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Applied Behaviour Analysis and Autism Spectrum Disorders: A Systematic Analysis

Hina Ayaz and Farhan Kamrani

University of Karachi

Nina Ayaz

Fatima Jinnah Dental College

Autism spectrum disorders (ASD) are commonly occurring group of neurodevelopmental conditions and applied behaviour analysis (ABA) is used to treat a range of their core symptoms as well as psychopathology and challenging behaviours. Present study is a systematic analysis that synthesizes present literature about use and efficacy of ABA to treat ASD, trends in use of ABA, and variables that may affect the treatment. For these 18 studies were selected and analysed it is extracted that as an early childhood intervention ABA is effective treatment of ASD. Systematic review shows that efficacy remains unquestionable even if it is implemented in some later stage of childhood. It is also suggested that ABA improves social, cognitive, language, adaptive and independent living skills as well as functional, cognitive domain and developmental delays. Parental training, professional education, and individual factors impact efficacy of ABA, however, conclusions regarding intervention's intensity and duration on efficacy of intervention need further research.

Keywords. Applied behaviour analysis, autism spectrum disorders, systematic analysis

Autism spectrum disorders (ASD) are commonly occurring group of neurodevelopmental conditions which according to estimates effect 1.5% of the entire population in developed countries (Baxter et al., 2015). Epidemiological studies (such as Baird et al., 2006; Kim et al., 2011; Saemundsen et al., 2013) across the globe reveal that the

Hina Ayaz, Institute of Clinical Psychology, University of Karachi, Karachi, Pakistan.

Farhan Kamrani, Department of Psychology, University of Karachi, Karachi, Pakistan.

Nina Ayaz, Fatima Jinnah Dental College, Karachi, Pakistan.

Correspondence concerning this article should be addressed to Farhan Kamrani, Department of Psychology, University of Karachi, Karachi, Pakistan. Email: farhankamrani@uok.edu.pk

prevalence of ASD has dramatically increased over time. It increased by 121% in USA during 2002 to 2012 (Baio et al., 2018). It has been increasing ever since its first description which may be due to the diagnostic practices of validated and common tools developed and shared by clinicians and researchers worldwide (Hansen et al., 2015). Nevertheless, research that focuses on early and accurate diagnosis does not co-occur with corresponding progress in the validation or development of standardized assessment tools (Bolte & Diehl, 2013).

The global prevalence of ASD is 1% and this makes it the most discussed neuropsychiatric issue that critically affects lives of individuals suffering from it and also communities and caregivers (Lyall et al., 2017). There is an extensive body of literature evaluating the impact of various comorbid conditions affecting individuals with ASD (Hossain et al., 2020).

ASD is associated with deficits in social skills, communication, exhibiting ritualistic behaviours and stereotypies (Cederlund et al., 2010; Leung et al., 2010; Sevlever & Gillis, 2010). It may overlap with other serious disorders too including seizures and intellectual disabilities (Matson & Shoemaker, 2009; Smith & Matson, 2010). Co-occurring psychopathologies, particularly anxiety disorders, ADHD and depression are also common (Bakken et al., 2010).

It is estimated that the probability of people with ASD having one co-occurring psychiatric disorders is 70%, while that of more than two co-occurring psychiatric disorders is 10% (DeFilippis, 2018). Intellectual disabilities, self-injury, eating problems, and aggression are common in people suffering from this disorder and these problems are lifelong (Embregts et al., 2009; Farmer & Aman, 2009; Matson et al., 2009; Poppes et al., 2010; Sturmey et al., 2010).

Applied Behaviour Analysis (ABA)

Wolf et al. (1963) introduced ABA for ASD and Ghezzi (2010) asserts that he was first to highlight the efficacy of ABA in treating ASD. Employing it for ASD's treatment was later popularized by Lovaas (1987) with its popularity as a behaviour-based intervention has since then significantly expanded. Now ABA is used to treat a range of core ASD symptoms as well as psychopathologies and challenging behaviours (Makrygianni et al., 2018; Matson et al., 2007). It is also contended that treatment options most used for ASD are from the field of ABA based on operant conditioning and theories of learning as they are evidence based (Mohammadzaheri et al., 2014).

Despite ABA being regarded as the most evidence based, effective and commonly used treatment for ASD, misunderstandings

and misinterpretation related to methods and procedures that are based on operant conditioning, persist despite research and application of behaviour-based intervention being in action for over half a century (Hossain et al., 2020; Yu et al., 2020). A typical misunderstanding is combining a variety of methods and consequently their effectiveness which is subject to variation as per the case, as one method. An example is the study conducted by Callahan et al. (2009) who have reviewed an ABA approach-based school program for dealing with children with ASD. They conclude that the program reviewed by them is effective as an ABA method without recognizing that several ABA methods had been lumped together. Moreover, there is limited research to support their findings (Makrygianni et al., 2018).

Researchers (Bhuyan et al., 2017; Yin & Yin 2019; Yu et al., 2020) have evaluated efficacy of ABA interventions to treat ASD. They suggest that the opinion regarding ABA being the most effective treatment for autism would stay valid unless other methods and procedures are developed and proven to have better efficacy than it by means of direct comparison.

ASD is very much studied worldwide, and its treatment / management is an area of special concern for the mental health practitioners. There is a huge body of research that is focussed on the effectiveness of ABA, but there is a need to synthesize these findings to accumulate evidence regarding use and efficacy of ABA to treat ASD, trends in use of ABA for autism, and explore factors that may affect treatment.

Method

Search Strategy and Selection Criteria

A through literature search was undertaken and preferred reporting items for systematic review's (PRISMA) guidelines were used. Its checklist was compiled to select and evaluate studies for systematic analysis (Liberati, 2009). The databases searched to locate relevant literature included Medline, PsycInfo, EMBASE, CINAHL, Cochrane Library, and PsycArticles.

Inclusion Criteria

All types of studies that evaluated the efficacy of ABA in relation to ASD population (of all ages) were included. The studies employing intervention methods that are designed on the principles of ABA for

treatment of ASD were also made part of the study. Studies for 10 years (i.e. 2009-2019) are selected for this study. Studies published in English language were made part of this analysis. Only articles with that had full text available, were included. Extracting full text of the articles was not difficult as Medline, PsycInfo, EMBASE, CINAHL, Cochrane library and PsycArticles were utilized.

Assessment of the quality of the included research was a basic concern of the researchers of this study. There are certain quantitative yardsticks that are utilized many times to gauge the value of any paper, but all such quantitative measures can be questionable. For instance, a study with more citations can be termed more popular but does it mean that it is better in quality is not certain. Therefore, the quality assessment of any paper is a qualitative assessment that is done by the researchers by reading the papers in detail. To give a measurable angle to this assessment, number of citations of each paper is given in Table 2.

Exclusion Criteria

Studies evaluating use of ABA for generic psychological disorders not focusing on ASD population, editorials, letters, and articles from nonpeer reviewed journals, dissertations, policy papers, theses, and institutional papers the ones published before 2009 and those written in languages other than English were excluded. However, studies that did not focus specifically on use of ABA to treat ASD, but were part of treatment strategy were not eliminated.

Data Extraction

For the purpose of data extraction a standardized pro-forma was used to record variables including name of the author, publication year, study design (non-RCT or RCT, intervention study, systematic review, literature review, meta-analysis, sequential meta-analysis), follow up length in case of RCT and non RCT studies, study evaluation methods used by systematic reviews, meta-analyses, and literature reviews, sample size, proportion of genders used in sample size, research questions and assessment aim of the study, assessment tools used and their validity.

Specific keywords, logical operators (AND, OR), and queries were used to collect research (Table 1).

Table 1

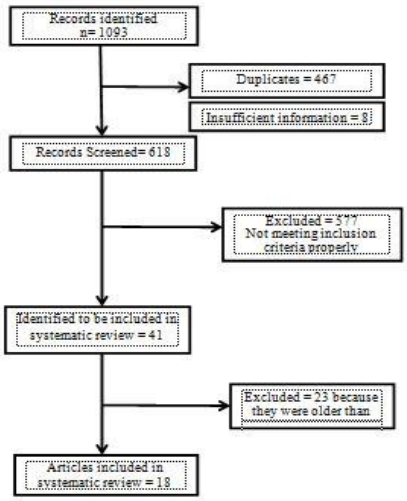
Search Terms and Keywords for Initial Search

Search query	Keywords
1	ASD, autism, autism spectrum disorder, autistic children, people with autism, autistic disorder, autistic individuals, individuals with autism
2	ABA, applied behaviour analysis, early behavioural intervention, intensive behavioural intervention, low intensity behavioural intervention, early intensive behavioural intervention.
3	Systematic review, sequential meta-analysis, meta-analysis, literature review, meta-regression, RCT, randomized control trial
4	Efficacy, effectiveness, use of, application of, implementing, as a means of
5	3 AND 1 AND 2 OR 4, 3 AND 2 OR 4

Initially 1093 articles were located. Peer reviewed articles were selected mechanically, duplicate results were excluded, and 618 articles were left. The titles were scanned, and abstracts were retrieved after which papers were evaluated according to the inclusion/exclusion criteria and a quality assessment was carried out for which the Cochrane risk of bias tool, methodological expectations for Cochrane intervention reviews (MECIR; Higgins et al., 2011). Through this procedure 18 studies were filtered for further analysis.

Figure 1

Flow Diagram for the Systematic Review



Results

Studies included are shown in Table 2 with approach used, nature of study, sample size, and citations.

Table 2

Summary of Studies Included in the Review

Author(s)	Approach	Case load	Citations
Peters-Scheffer et al. (2011)	Meta-analysis	11 quantitative studies	637
DeFilippis and Wagner (2016)	Descriptive study	ABA along with pharmacological approaches to ASD discussed	250
Grindle et al. (2012)	RCT	11 children in intervention and 18 in control group	125
Hayward et al. (2009)	RCT	23 received intensive clinic-based treatments; 21 received parent-based treatment model; and 13 for control group; non concurrent cases	186
Weinmann et al. (2009)	Systematic review	15 publications based on 14 studies	27
Virués-Ortega (2010)	Meta-analysis	Included 22 studies	898
Fernell et al. (2011)	RCT	208 children	173
Flanagan et al. (2012)	Intervention study	61 children	146
Howlin et al. (2009)	Systematic review	11 studies	902
Kuppens and Onghena (2012)	Sequential meta-analysis	N/A	48
Makrygianni and Reed (2010)	Meta-analysis	14 studies	419
Peters-Scheffer et al. (2010)	Intervention study	22 children	129
Makrygianni et al. (2018)	Meta-analysis	29 studies	189
Matson et al. (2012)	Descriptive review	N/A	185
Mohammadzaheri et al. (2014)	RCT	30 (18 boys, 12 girls)	239
Fernandes and Amato (2013)	Literature review	52 studies	26
Welch and Polatajko (2016)	Literature review	N/A	87
Dillenburger et al. (2012)	ABA based intervention study	162 parents and professionals	71

Table 2 describes the details of author(s), approach, case load, and citations of the studies that are utilized to synthesise the evidence of (1) efficacy of ABA to treat ASD, (2) trends in use of ABA for ASD, and (3) variables that may affect treatment.

Peters-Scheffer et al. (2011) found that early behavioural intervention treatments for ASD were effective in improving IQ and adaptive behaviours. DeFilippis and Wagner (2016) conducted a study indicating that for ASD there are limited treatment options that is psychosocial therapies and medication, which are effective in treating associated symptoms but not core symptoms.

Grindle et al. (2012) report that ABA classroom intervention in a mainstream school setting improved language/learning skills for children with ASD. Hayward et al. (2009) found that children with ASD who received 36 hours of weekly ABA, either in a clinic or managed by their parents, showed significant improvements in various skills and abilities over a 1-year period. Weinmann et al. (2009) reviewed 15 studies on early interventions for autism and found that behavioural interventions based on the Loavaas model are the most empirically supported and effective.

Virués-Ortega (2010) found that long-term, comprehensive ABA intervention for children with ASD has shown to have a positive significant effect on intellectual functioning, language development, social functioning, and daily living skills. Fernell et al. (2011) conducted a large naturalistic study of 208 children with ASD found that intensive and non intensive interventions based on ABA had similar outcomes. Flanagan et al. (2012) showed that for ASD earlier age at treatment onset and higher initial adaptive skills predict better outcomes.

Howlin et al. (2009) conducted a review that found that early intensive behavioural interventions are effective for some, but not all, children with ASD. Kuppens and Onghena (2012) demonstrate the effectiveness of early intensive behavioural intervention (EIBI) for children with ASD. Makrygianni and Reed's meta-analysis (2010) of 14 studies shows that behavioural intervention programs for ASD children are effective in improving developmental level. Peters-Scheffer et al. (2010) conclude that behavioural treatment with lower intensity significantly improves developmental delays and adaptive skills in 3-6-year-olds with ASD.

Makrygianni et al.'s meta-analysis (2018) of 29 studies found that ABA is moderately to highly effective for children with ASD in improving intellectual abilities, communication skills, and adaptive behaviour. Matson et al. (2012) reviewed trends in ABA research for

ASD, focusing on areas such as early intervention, parent training, and skill development, with implications for improving treatment outcomes. Mohammadzaheri et al. (2014) conducted a study that compared two ASD therapy approaches, Pivotal Response Treatment (PRT) and a structured ABA, and found that PRT more effective in improving communication skills in ASD children.

Fernandes and Amato (2013) conducted a systematic review of 52 ABA studies and found some evidence of effectiveness of ABA but no conclusive evidence of ABA's superiority over other alternatives. Welch and Polatajko (2016) found that occupational therapists may be overlooking the effectiveness of ABA in treating ASD despite its strong evidence base, due to misconceptions about ABA's client-centered approach. Dillenburger et al. (2012) found that families of children with ASD are more likely to be satisfied with their child's educational provision and support when they attend schools that provide intensive interventions based on ABA compared to non intensive ABA-based home programs.

Discussion

All RCTs made part of the study had examined the efficacy of intervention based on the Lovaas (1987) and the ABA model be it intensive behavioural analysis, early intervention behavioural analysis, intensive managed treatment model or pivotal response treatment (PRT).

This paper attempted to minimize bias by including studies that used different methodologies. This is an approach adopted by Lai et al. (2019). Moreover, quantitative studies cannot address issues that qualitative studies can and vice versa, therefore, including both types of studies in one systematic analysis could provide a deeper insight into the issue under investigation (Lugo-Marín et al., 2019). When ASD children studying in a mainstream school attended an ABA classroom intervention there were significant changes in adaptive behaviour, IQ, learning and language skills over the years, as compared to ASD children receiving regular education (Grindle et al., 2012). This supports the findings of Dillenburger et al. (2012).

Pivotal Response Treatment (PRT) designed on the principles of structured ABA when incorporated in mainstream schooling could help significantly improve targeted or untargeted areas in children with ASD (Mohammadzaheri et al., 2014). A study (Hayward et al., 2009) found that clinic based or home based (involving parents and family) intensive ABA treatments can help ASD children improve IQ, language comprehension, social skills, expressive language and

adaptive behaviour over a period of time. While an intervention study (Dillenburger et al., 2012) with control group, found that home-based ABA programs were not as effective as school-based programs.

ASD children, divided in three subgroups; with developmental delay, learning disability, and normal intellectual functioning when assessed for improvement after intensive and non-intensive ABA and targeted ABA interventions were all found to have equally improved in cognitive functioning, but not being problem free within two years of intervention (Fernell et al., 2011). This is not in agreement with the conclusions presented by Matson et al. (2012), Dillenburger et al. (2012), and Hossain et al. (2020) who argue that the type of ABA intervention suitable to treat ABA varies largely from person to person and many other individual, environmental, social, and family variables which in no way can deny the efficacy of ABA interventions in improving outcomes for individuals with ASD falling into any subgroup or combination of symptoms. However, Peters-Scheffer et al. (2010) asserts that ABA may aid in improving developmental areas or developmental age, but there is no evidence of ABA therapies effective in decreasing severity of symptoms of ASD or emotional problems.

The meta-analyses show that Early Intensive Behavioural Intervention (EIBI) significant improvement in outcomes such as adaptive behaviour, communication skills, social skills, daily living, and IQ for children with ASD (Makrygianni et al., 2018; Markygianni & Reed, 2010; Peters-Scheffer et al., 2011). Significant improvement in developmental and adaptation skills were also observed in an intervention study by Peters-Scheffer et al. (2010) for eight months after receiving low intensity ABA interventions. Some researches (Kuppens & Onghena, 2012; Markygianni & Reed, 2010) emphasize that early interventions may aid in significantly improving symptoms and conditions with the passage of time without any study claiming the child to be problem free within certain years of receiving ABA.

A study (Makrygianni & Reed, 2010) suggests that intensive ABA interventions lead to better outcomes in terms of development. This is contrary to a study (Fernell et al., 2011) that did not find significant improvement in participants even after intensive ABA. The negation of ABA efficacy though needs more search as the existing body of literature lacks evidence to support the claim.

However, systematic reviews and descriptive studies included in this paper yield inconsistent results. There is support for early ABA based interventions having a role in improving IQ of children with EIBI (Howlin et al., 2009; Weinmann et al., 2009), improvement in

functional and cognitive domains and social skills along with independent living skills (Matson et al., 2012). Howlin et al. (2009) did not find any statistically significant improvement in expression or comprehension skills of children after receiving EIBI. Weinmann et al. (2009) remark that factors that could make the intervention effective or the duration for which intervention should be provided is unclear, therefore, it is difficult to draw conclusive findings regarding efficacy of therapy for a diverse group of ASD children because outcomes may vary across the group.

DeFilippis and Wagner (2016) support more of a pharmacological treatment for ASD as compared to psychosocial therapies but they acknowledge that ABA is effective in treating certain domains of ASD. Welch and Polatajko (2016) have also criticized ABA as not being client centered. Fernandes and Amato (2013) do not see any conclusive evidence to believe preponderance of ABA to other alternatives for treatment of ASD. This is not in agreement with many RCTs, and intervention studies that regard ABA as the most commonly used and effective intervention. Both the studies have also argued that research having studied efficacy of ABA intervention fail to take into account variables such as role of parents in home-based ABA interventions, professional education, and individual limitations of children receiving therapy.

All the studies included in this analysis have drawn conclusions in support of ABA interventions improving one or more of the areas of development. These findings agree with studies (Bhuyanet et al., 2017; Ghezzi, 2010; Matson et al., 2010; Yin & Yin, 2019) that show that ABA has been recognized as an effective intervention for individuals with ASD. RCTs and intervention studies particularly observed that early behavioural interventions and intensive behavioural interventions improve the skills for children as compared to children in the control groups with Makrygianni and Reed (2010) emphasizing importance of parental training and Dillenburger et al. (2012) stressing the importance of ABA intervention delivered by trained individuals as it may enhance the outcomes.

Some researchers have questioned the preponderance and efficacy of ABA interventions for ASD claiming it to be expensive, not client centred (Welch & Polatajko, 2016) and overrated (DeFilippis & Wagner, 2016; Fernandes & Amato, 2013). The need to take into account variables such as professional education, role of parents, parental training, and individual differences is valid, but claiming that studies failed in it, needs to be reconsidered because older studies (Hastings & Symes, 2002; Short, 1984) as well as studies included in the present review have laid stress on all these

variables; for example parental training, role of parents (Dillenburger et al., 2012), professional education or delivery through professionals (Makrygianni & Reed, 2010), and individual differences (Fernell et al., 2011; Makrygianni & Reed, 2010). All these factors influence the efficacy of the interventions and outcomes. These criticisms need to be investigated further.

Two RCTs included in the study had a follow up period of two years. Hayward et al. (2009) had a follow up period of 1 year. Mohammadzaheri et al. (2014) had a follow-up period of 3 months and conclusion were presented after brief observations. It could be inferred that a structured approach adopted towards improvement in children with ASD guided by ABA principles even for a short time can lead to significant improvements which is in line with the conclusions presented by older studies (Landa & Kalb, 2012; Zachor et al., 2007). Moreover, an intervention study (Peters-Scheffer et al., 2010) had a follow-up period of only 8 months and found low intensity ABA intervention to be effective in improving developmental delays and learning abilities. However, there is a further need to find out the mediating effect of intensity of ABA intervention on the efficacy of the intervention given a specific time duration for which intervention is provided.

Conclusions

This systematic analysis had 3 objectives; to assess the efficacy of ABA to treat ASD, to explore the trends in use of ABA for ASD, and to explore factors that may affect treatment. Regarding the efficacy of ABA it is concluded that that it is effective in treating ASD especially with children when used as an early childhood intervention. Its efficacy does not become questionable even if it is implemented in some later stage of childhood. The findings suggest that it is effective in improving social, cognitive, language, independent living, and adaptive skills as well as functional, cognitive domain, and developmental delays.

Regarding the trends in use of ABA it is was found that ABA is the most commonly used intervention for ASD with more research coming up with evidence of its efficacy and schools offering it for ASD students. The factors that may affect the treatment it came to light that variables such as parental training, professional education, and individual factors have impact on the efficacy of ABA interventions for ASD, however, conclusions regarding intensity of intervention and its duration on the efficacy of intervention need further research to substantiate the claim.

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