance in the reversal phase of the reversal learning task in the robot condition compared with adult condition. The performance of the participants in the reversal phase of the task was measured using three types of errors: perseverative errors, regressive errors, and lose shift error. Regarding perseverative errors there were no significant differences between the robot and the adult condition in neither in the children with ASD group, nor in typically developing children group.

As concerning secondary outcomes of the study, our results generally confirmed the advanced hypotheses (i.e., the third and the fourth hypotheses) and they are in line with the majority of results from human-robot interaction studies (Feil-Seifer & Matarić, 2008; Kozima, Nakagawa, & Yasuda, 2007; Kim, Paul, Shic, & Scassellati, 2012; Stanton, Kahn, Severson, Ruckert, & Gill, 2008; Robins, Dickerson, Stribling, & Dautenhahn, 2004; Kim, et al., 2013) and with some of our own previous research (Pop, Pintea, Vanderborght, & David, 2014; Vanderborght et al., 2012).

The findings show that children with ASD had significantly more attentional engagement episodes in the robot condition compared to adult condition. 79% of children with ASD had a poorer performance (meaning less attentional engagement episodes) in the adult condition than the average performance of the children with ASD in the robot condition. Another interesting result was the fact that in the adult condition children with ASD had fewer attentional engagement episodes than typically developing children and in the robot condition there was no significant difference between the two groups.

One of the limits of the study can be that we had repeated measures for both groups and this may interfere with our results, although we have used a counterbalanced design. Another limit of the study was that children had only one session of interaction with the robot/adult and this could explain the variability of the data. Our future work should also consider other types of tasks that can be improved by using social robots in order to help psychologists to overcome the difficulties that they have in enhancing some abilities on children with ASD.

Study 5. Beliefs, emotions and behaviors - differences between children with ASD and typically developing children. A robot-enhanced task.

Introduction[5]

Autism spectrum disorder (ASD) is associated with amplified emotional responses and poor emotional control (Mazefsky et al., 2013). The emotional response involves multiple domains, such as behavior, subjective experience, and physiology. Based on Ellis's (1994; David et al. 2005a) binary model of distress, there are functional (e.g., sad, concerned/worried) and dysfunctional (e.g., depressed mood, anxious/panicked) negative emotions, which are not quantitatively but qualitatively different, and yet interrelated. Dysfunctional emotions such as: unhealthy anger and depressed mood (dysfunctional variant of sadness) are a serious concern for children with ASD especially because they may engage in inadequate coping strategies comparison to matched peers when faced with negative events (Jahromi et al., 2012).

The aim of our study was to test the differences between the dysfunctional/functional emotions and maladaptive/adaptive behaviors in children with ASD and typically developing children and the underlying mechanisms associated with dysfunctional emotions and maladaptive behaviors. Our hypothesis is that a. children with ASD will illustrate more irrational beliefs compared to typically developing children; b. children with ASD will illustrate more dysfunctional emotions compared to typically developing children; c. children with ASD will illustrate more maladaptive behaviors compared to typically developing children; d. children with ASD will demonstrate a high level of rigidity and use the same strategy to solve one task compared to typically developing children who will use different types of strategies to solve the problem. This is the first study to explore the role of rational and irrational beliefs in children with ASD and their connection with dysfunctional/functional emotions and adaptive and maladaptive behaviors.

Method

Participants

For this study, the children with ASD were recruited from Autism Baia Mare Association and Autism Transylvania Association from north of Romania. Our inclusion criteria were: a. previous diagnosis of ASD based on the criteria outlined in the DSM-IV-TR establish by a psychiatrist; b. minimal verbal abilities (e.g. the ability to combine 2-3 words in a phrase); c. and d. recognizing basic facial expression from photographs.

[5] This study was submitted for publication.
Costescu, C., Vanderborght, B. & David, D. (submitted) Beliefs, emotions and behaviors: differences between children with ASD and typically developing children: A robot-enhanced task. Emotion

Initially we had 48 children with ASD, from which only 41 (age between 5 and 11 years old) were included in the study; the rest of 7 children did not meet the inclusion criteria. A diagnosis confirmation using the Autism Diagnostic Observation Schedule – Generic ADOS-G, (Lord et al., 2000; adapted in Romanian by David, Anton, Stefan, Mogoase, & Matu, 2010) was also used.

Procedure

In order to measure children's beliefs, emotions and behaviors we have used a mood induction task: false feedback technique (Brenner, 2000). In success-failure or false feedback mood induction procedure, children receive false feedback on a laboratory task to induce them the illusion that they have either succeeded or failed. Children who think they have succeeded are expected to experience positive moods, whereas children who think they have failed are expected to experience negative moods. The negative feedback was given by the robotic toy Keepon.

In our task children had to choose their price from three possible options: to play for 5 minute on a tablet game, to make spoon balloons and to eat something from a container full of sweets. Afterwards they were told that they will receive their price only if the robot Keepon gives them positive feedback on the task. The task consisted in several pictures which had one piece missing and the participants had to find out of 3 possibilities the missing piece see Figure 3. After the trial version children received only negative feedback for 10 trials regardless their performance. At the end the child was asked to name their emotion (anger or sadness) and to rank the intensity of the emotion on a scale from 1 to 10.

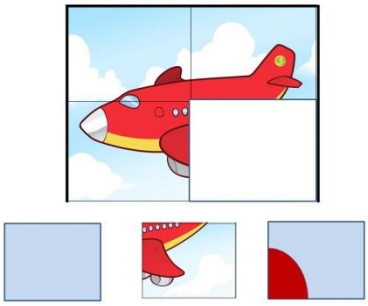

Figure 3 The experimental task

Measured outcomes

Rational and irrational beliefs (Dryden & DiGiuseppe, 2003**):**

1. Demandingness vs. preferences (flexible but strong beliefs; rational).
2. Awfulizing (catastrophizing [the worst things that could happen]; irrational) vs. non-awfulizing (evaluating in terms of badness [e.g., extremely bad]; rational).
3. Low frustration tolerance (irrational) vs. frustration tolerance (rational).
4. Global evaluation of the self, others, and/or life (irrational) vs. non-global evaluation (accepting and focusing on changing specific behaviors) of the self, others, and/or life (rational). th

Expressions of anger and sadness during the robot-enhanced task

These emotions were coded on the basis of facial, vocal, or postural cues developed by Dennis, Cole, Wiggins, Cohen, & Zalewski (2009). Expressions were coded if either one or more cues were present.

Intensity of anger and sadness at the end of the robot-enhanced task

First children had to name the emotion that they felt at the end of the task: anger or sadness and then using a Likert Scale they had to rank the intensity of their emotion from 1 (not at all angry/sad) to 10 (very angry/sad). For a better understanding of the test, we have used also some visual supports (see Figure 4).

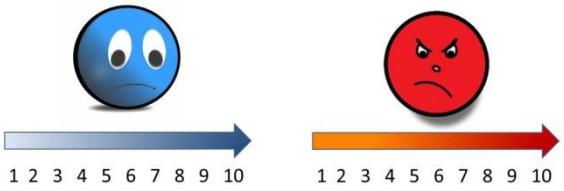

Figure 4 Visual supports for ranking intensity of anger and sadness at the end of the robot-enhanced task

Adaptive and maladaptive behaviors during the robot-enhanced task

Table 2 presents definitions for strategy codes grouped into the following categories: adaptive behaviors and maladaptive behaviors.

Table 2. The definition of adaptive and maladaptive behaviors

Adaptive behaviours	**Maladaptive behaviours**
Approach for help - trying to solve the problem by making statements and questions that are aimed at understanding the situation. **Joint attention episodes** - behaviours of orienting to the environment and looking to experimenter. **Seeking comfort** - soothing/communication self-comforting, gesture, and seeking comfort/ contact.	**Behavioural distraction/ Avoidance** - doing something else than focusing on the task, turning attention away from the task (e.g. shifting gaze, staring into space, laying his or her head on the table). **Demands** - expressing requests to others to do something in a louder voice and with an imposing tone; socially inappropriate words. **Aggression (direct and indirect)** - disruptive behaviours: socially inappropriate actions directed toward the experimenter, or the robot (e.g. throwing objects, self-aggression, physically aggressive toward others or others' toys).

Using the same strategy or a new one to solve the problem

At each trial, out of 10 trials from the experimental task, children had the possibility to choose the same strategy of solving the problem (e.g. always showing the correct answer, although they received negative feedback, meaning that the answer was incorrect) or to try different types of answers, enacting possible new solutions to the task (e.g., trying different ways to solve the problem).

Coding the responses

An inter-rater agreement analysis was performed on the measured variables. The Pearson coefficient was found to be statistically significant and showing high magnitude for the number of total rational and irrational beliefs ($r = .88$, $p < .010$), expressions of anger and sadness during the robot-enhanced task ($r = .86$, $p < .010$), intensity of anger and sadness at the end of the robot-enhanced task ($r = .90$, $p < .010$), adaptive and maladaptive behaviors during the robot-enhanced task and using the same strategy or a new one to solve the problem ($r = .87$, $p < .010$).

Results

Data were analyzed using SPSS version 16. In order to test if there are differences of between children with ASD and typically developing children we used the t test for independent samples.The children with ASD (M= 1.44, SD=2.16) reported statistically significant more irrational beliefs during the experimental task than typically developing children (M= 0.38, SD=1.10), t (79) = 2.77, p = .007, d = .61, illustrating a medium to large effect size. That means that 73% typically developing children had fewer irrational beliefs than the average number of irrational beliefs of children with ASD. When considering the type of the irrational beliefs used by children our findings suggest that children with ASD make significantly more absolutist demands (demandigness) (M=0.44, SD=0.80) than typically developing children (M=0.08, SD=0.35) t (79) = 2.62, p = .01, d = .58, illustrating a medium to large effect size; meaning that 69% typically developing children had fewer absolutist demands than the average number of absolutist demands of children with ASD. Also, there was a statistically significant difference between children with ASD (M=0.49, SD=1.02) and typically developing children (M=0.08, 0.26) t(79) = .244, p = .03, d = .55 (illustrating a medium effect size) regarding to awfulizing. This means that 69% typically developing children had fewer awfulizing beliefs than the average number of awfulizing beliefs that children with ASD had.

Functional and dysfunctional emotions

The children with ASD (M= 1.05, SD=2.10) reported statistically significant more dysfunctional emotions than typically developing children (M= 0.00, SD=0.00), t (79) = 3.14, p = .001, d = .70, illustrating a large effect size. 41.5% of children with ASD have presented dysfunctional emotions during the robot-assisted task compared to typically developing children who expressed only functional negative emotions. There was also a significant difference between the two groups regarding the functional negative emotions: children with ASD (M= 1.27, SD=2.06) reported statistically significant less functional emotions than typically developing children (M= 2.75, SD=2.49), t(79) = 2.91, p = .000, d = .64, illustrating a medium to large effect size. These means that 73% children with

ASD had fewer functional negative emotions than the average number of functional negative emotions of typically developing children.

Adaptive and maladaptive behaviors

Our results have shown that children with ASD use statistically significant more maladaptive behaviors than typically developing children (M= 5.51, SD=4.21), t (79) = 1.98, p = .05, d = .44, illustrating a medium effect size. That means that 66% typically developing children had fewer maladaptive behaviors than the average number of maladaptive behaviors of children with ASD. Typically developing children exhibited more adaptive behaviors (e.g. approaching) compared with children with ASD, who 39% of them engaged in maladaptive behaviors (aggressive behaviors).

The use of the same strategy or new strategies for providing the correct answer

Another interesting result was the fact that children with ASD used the same strategy (reasoning) for providing the correct answer during the whole task, without trying new alternatives, although the feedback that they received was negative (M=8.41, SD=1.73) compared typically developing children who didn't used the same strategy when they have noticed that the strategy used was not correct (M=6.90, SD=2.56). There was a significant difference between the two groups, t (79) = 3.12, p = .02, d = .69, illustrating a medium to large effect size; meaning that 76% children with ASD used fewer new strategies than the average number of new strategies used by typically developing children.

Conclusions and Discussion

Working with children with ASD can be very challenging, especially if you want to evaluate their beliefs. They have problems in differentiating between emotions, cognitions and behaviors and also expressing the way they think. This study provides important information on rational and irrational beliefs, dysfunctional emotions and behaviors adopted by children with ASD in comparison with typically developing children in a mood induction task. We found a massive presence of irrational beliefs in children with ASD speech during the robot-enhanced task. Moreover, Ellis's theory has been proven also in the case of children with ASD; when high level of irrational beliefs is observed, high frequency of dysfunctional emotions and maladaptive behaviors are shown.

Our first hypothesis was that children with ASD will illustrate more irrational beliefs compared to typically developing children, which was based on the work of Ellis (1994) and Dryden (1995) according to whom the way we feel or act is largely mediated by our rational and irrational beliefs. The results confirmed our assumption and the data had shown that children with ASD have and express more irrational beliefs compared to typically developing children in the experimental task.

When analyzing the type of irrational beliefs used, we have found that children with ASD make significantly more absolutist demands than typically developing children. Also, children with ASD did more often statements like "It is extremely bad if Keepon says I am wrong" (awfulizing) compared to typically developing children. The less expressed irrational belief was global evaluation, meaning that only 7.3% of children with ASD used it and it was never used during the experimental task by typically developing children.

Key differences between the ASD and control group in this study were higher levels of irrational beliefs, dysfunctional emotions and maladaptive behaviors in the ASD

group. People typically display both rational and irrational beliefs. The fact that children with ASD didn't express any rational beliefs and primed especially irrational beliefs; it may be that due to their specific difficulties in perspective taking or theory of mind problems

Limits and future directions

As a conclusion we may say that the important information coming from this study could foster new theoretical research (e.g., reanalyzing how maladaptive behaviors appear and how we can transform dysfunctional emotions into functional ones) and has practical implications as well. However, it is important to mention the limitations of our results: first we had some methodological limitations taking into account the fact that the mood induction task may have not induce a negative emotion for all the children; secondly the children had only one session of interaction with the robot and this could explain the variability of the data. Future studies should investigate these findings using implicit measures.

Study 6. Parental distress predicted by characteristics of children with ASD

Introduction

Parents of children with ASD have consistently been found to be at a higher risk for stress than parents of typically developing children or those diagnosed with other developmental disorders (Dunn, Burbine, Bowers, &Tantleff-Dunn, 2001; Mancil, Boyd, &Bedesem, 2009). The amount of stress in parents of children with developmental disabilities appears strongly related to increases in their depressive symptoms and to decreases in their psychological well-being (Walker, Ortiz-Valdes, &Newbrough, 1989; Feldman, Hancock, Rielly, Minnes, & Cairns, 2000; Abbeduto et al., 2004). Stress in parents of children with ASD seems related to parent characteristics as gender, age, and coping style (Dabrowska & Pisula, 2010; Dunn, Burbine, Bowers, &Tantleff-Dunn, 2001; Hastings & Johnson, 2001; Herring et al., 2006) and (perceived) levels of social and professional support (Bromley, Hare, Davison, & Emerson, 2004; Danrowska & Pisula, 2010; Dunn et al., 2001; Hastings & Johnson, 2001). In addition, child variables may be linked to increased levels in parental stress. Most studies have focused on the severity of the child's disability and behavioral problems and found that the latter may be a more prominent stressor for parents than the severity of the disability itself (Bromley et al., 2004; Hastings, 2002; Hastings et al., 2005; Herring et al., 2006; Lecavalier, Leone, &Wiltz, 2006).

Our aims were to a. investigate the relation between perceived (by the parents) emotional and behavioral problems of children with ASD and emotional distress; b. investigate the relation between perceived (by the parents) characteristics of children with ASD (in terms of level of severity) and emotional distress; c. identify possible mediators of the relation between parental distress and children's characteristics; d. investigate whether parents irrational beliefs with correlate positively with perceived behavioral inflexibility of the children.

Method

Participants

Participants consisted of 74 mothers of children between the ages of 4 and 12, diagnosed with ASD, mostly autistic disorder. Three parents were excluded from analyses because

of incomplete responses to over half of the questionnaires. Therefore, 71 parents were used in the final analyses. Cognitive/intellectual impairment was not an exclusion criterion for the current study, in order to allow for the full spectrum of ASD to be included. There were no other inclusion or exclusion criteria. The average age of the parents completing the study was 43.1 years (Sd=7.6).

Design and Procedure

In order to test our hypotheses, we used a correlational design. Questionnaires were administered to parents based on a strict protocol regarding the ethical handling of the data. After gaining informed consent, the questionnaires were completed by the parents independently; these lasted for approximately 50 minutes for each participant.

Instruments

The Child Behavior Checklist (CBCL) (Achenbach & Rescorla, 2001) The Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2000) is a well-known and widely used questionnaire with 100 items on various problem behaviors grouped into seven syndrome scales: emotional reactive, anxiety, somatic complaints, withdrawn, sleep problems, aggressive behavior and attention deficits. In addition, scores on internalizing, externalizing and total scales were calculated.

Autism Treatment Evaluation Checklist (ATEC) (Rimland & Edelson, 2000) The Autism Treatment Evaluation Checklist (ATEC) was developed by Bernard Rimland and Stephen M. Edelson of the Autism Research Institute San Diego, CA [6]. The ATEC is designed to collect information on development and behavior. It consists of four major categories: a. communication; b. sociability c. cognitive awareness and d. health or behavioral problems.

Behavior Flexibility Rating Scale (BFRS) (Peters-Scheffers et al., 2008) The Behavioral Flexibility Rating Scale – revised (BFRS-R; Green et al., 2006, 2007) is a scale for assessing behavioral flexibility in individuals with developmental disabilities. Using a three-point Likert-type scale, ranging from 0 ('not a problem at all') to 2 ('the situation causes severe problems'), caregivers rated the severity of challenging behavior as a result to specific and unexpected events and changed routines that could be problematic to the individual.

Social Communication Questionnaire (SCQ) (Rutter, Bailey, & Lord, 2003) The Social Communication Questionnaire (Rutter *et al*, 2003) is a 40-item parent-report questionnaire that asks about characteristic autistic behavior. Each item is scored 0 or 1, with 1 being the score for endorsement of each symptom of autism. Total scores can range from 0 to 39.

Attitude and Beliefs Scale (ABS-II) (DiGiuseppe et al., 1988; Macavei, 2002) Attitude and Belief Scale 2 (ABS2; DiGiuseppe et al., 1988) is a 72-item measure of rational and irrational beliefs concerning three major life domains: comfort, approval, and achievement. The participants have to indicate their agreement with rational and irrational assertions on a 5-point Likert scale (0 – strongly disagree; 4 – strongly agree).

The Parenting Sense of Competence Scale PSCS (Gibaud-Wallston & Wander, 1978) The PSOC was used to assess parenting self-efficacy. The PSOC is a 16-item self-report measure that assesses perceptions of self-competency in the parental role. This

questionnaire contains two subscales, parenting self-efficacy and parenting satisfaction, and measures them on a 6-point Likert scale, strongly disagree (1) to strongly agree (6).

Penn State Worry Questionnaire (PSWQ) (Meyer, Miller, Metzger, & Borkovec, 1990) Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990) is a 16-item instrument designed to measure trait worry in terms of frequency and controllability. The items are answered on a 5-point Likert scale ranging from 1 (not at all typical of me) to 5 (very typical of me).

Unconditional Acceptance Questionnaire UAQ (David, Coteț, Szentagotai, McMahon, &DiGiuseppe, 2013) Unconditional Acceptance Questionnaire (UAQ), a scale intended to measure unconditional acceptance of self, others, and life. More precisely, the scale consists of 35 items organized on various axes: (1) psychological vs. philosophical axis; (2) moral/character traits vs.intellectual traits vs. physical characteristics; (3) self vs. others vs. life; and (4) acceptance vs. non-acceptance.

Profile of Affective Distress (Opriș & Macavei, 2007) Profile of Affective Distress (PDA, Opris & Macavei, 2007) is a 39-item measure of functional and dysfunctional emotional states. The participants have to indicate, on a 5-point Likert scale (0 – not at all; 4 – a lot), how frequently they have experienced different emotions during the last two weeks. The PDA includes items referring to functional negative emotions, dysfunctional negative emotions and positive emotions.

*Parental Stress Scale (PSS; Berry & Jones, 1995).*Parental Stress Scale (PSS) is a self-report scale with 18-items that represent positive themes of parenthood (i.e., emotional benefits, self-enrichment, personal development) and negative indicators (i.e., demands on resources, opportunity costs and restrictions). Higher scores on the scale indicate greater stress. The scale assesses parental stress (for both mothers and fathers) of children with and without clinical problems.

Functional and Dysfunctional Negative Emotions Scale (FADNES) (Mogoase & Stefan, 2013) Functional and Dysfunctional Negative Emotions Scale (FADNES) includes a total of 10 items, comprising emotions from the following categories: sadness/depression (3 items), concern/anxiety (4 items), annoyance/angry (2 items), and regret/guilty (one item). Each of the FADNES items targets a certain category of emotions and consists of a set of four response alternatives: one functional emotion, its dysfunctional counterpart, a combination of the functional and the dysfunctional emotion and a response alternative stating that neither the functional, nor the dysfunctional emotion was experienced.

The Functional Assessment of Cancer Therapy – General Population - Quality of Life (FACT GP) (Cella et al., 1993) The Functional Assessment of Cancer Therapy – General Population (FACT-GP) version 4 is a 21-item scale that measures health-related quality of life (HRQQL) using four subscales: physical well-being, social/family well-being, emotional well-being, and functional well-being. Each FACT question is scored 0-4 and then summed, multiplied by the number of items in the subscale, and divided by the number of items answered to produce a final subscale score.

The Beck Depression Inventory – Second edition (BDI-II; Beck, Steer, & Brown, 1996; David &Dobrean,2012) The Beck Depression Inventory – Second Edition (BDI-II) is a 21-item self-report instrument designed to assess the severity of depression in adults and adolescents. The BDI-II was designed to act as an indicator of depressive symptoms

based on diagnostic criteria in the DSM-IV. The tool consists of 21 items that are self-rated on a 4-point scale ranging from 0 to 3.

Results

Autism severity and emotional problems associated with parental distress

When it comes to the relation between child characteristics, in terms of severity of the symptoms and parental distress, the results show that, the persistence on sameness (behavioral inflexibility) is correlated positively to dysfunctional emotions on parents, $r(71) = .563$, $p = .000$. Regarding functional negative emotions, these were negatively correlated to communication problems, $r\ (71) = -.315$, $p = .000$. We also found a significant negative relation between parental stress and the level of cognitive conciseness, $r\ (71) = -.314$, $p = .008$, and positive correlation with social interaction problems, $r\ (71) = .269$, $p = .023$. Regarding the relation between perceived emotional problems on children with ASD and parental distress, the results show that, perceived externalization problems in children with ASD is related positively to anxiety symptoms on parents, $r(71) = .250$, $p = .036$. Perceived externalization problems are also related to functional negative emotions $r\ (71) = .271$, $p = .022$, the last mentioned are related also to perceived emotional problems in children $r\ (71) = .248$, $p = .037$.

Parents beliefs and emotional distress

Regarding the relation between parents beliefs and emotional distress, the results show that, parenting related rational beliefs (P-RIBS) are negatively correlated with dysfunctional negative emotions $r(71) = -.390$, $p = .000$ and depressive symptoms $r(71) = -.389$, $p = .000$. Dysfunctional negative emotions are also positively correlated with increased worry score $r\ (71) = .319$, $p = .000$ and decreased self-competence $r\ (71) = .383$, $p = .000$, and marginally to irrational beliefs $r\ (71) = .263$, $p = .022$. We also found a significant positive relation between the worry level and parental stress, $r\ (71) = .371$, $p = .002$, well-being $r\ (71) = .314$ $p = .000$, and depressive symptoms $r\ (71) = .436$, $p = .003$. Self-competence also is positively related to those outcomes: parental stress, $r\ (71) = .678$, $p = .000$, well-being $r\ (71) = .312$ $p = .001$, and depressive symptoms $r\ (71) = .434$ $p = .000$. Also our findings suggest that there is a negative relation between unconditional self-acceptance and parental stress $r\ (71) = -.678$, $p = .000$, and unconditional self-acceptance and well-being $r\ (71) = -.429$, $p = .000$.

Mediation analyses

In order to test the proposed mediation models, we used the bootstrapping procedure for assessing indirect effects, a methodological approach proposed by Preacher and Hayes (2008).This method has been shown to be a more reliable approach when compared to both the Baron and Kenny (1986) mediation procedure, as well as with the Sobel test approach (Sobel, 1982), particularly because it does not depend on sample size and it does not assume a normal sampling distribution of the indirect effect (Hayes, 2009). We used the Preacher & Hayes (2008) mediation script for SPSS for calculations. We used bootstrapping tests with 5000 re-samples and we reported a bias corrected and accelerated confidence interval (Preacher & Hayes, 2008). Mediation is considered to be present when the confidence interval for the estimation of the indirect effect does not contain 0. Theoretically speaking, while a mediation effect would imply a significant

correlation between the independent variable and the outcome (i.e., a significant total effect), an indirect effect is not based on this assumption (Preacher & Hayes, 2004). The results showed that unconditional self-acceptance mediated the relation between behavioral inflexibility of the child and well-being of the parent, indirect effect =.106, *SE*=.681, 95% *CI* (bias corrected and accelerated) = .007 to .288.. The indirect effects diagrams are presented in Figure 1.

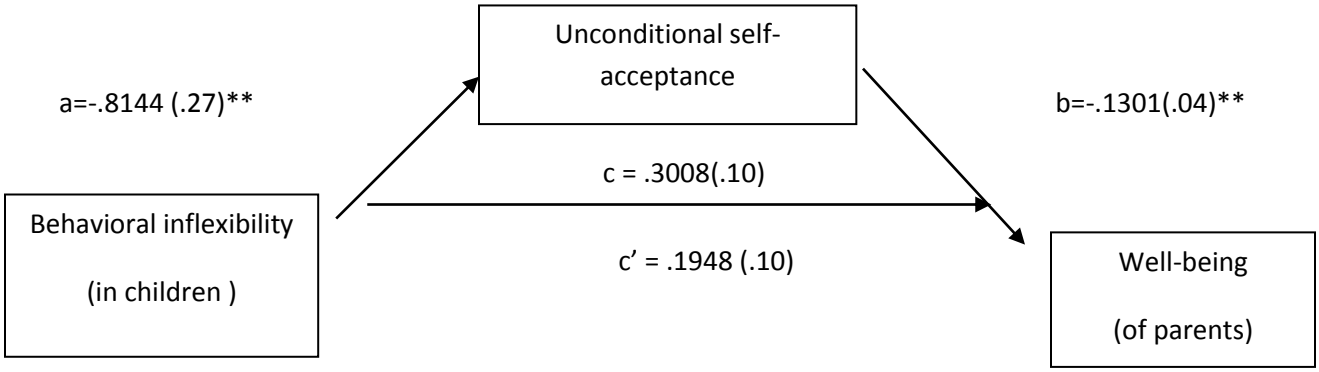

Figure 1. Indirect effects diagrams. Values are path coefficients representing unstandardized regression weights and standard errors (in parentheses). The paths are represented as follows: a = Independent variable (IV) to mediator; b = Mediator to dependent variable (DV); c = Total effect of IV on DV; c' = Direct effect of IV on DV.

Conclusion and discussion

This study investigates parental distress in parent of children with ASD. Besides, child characteristics predicting parental distress were explored also the underlying mechanism of distress, as they were studied by Ellis (1994) and Dryden (1995). Studies have shown that parent of children with ASD generally experience more stress and elevated symptoms of depression and anxiety than parents of typically developing children, our results indicate that stress and dysfunctional negative emotions in parents are associated with: the persistence on sameness, communication problems, the level of cognitive conciseness, social interaction problems, the perceived health and behavior problems of children.

When it comes to the relation between children characteristics, in terms of severity of the symptoms and parental distress, the results show that, the persistence on sameness (behavioral inflexibility) is correlated positively to dysfunctional emotions on parents and parental stress is associated with level of cognitive conciseness and social interaction problems. Regarding the relation between perceived emotional problems on children with ASD and parental distress, the results show that, perceived externalization problems in children with ASD are related positively to anxiety symptoms. Also results revealed a positive relation between anxiety symptoms and conduct disorders features.

Regarding the relation between parent's beliefs and emotional distress, the results show that, parenting related rational beliefs (P-RIBS) are negatively correlated with dysfunctional negative emotions and depressive symptoms. Dysfunctional negative emotions are also positively correlated with increased worry score and decreased self-competence and marginally to irrational beliefs. We also found a significant positive relation between the worry level and parental stress, well-being and depressive

symptoms. Self-competence also is positively related to those outcomes: parental stress, well-being, and depressive symptoms Also our findings suggest that there is a negative relation between unconditional self-acceptance and parental stress and unconditional self-acceptance and well-being.

Limits and future directions

The current study has some limitations in the sample and method that should be considered in interpreting its results. Parents of the children with ASD were selected through associations that provide services for children with ASD meaning their children are included in some intervention programs, issues that it may interfere with the results. However, as involvement in an extensive study is time-consuming and the study involved a part of evaluation of some aspects, parents with the highest levels of stress may decline participation and caution is needed when generalizing these results to the population of children with ASD.

Study 7. Testing the effectiveness of an R-CBT program for children with ASD

Introduction

The ability to identify and make distinctions between emotional states appears to have adaptive value and plays an important role in psychological well-being. Indeed, higher emotion awareness is found to be related to a more differentiated use of emotion regulation strategies (Barrett et al., 2001), and low depression symptoms (Demiralp et al., 2012), higher self-esteem, and lower levels of neuroticism (Erbaset al.,2013). Since individuals with ASD seem to have highrates of depression, anxiety and other internalizing problems as evidenced by several studies (Kuusikko et al., 2008; Simonoffet al., 2008; Stewart, Barnard, Pearson, Hasan, & O'Brien, 2006), and indeed seem to be less effective in regulating their emotions (Laurent & Rubin, 2004; Rieffe et al., 2011; Samson, Huber, & Gross, 2012), research on emotion awareness can be of great potential for decreasing their emotional problems.

Cognitive Behaviour Therapy (CBT) has been developed and refined over several decades and research studies have established that CBT is an effective treatment to change the way a person thinks about and responds to emotions such as anxiety, sadness and anger (Graham, 1998; Grave &Blissett, 2004; Kendall, 2000). CBT focuses on aspects of cognitive deficiency in terms of the maturity, complexity and expression of emotions, and cognitive distortion in terms of dysfunctional thinking and incorrect assumptions. Thus, it has direct applicability to children and adults with ASD who have impaired or delayed Theory of Mind abilities and difficulty understanding, expressing and managing emotions

Short Enhanced REBT protocol for parents

Parenting distress has been researched quite extensively in autism and other developmental disabilities (e.g., Hastings & Johnson, 2001; Perry, 2004b) but is typically viewed as an outcome variable. Here, parenting distress is also considered as a potential factor influencing parent involvement. Clinical experience suggests that parents experiencing high stress levels may be less able to be involved effectively with their

children's therapy. Conversely, parents who feel less distress in their daily lives are likely able to devote more emotional, cognitive, and physical resources toward helping their children. Furthermore, some research suggests that high parental stress can negatively impact the child's progress in behavioral interventions (e.g., Plienis et al., 1988; Robbins et al., 1991). Considering this, in order to increase the benefits of cognitive behavioral interventions for children with ASD we have decided, not only to involve the parents in children's' psychotherapy sessions but also to deliver an Short Enhanced REBT (Rational-Emotive Behavior Therapy)protocol for parents, with the aim to decrease the parental distress.

Overview of our present research

Considering the limits of previous research studies we aim to investigate whether if: a.children with ASD that benefit from robot-enhanced therapy will have an increased level of awareness about their emotions (anger, sadness and fear) and about the situations that are connected with these emotions at post intervention compared to pre intervention; b. children with ASD that benefit from robot-enhanced therapy will have a low score on the emotional problem scale and a decreased number of maladaptive behaviors at post intervention compared to pre intervention; c.children with ASD that benefit from robot-enhanced therapy will have an increased level of awareness about their emotions (anger, sadness and fear) and about the situations that are connected with these emotions compared to children that were in the TAU group; d. children with ASD that benefit from robot-enhanced therapy will have a low score on the emotional problem scale and a decreased number of maladaptive behaviors at post intervention compared to pre intervention; e. parental stress, depressive symptoms and dysfunctional negative emotion will decrease more in the parents that are included in the intervention group compared to parents that are in the control group; f. parental stress, depressive symptoms and dysfunctional negative emotion will decrease in the parents that are included in the intervention group from pre intervention to post intervention; g. the number of positive emotions and functional negative emotion will increase more in the parents that are included in the intervention group compared to parents that are in the control group; h. the number of positive emotions and functional negative emotion will increase more in the parents that are included in the intervention group from pre intervention to post intervention; i. irrational beliefs and worry will decrease more in the parents that are included in the intervention group compared to parents that are in the control group; j. irrational beliefs and worrywill decrease in the parents that are included in the intervention group from pre intervention to post intervention; k. rational beliefs and sense of competence will increase more in the parents that are included in the intervention group compared to parents that are in the control group; l. rational beliefs and sense of competence will increase more in the parents that are included in the intervention group from pre intervention to post intervention.

Method

Participants

Thirty – nine children with a primary diagnosis primary diagnosis of ASD from a pediatrician, aged 6 - 12 years, were randomly assigned to either intervention (17 children) or treatment as usual (TAU) (22 children) conditions (Figure 1). We have used Research Randomizer online software**.** The children were recruited from two different

Romanian autism centers (Autism Transylvania Association and Autism Baia Mare Association). Based on the Autism Diagnostic Observation Schedule – Generic ADOS-G (Lord et al., 2000), the participants from each group did not differ on variables like gender, age, severity of autism. The inclusion criteria were the following: (a) a current diagnosis of ASD, confirmed by an evaluator using the Autism Diagnostic Observation Schedule – Generic ADOS-G (Lord et al., 2000; adapted in Romanian by David, Anton, Stefan, Mogoase, & Matu, 2010) and the criteria outlined in DSM IV-TR (American Psychiatric Association, 2000). All parents were informed and agreed to the participation of their children in this study.

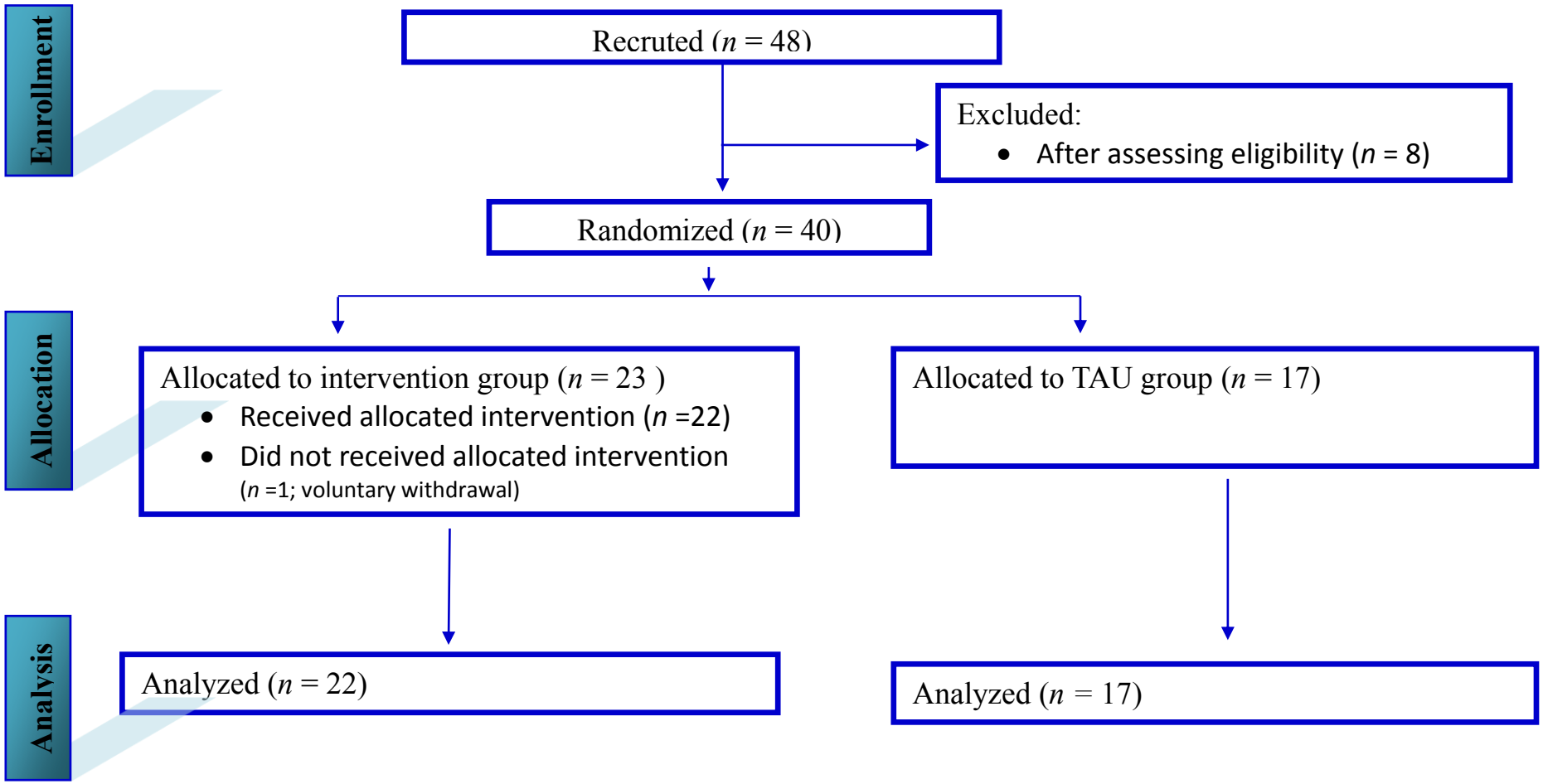

Figure 1. Participants' flow through the study (CONSORT flow diagram; (Schulz, Altman, Moher, & the CONSORT Group,2010)

Design and instruments

We used an experimental design. The independent variable was the intervention delivered. We had as primary dependent variables, emotion awareness in children, identifying their thoughts (cognitions), identifying the activating events, adaptive and maladaptive behaviors, frequency of dysfunctional emotions and emotional problems. As secondary outcomes we had functional and dysfunctional emotions, parental stress and depressive symptoms. We had also measured the presumed mechanism of change: rational and irrational beliefs, sense of competence and worry.

Instruments

The Child Behavior Checklist (CBCL) (Achenbach & Rescorla, 2001) The Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2000) is a well-known and widely used questionnaire with items on various problem behaviors grouped into seven syndrome scales: emotional reactive, anxiety, somatic complaints, withdrawn, sleep problems, aggressive behavior and attention deficits. In addition, scores on internalizing, externalizing and total scales were calculated.

Beck Depression Inventory (BDI II, Beck, Steer, & Brown, 1996) Beck Depression Inventory (BDI II, Beck, Steer, & Brown, 1996) is a revised version of the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and it comprises 21 questions related to depressive symptoms experienced during the last two weeks, each answer being scored on a scale from 0 to 3.

Profile of Affective Distress (PDA, Opris &Macavei, 2007) Profile of Affective Distress (PDA, Opris &Macavei, 2007) is a 39-item measure of functional and dysfunctional emotional states. The participants have to indicate, on a 5-point Likert scale (0 – not at all; 4 – a lot), how frequently they have experienced different emotions during the last two weeks. The PDA includes items referring to functional negative emotions (e.g., sad, concerned, tense), dysfunctional negative emotions (e.g., depressed, frightened, panicked), and positive emotions (e.g., happy, cheerful, content). Total scores can be computed to obtain overall measures of these categories of emotions.

Parent Rational and Irrational Beliefs Scale (PRIBS) (Gavita, David, DiGiuseppe, &DelVecchio, 2011) Parent Rational and Irrational Beliefs Scale (P-RIBS) was developed by Gavita, DiGiuseppe, David, & DelVecchio, based on the view of IBs and RBs as non-polar opposites (DiGiuseppe, Leaf, Exner, & Robin, 1988). P-RIBS also considers the recent priming methodologies (i.e., Articulated Thoughts in Simulated Situations; ATSS–Davidson, Robins, & Johnson, 1983; David, Szentagotai, Kallai, & Macavei, 2005); that is, the following guided imagery instruction was introduced as a way to prime/access parents' evaluative beliefs: "Please think about a situation when your child(ren) disobey, or disrespect you. Try and recall the thoughts that you have had in such situations."

The Parental Stress Scale (PSS) (Berry & Jones, 1995) The Parental Stress Scale (PSS) is a series of 18 questions designed to measure the level of stress a participant feels as a parent. Items are scored on a five-point scale ranging from "strongly disagree" to "strongly agree". Developed by Berry and Jones (1995) as an alternative to the 101-item *Attitude and Beliefs Scale (ABS-II) (DiGiuseppe et al., 1988; Macavei, 2002)* The Attitudes and Beliefs Scale (ABS-II; DiGiuseppe, Leaf, Exner, & Robin, 1988) is a 72 items instrument that measures irrational

cognitions (demandingness, global evaluation/self-downing, low frustration tolerance, and awfulizing) shown to be involved in the onset and maintenance of emotional distress, as well as their rational counterparts (preferential thinking, unconditional self-acceptance, frustration tolerance, and nonawfulizing). Each item is rated on a 5-point Likert scale, where 0 = strongly disagree and 4 = strongly agree.

The Parenting Sense of Competence Scale PSCS (Gibaud-Wallston& Wander, 1978) The PSOC was used to assess parenting self-efficacy. The PSOC is a 16-item self-report measure that assesses perceptions of self-competency in the parental role. This questionnaire contains two subscales, parenting self-efficacy and parenting satisfaction, and measures them on a 6-point Likert scale, strongly disagree (1) to strongly agree (6). *Penn State Worry Questionnaire (PSWQ) (Meyer, Miller,Metzger, &Borkovec, 1990).* Penn State Worry Questionnaire (PSWQ, Meyer et al., 1990) is a 16-item instrument designed to measure trait worry in terms of frequency and controllability. The items are answered on a 5-point Likert scale ranging from 1 (not at all typical of me) to 5 (very typical of me). The scale has shown good internal consistency, with alpha values ranging from .86 to .93 in both clinical samples and normal population (Molina & Borkovec, 1994).

Procedure

The sessions were conducted by licensed clinical psychologists trained by the experimenter and certified by our National Board of Psychologists. Children in the TAU condition followed their regularly intervention sessions in the specialized center at least twice a week and at maximum four days per week. Children in the intervention group participated in 8 individual sessions of therapy. For the robot-enhanced therapy sessions we have used a hacked version of the robot Keepon (Kozima, Nakagawa, & Yano, 2003; Hoang-Cao et al., 2014), which was controlled by an operator and who helped children to learn the psychological contents and strategies by proving appropriate feedback. Positive feedback was illustrated by robot Keepon through a winning sound and by two popping movements. Negative feedback was illustrated by robot Keepon through a losing sound and by bending the head twice.

Results

Intervention effect on primary outcomes

When controlling for the level of cognition identification in the baseline, we have found significant differences between children's performance from TAU group (M=1.24, SD=2.55) and robot-enhanced intervention group (M=5.59, SD=4.62), F (2, 36) =12.872; p = .001, $\acute{\eta}^2$=.264, illustrating the effect of robot-enhanced therapy among cognition identification. Also we have found significant differences between children's performance from TAU group (M=4.76, SD=2.41) and robot-enhanced intervention group (M=8.68, SD=2.37), F (2, 36) = 26.590; p = .000, $\acute{\eta}^2$=.425, regarding their ability to identify the events related to dysfunctional emotions and maladaptive behaviors, when controlling for the level of activating event identification in the baseline. When controlling for the level of maladaptive behaviors in baseline, we have found significant differences between children's behaviors from TAU group (M=2.11, SD=1.93) and robot-enhanced intervention group (M=0.31, SD=0.64), F(2, 36) = 18.855; p = .000, $\acute{\eta}^2$=.344, illustrating the effect of robot-enhanced therapy among the decrease of maladaptive behaviors.

Intervention effect on secondary outcomes

ANCOVA conducted on the outcomes of parents, while controlling for baseline levels, revealed no significant differences the two groups of parents, control group and intervention group for parental stress and functional emotions. Opposite, ANCOVA conducted on depressive symptoms, dysfunctional emotions and positive emotions at post intervention, while controlling for baseline levels, revealed significant differences between groups**.** When controlling for the level of depressive symptoms in the baseline, we have found significant differences between control group of parents (M=12.97, SD=10.90) and intervention group of parents (M=8.40 SD=6.90), $F(2,35) = 4.470$; $p = .042$, $\acute{\eta}^2 = .113$, illustrating the effect of enhanced REBT among decreasing the depressive symptoms in parents of children with ASD. We have also found significant differences between control group of parents (M=21.90, SD=4.92) and intervention group of parents (M=17.39, SD=3.87), $F(2, 35) = 9.689$; $p = .004$, $\acute{\eta}^2 = .217$, when coming to dysfunctional emotions. We had noticed a significant effect even when controlling for the level of dysfunctional emotions in the baseline, meaning that our intervention proved to be effective in reducing dysfunctional negative emotions in parents.

Intervention effect on presumed mechanisms of change

ANCOVA conducted on presumed mechanisms of change in parents, while controlling for baseline levels, revealed no significant differences between the two groups of parents, control group and intervention group for parent specific rational or irrational beliefs, general rational beliefs, worry or sense of competence. However, we have found significant differences, in terms of general irrational beliefs between control group of parents (M=95.50, SD=15.18) and intervention group of parents (M=82.49, SD=20.79), $F(2,35) = 5.032$; $p = .031$, $\acute{\eta}^2 = .126$, when controlling for the level of irrational beliefs from baseline, illustrating the effect of enhanced REBT among reducing irrational beliefs.

Effect of the robot-enhanced therapy on primary outcome from pre intervention to post intervention

Paired samples t tests showed that there were significant differences, in the robot-enhanced intervention group, from pre- to post-intervention. Means and standard deviations for primary outcome measures are shown in Table 3. Our analysis confirmed the presence of significant differences pre – post in the robot-enhanced intervention group concerning emotion identification, $t(21) = 4.999$, $p = .000$, $d=1.20$, indicating a large effect size. That means that88% children with ASD had a poorer performance in the TAU group than the average performance of the children with ASD in the robot-enhanced group. Our findings revealed significant differences from pre intervention to post intervention also in case of activating events identification, $t(21) = 6.234$, $p = .000$, $d= 1.64$, illustrating a large effect size and from a clinical point of view it means that 95% children with ASD in the TAU group had a poorer performance than the average performance of the children with ASD in the robot-enhanced group. We have also noticed a decrease in the maladaptive behaviors in children with ASD from pre intervention to post intervention $t(21) = 5.317$, $p = .000$, $d=1.25$, with a large effect size. This means that88% children with ASD had more maladaptive behaviors in the TAU group than the average maladaptive behaviors of children with ASD in the robot-enhanced group.

When analyzing the outcome of the children reported by their parents the results revealed significant differences from pre intervention to post intervention for total score of emotional problems,t(21) = 3.346, p = .003, d=0.24, illustrating a small effect size. This means that 58% children with ASD had a high score on the emotional problems scale in the TAU group than the average score on the emotional problems scale in children with ASD in the robot-enhanced group. We have also noticed a decrease in the externalization problems in children with ASD from pre intervention to post intervention t(21) = 3.793, p = .001, d=0.66, with a medium to large effect size. This means that76% children with ASD had a more externalization problems in the TAU group than the average externalization problems of the children with ASD in the robot-enhanced group.

Effect of the robot-enhanced therapy on parents' beliefs of from pre intervention to post intervention

When analyzing the presumed mechanisms of change from pre intervention to post intervention on parents, the results revealed significant differences for several outcomes. There was a decrease in the general irrational beliefs score from pre intervention to post intervention, t (21) = 2,450, p = .023, d = 0.40, illustrating a small to medium effect size. This means that66% of the parents from control group had a higher score on irrational beliefs scalethan the average score on the irrational beliefs scale in of parents from intervention group. We have also noticed anincrease in the parent specific rational beliefs score from pre intervention to post intervention from intervention groupt (21) = 7,859, p = .000, d = 0.40, with a small to medium effect size. This means that 66% of the parents from control group had a lower score on rational beliefs scale than the average score on the rational beliefs scale of parents from intervention group. Another interesting result was the increase score of sense of competence from pre intervention to post intervention for the intervention group, t (21) = 2.993, p = .007, d = 0.40, illustrating a small to medium effect size.

Conclusion and Discussion

The major question addressed in this research project was whether robot-enhanced cognitive behavioral intervention for increasing emotion and cognition awareness of anger, sadness and fear and related situations and reducing the maladaptive behaviors would be effective with a group of children diagnosed with ASD. It was also important to evaluate whether strategies taught and rehearsed in the clinic setting would be generalized to the home. Also we wanted to see if the involvement of parents in an enhanced REBT protocol could reduce the parental distress and significantly contribute to the children's outcomes.

Regarding the cognition identification, activating event identification and maladaptive behaviors, we did found significant differences between children's from TAU group and robot-enhanced intervention group in posttest. Since awareness of their own emotions and awareness of situations that are related with this emotions proved to be an important part of effective regulation strategies, our aim was to increase them in order to reduce the unpredictability and maladaptive behaviors. Robot-enhanced therapy proved to be effective in increasing the awareness about their cognitions in specific situations, about the situations associated with dysfunctional emotions and to decrease the number of maladaptive behaviors.

Moreover, accordingly to reports of the parents who took baseline measures of the number of activating events associated with dysfunctional emotions (anger, sadness and fear) in the week prior to starting the program, and after the program, the number of anger, sadness and fear episodes reported by parents decreased significantly over time. These findings are an added value to this study since it proves, not only the effectiveness of this intervention in the experimental setup, but also the generalizability of the skills learned in other contexts. When considering our secondary outcomes of the study, the parental distress, more specifically: depressive symptoms, dysfunctional emotions and positive emotions, we did found significant differences between parents from control group and intervention group in posttest. REBT enhanced therapy proved to be effective in decreasing the number of irrational beliefs, increasing rational beliefs and sense of competence in parents of children with ASD.

Limitations and future research

It is important to acknowledge several limitations of the study including a relatively small sample size and reliance for some aspects of the therapy on parent report measures. Another possible limit of this study could be considered the fact that since we have combined the two types of intervention, it is not clear which the most important component in impacting the results was. Although our aim was not to develop an efficacy study, the absence of a placebo group could be considered a limit and should be addressed in future studies. An essential way of developing this domain of research is to collect further data on the program for replication purposes and also to conduct trials in other settings of formats (e.g., school or group sessions) administered by teachers and so to allow greater dissemination of programs.

CHAPTER IV. GENERAL CONCLUSIONS AND DISCUSSIONS

4.1. Theoretical and conceptual advances

Our first study, the systematic review in which we aimed to provide an estimation of the overall effect of the robot-enhanced therapy on psychological outcome for different types of outcomes, such as cognitive, behavioural and subjective, revealed a medium significant effect of the overall and a medium significant effect of the on the behavioral level. The results show that robot-enhanced therapy yielded a medium effect size overall on the behavioral level, indicating that 69% of patients in the control groups did worse than the average number of participants in the intervention group. We didn't find significant effect of the robot-enhanced therapy on improving the performances on the cognitive level or subjective level when compared to non-robotic condition (e.g., human condition).

These results answer one important research question formulated in our meta-analysis: what type of outcome does the use of social robot in psychotherapy impact more? We can conclude regarding the outcomes that the ones measured at a behavioral level seem to be influenced most by robot-enhanced therapy. Based on this finding we have developed new research design in which we have investigated several issues raised by the meta-analysis.

The second major objective of our research was to investigate the attitude towards using robots in mental health services and to pilot the use of robot-enhanced therapy for children with ASD. As previous studies have shown one of the determinant variables of technology acceptance are attitude towards use and intention to use. Considering that in our research project we aim to to investigate the attitudes toward using social robots in mental health care of three different

populations: parents, adolescents and children. We also aimed to investigate the impact of perceived benefits of using social robots in psychotherapy and if the level of information that participants have influence their attitudes towards robots. The results of Study 2 reveal that the majority of the participants have positive attitudes toward using robots in general, psychotherapy and for children. The level of information provided to the participants from the two groups made no differences in their attitudes toward the use of social robots, or in the degree to which they agreed to participate at a robot-enhanced session. The majority of the participants believe that including a robot in the psychological counseling process could increase the effectiveness of the treatment (52.%) and this represents an encouraging result for this field.

In Study 3 we did actually begin our investigations regarding whether one social robot can influence the performance of children with ASD in a play task. There have been several studies showing that social robots can help children to improve their performance, especially their social abilities. Our findings suggest mixed results when comparing the two conditions (with the robot and with the adult): children exhibit more collaborative play, show more engagement and have significant less stereotype behaviors when interacting with the robot. However as it may concern the other behaviors measured in our study: play performance, eye contact, positive emotions, contingent utterances no significant differences were found between the two conditions. As Diehl et al., 2012 have stated the inconsistence of the responses and behaviors may highlight the heterogeneity of the disorder, and may emphasize the importance of the predictors that might account for individual patterns of response to human-robot interaction.

The third theoretical objective was to extend previously reported results by investigating robot-enhanced therapy for other types of outcomes (e.g, cognitive performance) and also to compare the performances of TD children with ASD children. Study 4 enquired whether the role of the robotic toy Keepon in a cognitive flexibility task can improve the performance of children and also whether there are differences between children with ASD and TD children. The results of this study showed that children with ASD are more engaged in the task and they seem to enjoy more the task when interacting with the robot compared with the interaction with the adult. On the other hand their cognitive flexibility performance is, in general, similar in the robot and the human conditions with the exception of the learning phase where the robot can interfere with the performance. We also did not find significant differences in terms of cognitive performance between the two groups. Future studies should rigorously investigate the mechanisms (e.g., distraction) involved in the generation of these outcomes.

We have investigated the differences between children with ASD and TD children also in terms of dysfunction emotions and maladaptive behaviors and the underlying mechanisms associated with it: rational or irrational beliefs (Study 5). Our hypothesis was that children with ASD will illustrate more irrational beliefs and therefore more dysfunctional emotions and maladaptive behaviors compared to typically developing children. We found a massive presence of irrational beliefs in children with ASD speech during the robot-enhanced task. Moreover, Ellis's theory has been proven also in the case of children with ASD; when high level of irrational beliefs is observed, high frequency of dysfunctional emotions and maladaptive behaviors are shown. The more used irrational cognitions were "demandigness" and "awfulazing". 41.5% of children with ASD have presented dysfunctional emotions during the robot-assisted task compared to typically developing children who expressed only functional negative emotions. These findings represent important inputs for our next main objective, which

is to integrate robot-enhanced intervention in a classical CBT protocol and to address children's emotional problems.

With respects to robot-enhanced CBT protocol (Study 7), among the classical modification/adaptations that are required to the CBT protocol when applied on children with ASD (e.g. increasing the structure and predictability, including visual supports and verbal labeling) we have tried also to increase the engagement in the task by using the social robot Keepon. More specifically we have compared a robot-enhanced CBT protocol for children with treatment as usual for children with ASD. Robot-enhanced CBT proved to be effective in increasing the awareness about children's cognitions in specific situations, about the situations associated with dysfunctional emotions and to decrease the number of maladaptive behaviors. Also when analyzing the outcomes from the parents of children with ASD, we did find that children with ASD that were in the robot-enhanced CBT showed significant decrease in the externalizing problems from pre intervention to post intervention.

Moreover we have noticed that they were much more interested in the feedback offered by the robot and they learned some psychological contents easier when receiving the feedback from the robot. These findings can represent a great contribution the field of human-robot interaction and offers important information regarding how to improve interventions for emotional problems in children with ASD.

Additional to robot-enhanced CBT we have investigated to what extend the involvement of the parents in a REBT protocol can reduce their distress. We have decided also to include an additional program for parents considering previous research which emphasizes the importance of distress level in parents for children's outcome. Based on our results from Study 6 which investigated child variables that may be linked to heightened levels of parental distress, as well as underlying mechanisms for elevated symptoms of anxiety, depression and dysfunctional emotions of parents, we have introduced in Study 7 some issues regarding stress management, emotion monitoring and adaptive coping strategies.

Our results (Study 6) indicate that stress and dysfunctional negative emotions in parents are associated with: the persistence on sameness, communication problems, the level of cognitive conciseness, social interaction problems, the perceived health and behavior problems of children. Among these cognitive behavioral inflexibility contributed significantly to parental stress with 31.7% of the variance in dysfunctional negative emotions accounted for and also we have also found that health and behavior problems contributed significantly to dysfunctional negative emotions in parents with 38.6% of the variance in dysfunctional negative emotions accounted for. Regarding the underlying mechanism of the parental distress, the results showed that unconditional self-acceptance mediated the relation between behavioral inflexibility of the child and well-being of the parent.

When considering our secondary outcomes of the Study 7, the parental distress, more specifically: depressive symptoms, dysfunctional emotions and positive emotions, we did found significant differences between parents from control group and intervention group in posttest. REBT enhanced therapy proved to be effective in decreasing the number of irrational beliefs, increasing rational beliefs and sense of competence in parents of children with ASD.

4.2. Practical contributions

The clinical implications of this research project could be represented on three levels. The first level can address issues regarding how children with ASD perceive and interact with social robots, the second level refers to differences between children with ASD and TD children in terms of cognitive performances, beliefs, emotions and behaviors and also perception of social robots, and the third level may significantly contribute to the state of art of the domain by adding new advances about improvements of standard interventions.

When it comes to differences between TD children and children with ASD regarding beliefs, emotions and behaviors the important information coming from this research project could foster new theoretical research. For example starting from the differences in terms of irrational belief between children with ASD and TD children, we could reanalyze how maladaptive behaviors appear and how we can transform dysfunctional emotions into functional ones.

Regarding robot-enhanced therapy our findings suggest that it could represent a great potential for improving standard interventions, for several types of problems, including clinical populations. As we have mentioned above the role of using social robots in psychotherapy is to improve the therapeutic process, in order to reduce the symptoms associated with different psychopathologies and to improve the quality of life of the clients. From the psychologist's point of view, in clinical practice, social robots may help them reach their objectives in psychotherapy easily and to reduce the workload (especially when working with clinical population, such as individuals with ASD).

Concerning the innovation of the intervention protocol for children with ASD, the presence and involvement of the robot, we may say that our findings can be added to the amount of studies that highlight that robots can be a component of intervention for children with ASD; they can mediate the interaction between the child and the human therapist. It is clear that children with ASD were motivated to interact with the robot, as indicated by their engagement and their wish to spend more time in the task (compared with children in the TAU group).

4.3. Limitations and future directions

Future research should also focus on other types of pathologies (e.g. anxiety, depression) in order to test the effects of robot-enhanced therapy on reducing the symptoms, since the current studies considered mostly autism spectrum disorders and dementia in elderly. Until now, the majority of studies investigated the outcomes in therapy; future studies should investigate the mechanisms of change and should elaborate some cost-effectiveness analysis regarding robot-enhanced therapy.

Although the design of the robots has received considerable attention there is still a gap between the needs of the special populations and the characteristics of the robots which are not specially designed in order to meet the psychological needs of the targeted population. These may be due to the difficulties that appear in the collaboration between the two fields: engineering and psychology. For example robotics work consists in design and development; creating a new robotics platform involve design work, machining, programming, and trouble-shooting, while clinical work, especially experimental trials, involve very careful study design, an extended period of experimental delivery, and rigorous statistical analysis and interpretation (Kim, Paul, Shic, & Scassellati, 2012).

There are many potential advantages to using interactive robots in clinical settings with individuals with ASD. These advantages include the intrinsic appeal of technology to individuals on the spectrum, robots' ability to produce simple and isolated social behaviors repetitively, and the fact that they can be readily be programmed and adapted so that each child gets individualized treatment. Despite these promising possibilities, research in this area is in its infancy, and further research is needed to determine the incremental validity of this approach.

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