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A Systematic Review of Applied Behavior Analytic Interventions for Children with Autism in Mainland China

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Systematic reviews of applied behavior analytic interventions for children diagnosed with autism in mainland China

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Abstract

Applied Behavior Analysis (ABA)-based interventions, particularly when utilised to support children diagnosed with Autism Spectrum Disorders (ASD), are typically conducted in Western societies and published in the English language. However, little is known about the utilisation of applied behavior analysis for children with autism in

China. This paper provides systematic reviews of English and Chinese studies conducted in Mainland China. The search generated 33 articles that met the selection criteria. The results suggest that Chinese ABA-based programmes appear to be equally as effective as programmes elsewhere. One of the key differences of the Chinese programmes was the strong emphasis on parental involvement. The review also revealed the wide use of non-behavioral eclectic methods and the lack of well-designed experimental studies in Chinese studies. The implications of these findings for future researchers and practitioners are discussed.

Key words: Review; ABA; autism spectrum disorder; ASD; China

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Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that is diagnosed when individuals display difficulties in social communication and/or restricted, ritualized behaviors over a prolonged period (American Psychiatric Association, APA, 2013). Various treatment approaches have been developed to help children with autism and their families. Nearly all evidence-based interventions (Eikeseth, Hayward, Gale, Gitlesen, & Eldevik, 2009; Howard, Stanislaw, Green, Sparkman, & Cohen, 2014; Smith, Hayward, Gale, Eikeseth, & Klintwall, 2019) are based on the application of the scientific discipline of behavior analysis (Baer, 1962; Baer, Wolf, & Risley, 1968, 1987; Skinner, 1988). ABA-based interventions for children diagnosed with autism were originally developed in the United States (Lovaas, 1987, Smith, 2001; United States Surgeon General, 1999) and are now used across the world (Eikeseth, Klintwall, Jahr, and Karlsson, 2012; Liao, Dillenburger & Buchanan, 2018; Love, Carr, Almason, & Petursdottir, 2009; Peters-Scheffer, Didden, Mulders, & Korzilius, 2010). In applied behaviour analysis (ABA), data collection and analysis are key elements (Cooper, Heron, & Heward, 2007), that typically are demonstrated through intra-subject comparisons, using single-system designs (Hitchcock, Kratochwill, & Chezan, 2015; Institute of Education Sciences, IES, 2017; Kratochwill et al., 2013). By visually analyzing the graphed data in different phases of the intervention, researchers and clinicians assess the effects of the intervention and, if necessary, adjust interventions in a timely and individually tailored manner.

Early Intensive Behavioral Interventions (EIBI) are commonly part of the comprehensive ABA-based treatment package for young children with autism, that include procedures, such as Discrete Trial Teaching (DTT) and Natural Environment Training (NET) (Lovaas, 1987; Orinstein et al., 2014; Smith, Groen, & Wynn, 2000), amongst others. EIBI has been used to increase many socially significant behaviors, including language and communication skills, life skills, cognitive and functional behaviors (Fein et al., 2013; Lovaas, 1987; Reichow, Barton, Boyd, & Hume, 2012; Reichow & Wolery, 2009; Wong et al., 2015).

ABA-based interventions have been used in developed as well as developing countries. In China, the first case of autism was recognized in 1982 (Tao, 1987), much later than in the USA where early cases were reported by Leo Kanner in 1938 (Kanner, 1943) or in Austria where first cases were reported by Hans Asperger in 1944 (Translated by Frith, 1991). It was not until 1995 that autism was included in the second edition of the Chinese

Category of Mental Disorders (Psychosis Branch of Chinese Medical Association & Brain Hospital of Nanjing Medical University, 1995).

Partly due to the relatively late identification of autism as a stand-alone diagnostic category, studies of prevalence rates are still being accumulated while existing data of prevalence rate are not consistent across existing studies. For example, Jin, Yang, Liu, Huang, & Jin (2018) conducted a cross-sectional study among 74,252 children aged between 3 and 12 years old in Shanghai, and found that 8.3 in every 10,000 children were diagnosed with autism according to DSM-5. Yang et al. (2015) surveyed 15,200 preschool children in a city in South China, and reported 260 per 10,000 of the children had a high risk of autism and 400 per 10,000 were suspected to have autism. Guo (2004) reported only 5 children with autism and co-occurring intellectual disability among 3,606 children (2-6 year olds) in a city in North China. Other studies reported that the pooled prevalence of autism in mainland China is estimated 39.23 per 10,000 children aged between 1.6 and 8 years old (Wang et al., 2018) and 70 per 10,000 children aged between 6 and 12 years old (Zhou et al., 2018).

Although autism prevalence rates vary significantly across Chinese studies, they are generally lower than that in Western countries. For example, in the USA, 241 in 10,000 children were diagnosed with autism (Xu, Strathearn, Liu, & Bao, 2018) and in the UK, 350 in 10,000 children were reported to have autism in a sample of over 15,000 families (Dillenburger, Jordan, McKerr, & Keenan, 2015). The reasons for the relatively low prevalence of autism reported in China are unclear, but they are likely related to the relatively late recognition of autism as a stand-alone diagnostic category. If this indeed were to be the case, future studies likely will report prevalence rates be more aligned with Western figures.

Given the huge population of China, there are a very significant number of Chinese children with this neurodevelopmental disorder (Sun et al., 2013). Not surprisingly, many organisations that aim to support these children have been established since 1990s (McCabe & Tian, 2001). There now are approximately 1,000 autism training centres in mainland China that use various intervention approaches (Zhou et al., 2014). The first training organization in mainland China, *Beijing Stars and Rain*, was established in 1993, and it was also the first one that introduced ABA-based interventions into their program (Guo, 2006; McCabe & Tian, 2001; Wen, 2014; Zhou et al., 2014). Subsequently, therapists, researchers, and government policy makers together promoted ABA-based approaches and make them publically available (Zheng, Maude, Brotherson, & Merritts, 2016).

However, little is known about the extent of the use of ABA-based interventions in mainland China. For example, there is no research about the proportion of ABA-based interventions used when compared to other interventions, that are utilized by autism organisations and families. Similarly, little is known about how ABA-based interventions are used by Chinese professionals and researchers and the effectiveness of these interventions. For example, it is not clear whether and how targeted behaviors have been changed after interventions; how and which family members are involved in the interventions; and whether the interventions also result in psychological changes in the family members. Answers to the above questions will depict the current status of the ABA-based interventions in mainland China.

Researching these questions will help deepen the understanding of ABA-based interventions that originate from the West, in diverse cultural contexts. This can enrich the development of novel ABA-based interventions, clarify the optimal settings in which ABA-based interventions can be applied, and facilitate the dissemination of the science of behavior analysis internationally. All of these help shape how ABA-based interventions develop in the future. For example, eye contact is considered a pivotal and important behavior in training for children with autism to attend socially (Foxy, 1977; Helgeson, Fantuzzo, Smith, & Barr, 1989). However, the interpretation of eye contact differs across cultures. In Eastern cultures, it is perceived very differently from Western norms (Akechi et al., 2013). Specifically, in East Asian cultures prolonged eye gazing at another person would be considered aggressive and/or disrespectful towards others (Uono & Hietanen, 2015). Therefore, while intensive and long-term behavior analytic intervention programs (e.g., Perry, Koudys, Prichard, & Ho, 2019) including strategies such as a progressive model of teaching (e.g., Cook et al., 2017; Rapp et al., 2018) and differential reinforcement (e.g., Hall, Maynes, & Reiss, 2009; Jeffries, Crosland, & Miltenberger, 2016) have been found to lead to optimal outcome for children in the West, these conclusions cannot be transferred across cultures without further analysis (Lovaas, 1987; Remington et al., 2007).

Chang and Zaroff (2018) have reviewed local service programs, supporting policies, and the use of ABA-based interventions in mainland China and Hong Kong. However, their review was limited to studies written in the English and did not include relevant findings published in Chinese. Given that quite a few Chinese researchers publish their work in Chinese journals, it is likely that Chang and Zaroff's review missed some important work and consequently, did not reveal the true extent of the use of ABA-based interventions in China.

In addition, their review did not report the feature of intervention services, or measurement tools and the quality of the research method. To overcome this limitation, the present review includes literature published in both English and Chinese. The review reported here focussed on two main research questions:

1. What is the status of ABA-based interventions for autism in mainland China?
2. What empirical methods have been used to study ABA-based interventions in mainland China?

Methods

To review empirical studies regarding ABA-based intervention in mainland China, two systematic reviews were conducted using the methodology of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Moher et al., 2009; 2015).

Search strategy

The search covered databases of journals in English or Chinese. In the English language databases, the key words used were ‘Autism Spectrum Disorder’, ‘Applied Behavior Analysis’ and ‘mainland China’, and the variants of these terms (e.g., ‘ABA’, ‘intensive behavior intervention’, ‘early intensive behavior intervention’) according to the thesaurus based on the Pearl Harvesting method (Sandieson, 2006, 2019). Boolean operators such as AND and OR were used in combination in the command line, the truncation operator ‘*’ was used to capture all variations of similar terms, e.g. autism and autistic become *autis**, and restriction of exact words was ensured by using double quotation marks around a term. For example, “applied behavior analysis” would return only those papers that refer to the exact UK spelling of *behavior*. However, the UK spelling “behavior” and the US spelling “behavior” were both searched.

In the Chinese language databases, the following key words were used: Autism (‘自闭症’ or ‘孤独症’) and Applied Behavior Analysis (‘应用行为分析’). The search strategy were the same as that in the English language review. The exact combinations of search terms used for the English and Chinese databases can be found in Appendix 1.

Selection criteria

To be included in analyses, all studies need to meet the following selection criteria:

- 1) They included children with autism; they also could include parents (mothers, fathers), other caregivers (e.g., grandparents) of these children, or professionals who worked with these children (e.g., therapists);
- 2) They focused on applied behavior analytic interventions or interventions that were based on or referred to Baer, Wolf and Risley (1968; 1987);
- 3) They were conducted in mainland China with a local population;
- 4) They were published in peer-reviewed journals;
- 5) They reported empirical studies that were either experimental, such as single-system design studies (SSDs), or non-experimental studies, such as quantitative surveys, qualitative interviews, census data and descriptive data.

English language databases

Five English databases and sixteen additional English journals were searched. English databases, included ERIC (Educational Resources Information Center – ProQuest), Web of Science, ProQuest Social Science, SCOPUS and PubMed. The initial search took place between 10 -25 January 2017 and this was updated between 10-13 January 2018. Sixteen journals were hand searched, including *Journal of Applied Behavior Analysis*, *Journal of Early and Intensive Behavior Intervention*, *Analysis of Verbal Behavior*, *Journal of the Experimental Analysis of Behavior*, *Behavior Analysis in Practice*, *European Journal of Behavior Analysis*, *Behavior Analyst*, *Behavioral Interventions*, *Behavior Analyst Today*, *Journal of Positive Behavior Interventions*, and *Behavior and Philosophy*, *Behavior Modification*, *Research in Autism Spectrum Disorder*, *Research in Developmental Disabilities*, *Research and Practice for Persons with Severe Disabilities*, *Journal of Autism and Developmental Disorder*.

PRISMA chart of English language databases

Figure 1 presents the PRISMA chart that shows the results of the English language search. The search across databases, additional backwards search, and hand-search of journals produced 273 articles. These articles reduced down to 251 articles after duplicates removed. An additional search was conducted through a backward literature search, i.e., searching the bibliography of the final included articles, which produced an additional 8 papers. The total of 259 papers reduced to 27, after 232 articles were removed because they proved irrelevant in their titles and/or abstracts). The full text of these 27 articles were read

for eligibility inclusion and 7 of them were selected for the final analyses. Figure 1 outlines the reasons for excluding the other 20 excluded articles.

[Figure 1 inserts here]

Figure 1: PRISMA chart of English articles

Chinese language databases

A separate systematic review was conducted using three Chinese language databases, including China National Knowledge Infrastructure (CNKI), WeiPu (VIP) and Wanfang, which are considered the most frequently used Chinese academic databases (e.g., Sun et al., 2013). Articles from CNKI were searched on 26-28 January 2017 and articles from VIP were search on 4-5 February 2017. An updated search including the three databases was conducted again between 11 -15 January, 2018. Since Chinese journals were all released in open access through databases (Huang, 2004; Wang & Yao, 2005), no additional journals were searched.

PRISMA chart of Chinese language databases

Figure 2 is the PRISMA chart showing the procedure of the search and review for articles in the Chinese language. The search produced 889 records, which filtered down to 749 articles after duplicates were removed. An additional search was conducted through a backward literature search and produced 2 additional records. A total of 173 records filtered down to 28 records after removing 578 papers which had titles and/or abstracts that were irrelevant. The full texts of 28 articles were read for the final analyses. The reasons for the 145 excluded articles are presented in Figure 2.

[Figure 2 inserts here]

Figure 2: PRISMA chart of Chinese articles

Excluded articles

As shown in Table 1, a total number of 165 articles were excluded full-text screening procedures. There were 20 English articles and 145 Chinese articles passing the duplication screening and eligibility screening. Of the 20 English papers, around half of these articles (n=8) were excluded due to not focusing on populations in mainland China (e.g., they focused on the populations in Hong Kong; e.g., Leung & Wu, 1997; Ling & Mak, 2012). For

the 145 Chinese articles which did not pass the duplication screening and the eligibility screening, the majority of them were further excluded because they were non-empirical reviews on the theories and practices of ABA-based interventions conducted in the West, i.e., 72 of them were general review on autism or treatment approaches (e.g., You & Yang, 2006) and 20 of them were ABA review such as outlining what ABA-based interventions are and how they can be implemented (e.g., Liu & Li, 2007), offering an overview of Pivotal Response Training (PRT), a specific ABA-based intervention (e.g., Huang, Chen & Li, 2010), and the usage of EIBI in the West (e.g., Wang & Kang, 2011). In addition, 48 of the excluded Chinese articles were not solely about ABA but about eclectic methods, where researchers regarded ABA as a type of interventions and used with other approaches (e.g., Peng & Yu, 2014).

Interobserver agreement

The first author YL undertook the majority of the search of both the English and the Chinese literature. In order to assess the internal validity of these reviews, a second reviewer independently searched and read the above databases and journal papers. Two authors discussed reasons for exclusion, such as ‘empirical study’, ‘eclectic approach’, ‘not focused on mainland China’ and ‘other empirical study but not focused on ABA-based interventions’ (see Table 1 for reasons of exclusion).

YL and the third author (WH) reached 100% of agreement in the English database and journal paper searches. YL and the fourth author (YX) reached 99.47% of agreement in Chinese database searches. Four disputed articles were discussed by YL, KD, and YX to a reached consensus and further clarifications were sought from the relevant authors before making the decisions to include or exclude from the review. In the end, all the four papers were clarified as not about ABA-based interventions.

Quality assessment of single-case design

Single-case research design (SCD) is commonly used in developing and evaluating behavior analytical interventions, including those in the field of special educational needs (Kratochwill et al., 2013), and interventions to support individuals with intellectual disabilities and/or autism (Matson, Turygin, Beighley, & Matson, 2012). The methodological rigor of single case design were assessed by What Works Clearinghouse (WWC) standards (Institute of Education Sciences, 2017). The WWC reviewers categorised studies into three

types, i.e., meeting evidence standards, meeting evidence standards with reservations, and not meeting evidence standards. In order to meet evidence standards: a) The independent variable (i.e., the intervention) must be systematically manipulated and the study must identify when and how the independent variable conditions changed; b) An inter-assessor agreement (IOA) must be collected by more than one assessor in each phase and at least 20% of the data points in each condition (e.g., baseline, intervention); and c) The study must have the minimum number of phases and data points per phase to demonstrate the intervention effects. The quality of group design and non-experimental design articles were not assessed, because single-system designs (Hitchcock, Kratochwill, & Chezan, 2015; Institute of Education Sciences, IES, 2017; Kratochwill et al., 2013) are the main research designs in the clinical and research area of behavior analysis. In addition, the limited number of Randomised Controlled Trials (RCTs) made the quality of assessment not significant. The first author (YL) and the fifth author (HC) reached 100% agreement on the quality assessment of the single case design studies.

Results

The two systematic reviews generated 35 relevant articles, including both English and Chinese articles. Among these articles, there were 24 experimental research design studies and 11 non-experiments, such as qualitative and quantitative research design articles. The details of the articles can be found in Table 2.

1. Research trend related to ABA and autism

A total of 200 articles were extracted for analyses at the full-text eligibility level (Table 1), i.e., 173 Chinese articles (145 excluded articles and 28 included articles) and 27 English articles (20 excluded articles and 7 included articles). In order to understand the research trend on children with autism and ABA-based interventions related contexts in mainland China, a further analysis was carried out on 103 articles, which included 35 final articles and excluded 68 articles with distinct reasons of ‘ABA review’ (Table 1, second row, third column) and ‘eclectic approach’ (Table 1, second row, fourth column).

[Figure 3 inserts here]

Figure 3: Research trend related to ABA and autism

In Figure 3, the horizontal line represents an equal number of 3-year divide. As the search ended on January 2018, the year of 2018 was grouped into the '2015-2018' category. The vertical line represents number of articles published in peer-reviewed journals. As indicated in Figure 3, articles coded as 'ABA review', eclectic approach' and 'ABA empirical studies' increased yearly. Empirical research increased after 2005. Before that, most of the literature focussed merely on introducing and reviewing ABA related research from the West. However, in the short time span since 2005, there has been a relatively broad coverage of behavior analytic topics (see No.6 of the results section). In addition, eclectic approach articles increased from 2009 onwards and empirical studies about ABA increased largely from 2012 onwards.

2. Empirical methods

Among the 35 articles, 14 articles used experimental study of single/multiple-case design, 10 articles used experimental study of group design and 11 articles were non-experimental empirical studies such as qualitative interviews (See Table 2 for details).

Of the 14 single/multiple case design studies, 9 studies used single-case design. To be specific, 5 of them used A-B-A design studies (Huo, Liu, & Hu, 2016; Qian, 2016; Wang, 2016; Xiao & Yu, 2015; Zhen & Li, 2017); 3 studies used A-B-A-B reversal design studies (Shen, 2017; Yang, Zhu, & Cao, 2012; Hu, Chen, & Zheng, 2016), and one used A-B research design study (Sun & Wei, 2011).

Of the remaining 5 single-case studies, Xu, Wang, Lee and Luke (2017) used changing criterion design and 4 studies used multiple-baseline design, with Hu and Fan (2014) using an A-B multiple baseline design; Hu, Xu, Xu and Feng (2015) using an A-B-A multiple baseline design across subjects; Hu, Liu, Fan, & Zhen (2016) using multiple baseline design across subjects. Lee, Feng, Xu and Jin (2017) used multiple baseline design across behaviors.

Of the 10 articles that used group research design, five used a within-group design, i.e., making measurement before and after intervention for the same group of participants (Duan & Niu, 2013; Liu & Chen, 2012; Ma, Cui & Zhang, 2016; Shi, Yu, Guo, & Li, 2007; Xiong et al., 2010). Five studies used a within-group design and between-group research design, i.e., comparing the experimental group and the control group, plus pre- and post-test on each group (Ding et al., 2015; Wang, 2008; Xu, Yao & Yang, 2017; Xu et al., 2018; Zou et

al., 2008); 3 of these 5 studies used Randomized Control Trials (RCT) related to ABA-based interventions on the Chinese population (Wang, 2008; Xu, Yao & Yang, 2017; Xu et al., 2018).

Of the 11 non-experiment empirical studies, 7 studies were empirical case studies without quantitative data (Han, 2016; He, 2017; Ma, 2017; Shao, Xu & Zhang, 2014; Wang, 2016; Zhong, 2016; Zhu, 2013). These studies used descriptive words to indicate the child's behavior changes after ABA-based intervention. For example, Han (2016) reported the implementation of functional behavior analysis reduced a boy's disruptive behavior in the classroom. Four of these studies lacked quantitative data (Han, 2016; He, 2017; Shao, Xu, & Zhang, 2014; Wang, 2016); one article lacked intervention and maintenance stage data (Ma, 2017) and 2 case study articles were reported as empirical studies by authors but lacked a clear research design (Zhong, 2016; Zhu, 2013). Two of the non-experiment empirical studies were qualitative interviews. Specifically, Guo, Liu and Du (2006) used telephone interviews with 64 parents to assess the type of school their children were enrolled in and their academic record at school; Liao, Dillenburger and Buchanan (2018) interviewed parents and professionals in England and China to explore cultural factors influencing ABA service delivery. The remaining 2 non-experiment studies collected children's past documentary data (archived data, Nichols, 2001) and parents' training data for research purpose. Specifically, Zhou et al. (2014) analysed the registration data between 1993 to 2012 at 'Stars and Rain', one of the earliest autism NGO founded by a Chinese mother, and surveyed 100 members of centres of Heart Alliance Autism Network, the organization started by Stars and Rain in 2005 to promote quality services and sharing resources (Zhou et al., 2014). Guo (2006) analyzed parents' training data to describe the characteristics of parental training and challenges faced by Chinese parents.

3. Quality of the single case design studies

All of the 14 single case design studies focused on improving children's behavior using ABA-based interventions. The methodological rigor of the 14 single/multiple case design were assessed using What Works Clearinghouse (WWC) standards (Institute of Education Sciences, 2017). Results showed that all 14 articles met the first level of quality; 8 of the articles met the criterion on inter-assessor agreement (IOA). For articles in which IOA process was not reported at all or was not detailed enough, emails were sent to corresponding authors for clarifications. If no responses were received after three weeks, the papers were excluded and deemed as not having met IOA level; 4 articles had the required number of

phases and data points per phase without reservation, and 2 articles met WWC pilot single-case design standards with reservations (Table 3).

4. *Measurement tools*

The most commonly used assessment and diagnostic tools in mainland China were Childhood Autism Rating Scale (CARS) (Schopler et al., 1986) and the Autism Behavior Checklist (ABC) (Krug, Arick, & Almond, 1980). Of the 24 experimental studies, 10 articles did not mentioned diagnostic criteria (Duan & Niu, 2013; He, 2017; Huo, Liu & Hu, 2016; Hu, Xu, Xu, & Feng, 2015; Hu & Fan; Ma, 2016; Shen, 2017; Wang, 2008; Yang, Zhu & Cao, 2012; Zheng & Li, 2017; Sun & Wei, 2011); 5 articles indicated the diagnoses of participants were confirmed by authoritative hospitals (Hu, Chen, & Zhen, 2016; Hu, Liu, Fan, & Zhen, 2016; Wang, 2016; Xiao & Yu, 2015). CARS was used in 6 papers (Shi, Yu, Guo, & Li, 2007; Wang, 2008; Wang, 2016; Xu, Yao & Yang, 2017; Xu et al., 2018; Zou et al., 2008). ABC was used in 3 papers (Duan & Niu, 2013; Xiong et al., 2010; Shen, 2017).

In addition, functional developmental tools, such as the Chinese version Psychoeducational Profile-Third Edition (PEP-3) (Heep Hong Society, 2009; Schopler, Lansing, Reichler, & Marcus, 2005) were used by Chinese researchers in 3 studies (Hu & Fan, 2014; Ma, 2017; Wang, 2008; Xu et al. 2018). The Gesell Developmental Scale (Gesell, 1925) was used by Shi, Yu, Guo and Li (2007). The Wechsler Primary and Preschool Scale of Intelligence-Revised (WPPSI-R) (Wechsler, 1989) was used by Hu and Fan (2014), Hu, Liu, Fan and Zhen (2016), and Qian (2016). All of the 14 single-case design studies used direct behavior observations to collect data at baselines and/or different phases of the intervention (Hitchcock, Kratochwill, & Chezan, 2015).

5. *Target behaviors*

The behaviors targeted with ABA-based interventions in mainland China were varied. The majority of papers focused on the overall performance improvements (Ding, Zhong, Cheng, & Jiang, 2015; Xiong et al., 2010; Zou et al., 2008), while some emphasized social communication (Hu & Fan, 2014; Qian, 2016; Shao, Xu, & Zhang, 2014; Zheng & Li, 2017; Hu, Liu, Fan, & Zhen, 2016; Hu, Chen, & Zhen, 2016), language (Ma, Cui, & Zhang, 2016), aggressive behavior (Hu & Fan, 2014; Zhong, 2016), theory of mind (Hu, Xu, Xu, & Feng, 2015), interference behavior (Wang, 2016), self-injurious behavior (Xiao & Yu, 2015), seat-leaving behavior (Yang, Zhu, & Cao, 2012) and food selecting behavior (Zhu, 2013).

6. *ABA-based interventions*

A variety of ABA-based interventions were used in China, including Picture Exchange Communication System (PECS; Hu & Fan, 2014; Qian, 2016; Shao, Xu, & Zhang, 2014; Zheng & Li, 2017), Speech-generating devices (Hu, Liu, Fan, & Zhen, 2016); Structured social play (Hu, Chen, & Zhen, 2016); Discrete Trial Teaching (DTT; Zheng & Li, 2017; Zou et al., 2008), Pivotal Response Training (PRT; Wang, 2016) and functional assessment (Wang, 2016; Xiao & Yu, 2015; Yang, Zhu, & Cao, 2012). In addition, Zhou et al. (2014) reported that of the 100 autism Non-Governmental Organizations (NGOs) of the *Heart Alliance*, 99 organisations provided ABA-based interventions, 73 provided sensory integrations intervention and 36 provided Treatment and Education of Autistic and related Communication Handicapped Children (TEACCH). A total of 87 organisations provided more than two approaches (Zhou et al., 2014).

The duration of program was short, e.g., around three months (Ding, Zhong, Cheng, & Jiang, 2015; Guo, 2006; Xiong et al., 2010). Most autism organisations served for young children, and only 18 out of 100 centres provided services for adults, aged 18 years or older. The number of professionals working at each organisation ranged widely from 3 to 75, with a median staff to child ratio of 1: 2.77 (Zhou et al., 2014).

Some researchers explored cultural differences that affected the service delivery of ABA-based interventions across countries (Liao et al., 2018) and culturally adapted services in China (Xu et al, 2018).

7. Parental involvements and mental health

Parents took an active role in ABA-based intervention programs in mainland China (Guo, 2006; Wang, 2008; Xiong et al., 2010; Zhou et al., 2014). Results showed 4 out of the 10 group design articles studied parental involvements in children's ABA-based intervention programs, such as the exploration of low intensity of behavior analytic training when parents involved in children's ABA-based intervention programs (e.g., Xu, Yao & Yang, 2017; Xu et al., 2018), and child's behavior change after parents had ABA training (e.g., Wang, 2008; Zou, 2008). Many parents, who travelled from their home to one of the major cities to access quality parent training, chose to leave their job (Liao et al., 2018). Of 100 autism NGOs included in Zhou et al. (2014), 73 organisations provided both children and parent training, 24 organisations solely provided children intervention, and 3 organisations solely provided parent training. The effectiveness of parent training was demonstrated also by Wang (2008), who reported improvements in interaction between the parent and the child with autism after

parent-focused training. Parents were more accepting of their child, clearer about their child's interests, more able to deal appropriately with the child's challenging behavior, and able to better interact and communicate with their child.

With regards to parental mental health, the Chinese model of including parent training provided parents a forum to share their feelings, to support each other, and to some extent, to relieve psychological pressure. Xiong et al. (2010) conducted a study comprised 76 mothers and children with autism. In their 70 Days' Project, mothers were trained to support their own children under the supervision of ABA professionals. The study revealed that mothers' depression and anxiety level did not change, however, they suggested that further strengthening of training for parents could help relieve of mothers' mental health issues.

8. *Child outcomes*

With regards to child outcomes, the majority of the Chinese researchers reported optimal outcomes in favour of ABA-based interventions. Zhou et al. (2014) reported that, over a twenty-year period (1993 to 2012), ABA-based interventions were highly effective for students at *Heart Alliance* and *Stars and Rains*. Wang (2008) conducted an assessment of 76 mothers after three months intervention of a parent-focused ABA training program, where interventions were based on the parent-child dyad under a teacher's supervision. Results showed notable improvement in the children's abilities with regards to sensory regulation, social skills, physical motor skills, verbal behavior and speech, and self-care skills. Interestingly, girls showed a greater improvement than boys in terms of social ability and independent skills; older children had better outcomes than younger ones in terms of self-care competence.

A number of researchers reported specifically positive effects of ABA-based interventions on language and communication skills and challenging behaviors. For example, Liu and Chen (2012) conducted ABA communication training with 41 children with autism aged 2½ - 5-years-old and found that the children's pronunciation, single word sentences, and expression significantly improved after training. Hu and Fan (2014) reported children's ability with regards to 'theory of mind' improved significantly and Zhong (2016) revealed that after 3 months ABA-based training, the participant's aggressive behavior reduced significantly.

Ding, Zhong, Cheng, and Jiang (2015) assessed the physical ability, emotional ability, social ability and school behavior of 66 significantly challenged children with autism after they had received 3 months training in ABA program using the Pediatric Quality of Life Inventory Measurement Models (PedsQLTM). While results showed improved quality of life (physical functioning), however, due to some program inflexibility, fewer improvements were achieved in terms of emotional and social communication. Xiong et al. (2010) trained 76 mothers and children with autism and found that children's social skills, language, motor ability and self-care ability increased significantly.

9. Financing of services

Funding for autism in China is limited to services within each local province (Liao et al., 2018), consequently, most of the parents who wanted to avail of ABA-based services had to finance the interventions themselves. This meant that these families carried a larger financial burden (¥19582.4 per year = \$2,846.94, currency on 20 August 2018) than families of children with physical disability (¥16410.1 per year = \$2,385.74) or intellectual disability (¥6391.0 per year = \$929.13) (Xiong et al., 2011). This additional cost was incurred in the context of low wages, i.e., according to the recent report by National Bureau of Statistics (2018), in non-rural regions, the average annual disposable income was ¥36,396 per annum (= \$5,291.27) and in rural regions, the average annual disposable income was ¥13,432 per annum (= \$1,952.75).

Discussions

Two systematic reviews were conducted regarding ABA-based interventions in mainland China, one searching for English language papers and the other searching for literature in Chinese language. The current reviews identified 35 empirical studies specifically focusing on ABA-based interventions for children with autism in mainland China. However, this relatively low number of published studies does not mean ABA-based interventions have not been used widely in mainland China. In fact, ABA-based interventions were originally introduced by autism NGOs since 2000s (Zhou et al., 2014), and most Chinese indigenous research was driven by the needs of families rather than professionals and researchers. In addition, a local autism NGO, Shenzhen Autism Society (SAS, 2013) reported that 88.89% of 56 autism organisations across the nation used ABA-based interventions in 2012.

One possible reason for the lack of published empirical research in mainland China is that the ABA-based interventions have been used mainly by therapists and parents at autism organisations rather than researchers at professional institutions. The former typically applied interventions at clinic settings focussed on customers' needs rather than on publishing their work in peer-reviewed journals. The present review identified that some studies mixed the use of ABA-based interventions with other approaches, such as sensory integration, music therapy and language therapy. However, even when these studies were included the number of empirical studies was still less than 100 articles. This is likely due to the fact, that most therapists have few opportunities to receive good quality research training in ABA and this constraints their research abilities in the field.

Another reason may be that, there are few qualified ABA professionals in mainland China, which may result in the reduced quantity of published research articles. Behavior Analyst Certification Board (BACB) provides professional credentialing in the field of behavior analysis internationally. Board Certified Behavior Analysts (BCBAs) and Board Certified Behavior Analysts – Doctoral Level (BCBA-Ds) are graduate-level certificates that have demonstrated competency not only in directing and conducting applied behavior analytic interventions, but also in designing and implementing behavior analytic research (Shook & Neisworth, 2005). However, there are only 22 Board Certified Behavior Analysts (BCBAs), 2 Board Certified Behavior Analysts - Doctoral Level (BCBA-Ds) and 85 Board Certified assistant Behavior Analysts (BCaBAs) in mainland China (BACB, 2019), whereas there are 32,008 BCBAs and 3,437 BCaBAs around the world (BACB, 2019). The first Behavior Analyst Certification Board (BACB, 2019) verified course sequence was established at a Chinese university in 2017.

Results reported here show that the majority of the Chinese researchers believed children's ability improved with ABA-based interventions. Yet, few researchers reported to what extent ABA-based interventions worked and how external and environmental variables influenced their effectiveness. This raises concerns about the validity and reliability of research outcomes. In addition, utilisation of most commonly used instruments by Western researchers (e.g., Eikeseth, Smith, Jahr & Eldevik, 2007; Peters-Scheffer, Didden, Korzilius, & Sturmey, 2010), such as the Vineland Adaptive Behavior Scale (Sparrow, Cicchetti, & Saulnier, 2016), and the Wechsler Intelligence Scale for Children (Wechsler, 1991) to assess effectiveness of the interventions was rather limited in the Chinese papers reviewed here.

These results indicate that ABA-based interventions in mainland China are more about the practical application rather than theoretical exploration and research outputs. In addition, this review reflected a relatively short time of indigenous research on ABA-based interventions in mainland China. Very few studies have explored cultural adapted service delivery (e.g., Xu et al, 2018; Zhou et al., 2018), the efficiency of skill acquisition (e.g., Cariveau, La Cruz Montilla, Gonzalez, & Ball, 2019) and treating problematic behaviors based on experimental verification of different functions of behavior (e.g., Gover, Fahmie, & McKeown, 2019).

Interestingly, one of the main features that became apparent in this review was the importance placed on parental involvement. Findings reported here are consistent with the Shenzhen Autism Society (SAS, 2013) who reported that over half (56%) the founders of organisations that deliver autism interventions were parents of children diagnosed with autism, who wanted to help their own child and others like them. The reason for this intense focus on family is the Chinese culture and policy system. Children's educational development is regarded as one of core characteristics of a successful family in Chinese culture (Huang & Gove, 2012), where parents of children with disability, including children with autism, spent more time and energy on parenting and education than parents of other children (Liao et al., 2018). In addition, the lack of financial support from the authorities and lack of availability of quality professionals focusses caring issues on the family (Wang et al., 2013). Parents, especially those who come from rural areas, either have to take an active role to work as a therapist or move out-of-place of residence to access quality services. Finally, parental training provided participants a platform to share their feelings and improve mental health (Liao et al., 2018, McCabe, 2003, 2013). However, the possible problem of parental involvement is that parents, especially mothers, have to give up jobs to help their children avail of quality treatment services. Parents' quality of life might be influenced (Liao, 2017) and there is a potential for emotional conflict between being a mother and a professional, especially in dealing with problematic behaviors (McCabe, 2007).

Importantly, a lack of systematic understanding of ABA was reflected in many of the studies in this review. For instance, some papers mixed ABA up with other intervention approaches or attributed the effectiveness of ABA-based approaches to something else (Wang, 2016; Xiao & Yu, 2015). Some authors misread the origins of ABA. For example, some researchers stated that it was Lovaas who developed ABA as an intervention for children with autism in the 1970-80s (e.g., Xiong et al. 2010, p.971). This is a widely held

misunderstanding of the history of ABA and autism, even in the West. In fact, ABA is not a ‘therapy for autism’ (Dillenburger & Keenan, 2009) and it was Ferster and colleagues (Ferster & DeMyer, 1961) and Oppenheim (1974) who first explored ABA-based interventions to support children with autism. In addition, single system experimental design studies dominate the field, however, some of the Chinese research still lacked the expected rigour with regards to experimental control, generalisation, or maintenance data (Johnston & Pennypacker, 2010).

Finally, of the most papers included in this review, the term ‘ABA’ was used rather loosely. For example, specific ABA-based interventions (mainly Discrete Trial Teaching; DTT) were used along with other behavioral (e.g., Treatment and Education of Autistic and related Communication handicapped Children; TEACCH), or non-behavioral approaches, such as sensory integration, auditory integration (Wang et al., 2011), music therapy (Zhang, 2005), and pharmacological treatments. However, usually, researchers did not differentiate to which intervention approach the effectiveness of the overall intervention was attributable (McCabe, 2013), and there was little information on how control groups were managed (Clark & Zhou, 2005). This indicates that some of the Chinese researchers or parents regarded ABA as one type of method rather than a science that encompasses a large range of strategies, disciplines and techniques (Cooper, Heron, & Heward, 2007). It is doubtful that most of the ‘ABA’ interventions used in mainland China are truly behavior analytic in nature (Baer, Wolf, & Risley, 1968), because for the most part, ‘ABA’ was used synonymously with DTT (Liao, 2017).

Strengths, limitations and recommendations

To our best knowledge, this is the first systematic literature review that included both English and Chinese papers. The present systematic review reflects the status of ABA-based interventions in mainland China and thus provides practitioners, researchers and policy-makers with a landscape of behavior analytic interventions on children with autism in China.

On the other hand, clearly the review has a number of limitations. While the search focused on published articles regarding autism and ABA in mainland China, grey literature was not searched, thus unpublished research studies such as doctoral or masters level were not included. In addition, the search was conducted before Jan 2018. It is possible that some peer-reviewed articles have been published since then and future researchers are encouraged to replicate this review periodically.

This paper sheds lights on the pressing needs of empirical research and systematic training on behavior analytic interventions on mainland China. These can be achieved in three ways: First, it is recommended that more Chinese universities open behaviour analytic intervention courses, such as the verified course sequence by Behavior Analyst Certification Board (BACB), providing training to students at undergraduate and postgraduate levels. Second, since culturally adapted research is lacking in many areas of science, it is important to explore and compare the application of ABA-based interventions in different cultural contexts. Special education professionals are encouraged to receive systematic research training and to publish data-driven articles of their clinical practice. This may lead not only to a better understanding of behavior change procedures that support clients with autism, but also contribute to the exploration intervention strategies across cultures. Third, books and research instruments require adaptation and validation into the Chinese indigenous cultures. It is imperative to validate more Chinese assessment tools in research and clinical services. For example, the widely used Vineland Adaptive Behavior Scale (Sparrow, Cicchetti, & Saulnier, 2016) is only available in traditional Chinese characters and validated in Taiwan in 1990 (Zhang, Guo, & Wang, 2017). There are very few trainers on mainland China for the Autism Diagnostic Observation Schedule (ADOS), one of the mostly commonly used diagnostic tool in Western hospitals. Therefore, service providers should consider distance training courses or workshops, and invite experts from abroad where no local trainers are available. Last but not the least, parents working as therapist can relieve the shortage of special needs professionals. The awareness of parent training is increasing in mainland China and, given the large geographical area of mainland China, it could be beneficial if tele-health practices were used facilitate parents' hands-on experience (e.g., Dai et al., 2018).

Conclusions

The present study revealed a lack of fundamental knowledge in the science of behavior analysis in mainland China. The review suggests a deficit in theoretical and practical knowledge of ABA by Chinese researchers that was rather concerning. It is imperative for future Chinese researchers to conduct and publish experimental and non-experimental research in a more rigorous and well-designed manner (Pang et al., 2018). In particular, studies on the status of ABA-based interventions and service delivery are encouraged to adopt evidence-based methods by local Chinese policy makers. As these studies become more widespread, they should include evidence for treatment fidelity and

social validity, which would help dispel misinformation surrounding eclectic approaches and guide policy development. Chinese researchers are encouraged not only to replicate the Western model, but also to work on indigenous models that are adapted to the local educational system without distortion of the basic science of behavior analysis.

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Table 1: Breakdown of excluded and included articles at full-text screening level

	Chinese articles	English articles			Total
Excluded articles		Databases search	Additional backward search	Journal search	
Epidemiological study	4	1	-	-	
Overall review	72	2	-	-	
ABA review	20	0	-	-	
Eclectic approach	48	0	-	-	
Other empirical study but not on ABA	1	5	4	-	
Not focused on Mainland China	0	8	-	-	
Total	145	16	4	-	165
Inluded articles	28	2	4	1	35
Sum	173	18	8	1	200

Figure 1: PRISMA chart of English articles

Figure 2: PRISMA chart of Chinese articles

Figure 3 Research trend related to ABA and autism in mainland China

Table 2: Analysis of articles included in systematic reviews

Year	Authors	Location	Measurement tools	Participants	Outcomes	Research method	Diagnosis	Length of program
2018	Xu et al.	South east China	PEP-3; CARS	N=36; 16 boys, in experiment group (age= 47.5 mo); 20 children (18 boys and 2 girls) in control group (e age= 42.9 mo)	Decrease in autism symptoms and improved severity categorization	Within- and between-group design.	CARS & DSM-5	8 weeks (1 hr per day; 5 hrs per week)
2018	Liao, Dillenburg er & Buchanan	A city at Northern Ireland; Beijing and a city at Southern China	Self-administered interviews	N=15 10 professionals and 5 parents (age unknown)	Application of behavior analysis services vary widely across cultures	Semi-structured interview	N/A	N/A
2017	Xu, Yao & Yang	Hangzhou & Xiamen/ East coast of China	CARS	N=36 16 children (15 boys and 1 girl) in experiment; 20 children (19 boys and 1 girl) in control	Improved social interaction, communication and emotional expression.	Within- and between-group design.	CARS & DSM-5	8 weeks (80 sessions)

2017	Lee, Feng, Xu, & Jin	Central China	Child: Behavioral observation	N=5 4 boys and one girl (3-6 years of age)	Improved object-substitution symbolic play skills	Multiple probe design	(ADOS-2; Lord et al., 2012) and DSM-5; ADOS-2 and DSM-IV (APA, 1994).	1 hr per day, four days per week. Duration not reported
2017	Xu, Wang, Lee & Luke	Western China/ An inland city	Child: Behavioral observation* *	A 9 year-old boy	Increased academic engagement	Changing criterion design	CARS & WISC-IV (Wechsler, 2003)	29 15-minutes sessions
2017	Ma*	Inner Mongolia	Child: PEP-3	A 10.83 year-old boy	Reduced inappropriate behavior	Single case study, only baseline data, no intervention data.	N/R	23 days
2017	He	Nanchang city, Jiangxi province/ Southern China	Child: Behavioral observation	5 children (other informationa unknown)	ABA-based intervention helps improve children's emotional behavior.	Case study without quantitative data	N/R	3-12 months
2017	Zheng & Li	NR	Child: Behavioral observation	A 10 year-old child	The combination of PECS and DTT reduced child's maladaptive	Experiment al design: Single case design, A-B-A design	Self - administrator ed assessment tool and diagnosis	20 days (twice a day, 30 min per training session)

					behavior and increased child's demand behavior		confirmed by a hospital	
2017	Shen	Guangxi	Child: Behavior observation	A 7 year-old boy	Reduced inappropriate behavior	Single case reversal design, ABAB	N/R	13 weeks
2016	Hu, Chen & Zhen	Beijing/Northern China	Child: Behavioral observation	A 4 year-old boy	Improved structured play and joint attention	A-B-A-B design	An authoritative hospital	21 days
2016	Hu, Liu, Fan & Zhen	Beijing/Northern China	Child: Behavioral observation; WPPSI-R (participant selection)	Two 5.6 year-old boy and one 5 year old girl	Speech-generative device to improve speech	Multiple baseline design	An authoritative hospital & WPPSI-R	38 trials on average (10 min per trial per day)
2016	Wang L.*	A city at Hebei province/ North-central China	Child: CARS; ATEC (Lu, Yang, Shu, & Su, 2004); Autism Child Development Assessment Form (China Disabled Persons' Federation, 2009)	3 children reported between 1-6 year-old	Pivotal Response Training is effective for children with autism	Reported as empirical study by the author: Multiple baseline design across participants though quantitative data was not shown	Chinese Classification of Mental Diseases, 3rd (CCMD-3, Chen, 2002)	1.5 month

2016	Zhong	Heilongjiang province/ North-eastern China	Child: Behavioral observation	A 11 year-old boy	Aggressive behavior reduced	Case study without quantitative data	N/R	3 months
2016	Wang	Guanghzou, Guangdong province/ Southern China	Child: Behavior observation	A 10 year-old child	Disruptive behavior reduced	Single case study, ABA design	N/R, only mentioned diagnosed by a hospital	20 days
2016	Han*	Chongqing city/South-western China	Child: Behavioral observation	A 10 year-old boy	Disruptive behavior at classroom reduced	Case studies without quantitative data	N/R	NR
2016	Huo, Liu & Hu	Beijing/Nonrthern China	Child: Behavioral observation	Three 7.33 year-old boy (Gender not reported)	Facial expression recognition improved	Single case study (ABA design)	NR	More than 51 classes across several months (Length not reported)
2016	Ma, Cui & Zhang*	Ningxia/An autonomous region in North-central China	Child: ABC assessment	N=90 68 boys and 22 girls (Age: 2.3±1.6)	Language ability, independent living skill, social communication, physical activity and cognitive ability improved	Within group design	DSM-IV	NR

2016	Qian*	Shanghai/ Eastern China	Child: Behavior observation	One 8 year-old boy	language expressions improved	Single case study, ABA design	Wechsler Intelligence Test and Childhood Development al Assessment (WPPSI)	20 sessions (35 min/sessio n, 3 times per week)
2015	Hu, Xu, Xu, & Feng	Chongqing city/South- eastern China	Child: Reported IQ score but did not mention the exact measurement tool; Self- administered Curriculum Assessment Tool on Children with Autism	Three 6.8 year-old boys	Students progressed	Multiple baseline design across subjects (ABA design)	N/R	Two case undertook 11 week and the other case undertook 9 weeks
2015	Ding, Zhong, Cheng, & Jiang	City unkown, Hunan province/ Southern China	Parents: The Pediatric Quality of Life Inventory Measurement Models, (PedsQL™ , Lu Tian, Hao, Jing, Lin, Huang, 2008)	N=132 58 boys and 8 girls (average age: 2.9±1.5) in experiment group; 58 boys and 8 girls in control group (average age:3.1±1.3).	Children have poor quality of life; ABA improves child's quality of life	Within group design and between- group design	DSM-IV	3 months

2015	Xiao & Yu	Guangzhou, Guangdong province/ Southern China	Child: Behavior observation	A 11 year-old	Disruptive behavior reduced	Single case design, ABA design	N/R, only mentioned diagnosed by a hospital	12 weeks
2014	Zhou, Ye, Sun, Tian, Pu, Wu, Wang, Zhao, Lu, Yang & Wei	Beijing/ Northern China	NR	N=2,222 (gender unknown, 6 years of age and under); 100-member centres of Heart Alliance Autism Network	Increased number of hospitals making ASD diagnoses; increased service centers between 1993 and 2012; Average age of first autism diagnosis decreased; limited number of hospitals and intervention centers in under-developed regions.	Empirical study: Students' registration data and survey	ADI-R/DSM-IV-TR	NR
2014	Hu & Fan	Beijing/ Northern China	Child: WPPSI-R; PEP-3	A 4.25 year-old boy	Child's mand behavior improved and aggressive behavior decreased	Multiple baseline design across settings, AB design	N/R	3 months

2014	Shao, Xu & Zhang	Chongqing city/ West-southern China	Child: Behavioral observation	A 2.5 year-old boy	Communicati on skills improved	Case study without quantitative data	N/R	One year, one hour per week, 4 times per week
2013	Duan & Niu*	City unkown, Henan province/ Northern China	Child: The Autism Behavior Checklist (ABC)	N=48 26 boys and 22 girls (average age 5.9±1.3)	Sensory issues, social communicatio n, physical activity, language ability and self- independent skills improved	Within group design	N/R	6 months
2013	Zhu*	Hangzhou, Zhejiang province/ Eastern China	Child: Behavioral observation	One 7.41 year-old boy	Food selective behavior improved	Case study without quantitative data	N/R	10 months
2012	Liu & Chen	Quanzhou city, Fujian province/ South-eastern China	No validated measurement tool	N=41 36 boys and 5 girls (Age range: 2.5-5 years)	Language ability improved	Within group design	Chinese Classification of Mental Diseases, 3 rd (CCMD-3, Chen, 2002),	1 year
2012	Yang, Zhu & Cao	NR	Child: Behavior observation	one 5 year-old boy	Seat-leaving behavior reduced	Single case design, ABAB reversal design	N/R	7 weeks

2011	Sun & Wei	Beijing/ Northern China	Child: Behavior observations (include FBA)	11 year-old boy and a 12 year-old boy	Self-injury behavior reduced	single case design, AB design	An authorative hospital	One with 22 days and the other 14 days
2010	Xiong et al.	Beijing/ Northern China	Parents: Hospital Anxiety and Depression Scale (HADS, Barczak, Kane, Andrews, Congdon, Clay, & Betts, 1988); Child: ABC scale	N=76 Gener and age unknown	Children's sense ability, social ability, movement ability, speech ability and self-care ability improved significantly; Mothers' anxiety and depression not improve	Experiment al design: Within group design	DSM-III	10 weeks
2008	Wang	Shenyang city, Liaoning province /North-eastern China	Child: PEP- R (Schopler, Reichler, Bashford, Lansing, & Marcus, 1990), CARS	N=27 15 parents (average age: Father's, 34.53 years old; mother's, 33.4 years old) in the experiment group; 12 families in the control group (average age: father's, 34.92;	More appropriated responses to child's behavior; More acceptable of child; More engagement play with children	Experiment al design: Within group design and between- group design	N/R	20 h across a span of four weeks (16 hrs group training and 4 hrs individual home visits)

				mothers 33.5 years old) Child: 15 children (average age: 67.3 months) in experiment and 12 children (average age: 69.3 months) in control group				
2008	Zou et al.	Nangjing city, Jiangsu province/Easter n China	Child: CARS; Portage Early Education Behavior Checklist (Bluma, 1992)	N=135 51 children trained by parents (44 boys and 5 girls, age range: 23-106 months, 52+-17) ; 79 children (68 boys and 11 girls, age range: 24-116 months, 37+-6) trained by professionals	Parents' DTT implementation strategies improved after professional training; Children from both groups showed changes in socialization, self-help, language, cognitive, and motor development.	Within group design and between-group design	DSM-IV	3 months
2007	Shi, Yu, Guo & Li	Tianjin/Northern China	Child: Gesell Development Assessment (Gesell, 1925), CARS	N=85 75 boys and 10 girls (Average: 3.67 years old)	60% of children entered mainstream school.	Within group design	DSM-IV	3 -12 months depends on

								individuals ' ability
2006	Guo	Beijing/ Northern China	NR	N=129 parents Gender and age unkown	Better understanding of child's problematic behaviors; better ways of educating children; More cooperative with professionals	Empirical study witout quantitative data	N/R	3 months
2006	Guo, Liu & Du *	Shenyang city, Liaoning province/North- eastern China	Children's exam grades reported by parents	N=64 51 boys and 13 girls (average age 10.6 years old)	language, social communicatio n, social recoginition improved	Qualitative interview	Chinese Classification of Mental Diseases, 3 rd (CCMD-3, Chen, 2002)	Follow up study on ABA training for 2-4 years

* Title of articles was translated by the first author because articles do not have an Enligsh title.

**Behavior observations are typically using single-system designs (Hichcock, Kratochwill, & Chezan, 2015). Direct observation of ABC data (antecient, A; behavior, B and consequence, C) and Funcitonal Behaivour Assessment (FBA) were commonly types of behavior observations as of reported in this table.

Table 3 Quality of research of single case design studies

Year	Authors	Study design	(a)	(b)	(c)	Study Rating Determinants for Single-Case Designs
2017	Lee, Feng, Xu & Jin	Multiple probe design	✓	✓	✓	Meets WWC Pilot Single-Case Design Standards without Reservations
2017	Xu, Wang, Lee & Luke	Changing criterion design	✓	✓	✗	Does Not Meet WWC Pilot Single-Case Design Standards
2017	Zhen & Li	ABA design	✓	✗	✗	Does Not Meet WWC Pilot Single-Case Design Standards
2017	Shen	ABAB design	✓	✗	✓	Meets WWC Pilot Single-Case Design Standards without Reservations
2016	Hu, Chen & Zhen	ABAB design	✓	✓	With reservation	Meets WWC Pilot Single-Case Design Standards with Reservations
2016	Hu, Liu, Fan & Zhen	Multiple baseline design	✓	✓	✓	Meets WWC Pilot Single-Case Design Standards without Reservations
2016	Wang	ABA design	✓	✗	✗	Does Not Meet WWC Pilot Single-Case Design Standards
2016	Huo, Liu & Hu	ABA design	✓	✓	✗	Does Not Meet WWC Pilot Single-Case Design Standards

2016	Qian	ABA design	✓	✗	✗	Does Not Meet WWC Pilot Single-Case Design Standards
2015	Hu et al.	Multiple probe design	✓	✗	✗	Does Not Meet WWC Pilot Single-Case Design Standards
2015	Xiao & Yu	ABA design	✓	✓	✗	Does Not Meet WWC Pilot Single-Case Design Standards
2014	Hu & Fan	Multiple baseline design	✓	✓	✓	Meets WWC Pilot Single-Case Design Standards without Reservations
2012	Yang, Zhu & Cao	ABAB design	✓	✓	With reservation	Meets WWC Pilot Single-Case Design Standards with Reservations
2011	Sun & Wei	AB design	✓	✗	✗	Does Not Meet WWC Pilot Single-Case Design Standards

Appendix 1: Search terms of reviews

No.	Databases	Search terms	Records
1	ERIC	TX (autis* OR PDD OR “pervasive developmental disorder*” OR “pervasive developmental delay*” OR “pervasive developmental 47sperger47y*” OR “global developmental delay*” OR 47sperger* OR ASD OR HFA OR HFASD OR HF-ASD OR Rett* OR “childhood disintegrative disorder*” OR “triad of impairments” OR “Fragile X” OR PDDNOS OR PDD-NOS OR PDD/NOS OR savant OR “reactive attachment disorder*” OR AS/HFA OR Kanner* OR aspies OR “childhood schizophrenia” OR “atypical personality development”) AND (“early intensive behavio* intervention” OR EIBI OR “comprehensive ABA-based early intervention” OR “intensive behavio* intervention” OR “early behavio* intervention”OR “early applie* behavio* intervention” OR “applied behavio* analysis” OR ABA OR “applied behavio* analysis” OR “ABA-based intervention” OR “behavio* analysis” OR “behavio* intervention” OR “behavio* treatment*”) AND (China OR Chinese OR “P.R.C.” OR “People’s Republic of China” OR “China” OR “Hong Kong” OR “Moocow”)	4
2	Web of Science	TOPIC: (autis* OR PDD OR “pervasive developmental disorder*” OR “pervasive developmental delay*” OR “pervasive developmental 47sperger47y*” OR “global developmental delay*” OR 47sperger* OR ASD OR HFA OR HFASD OR HF-ASD OR Rett* OR “childhood disintegrative disorder*” OR “triad of impairments” OR “Fragile X” OR PDDNOS OR PDD-NOS OR PDD/NOS OR savant OR “reactive attachment disorder*” OR AS/HFA OR Kanner* OR aspies OR “childhood schizophrenia” OR “atypical personality development”) <i>AND</i> TOPIC: (“early intensive 47sperger* intervention” OR EIBI OR “comprehensive ABA-based early intervention” OR “intensive 47sperger* intervention” OR “early 47sperger* intervention”OR “early applie* 47sperger* intervention” OR “applied 47sperger* analysis” OR ABA OR “applied 47sperger* analysis” OR “ABA-based intervention” OR “47sperger* analysis” OR “47sperger* intervention” OR “47sperger* treatment*”) <i>AND</i> TOPIC: (China OR Chinese OR “P.R.C.” OR “People’s Republic of China” OR “China” OR “Hong Kong” OR “Moocow”) Refined by: DOCUMENT TYPES: (ARTICLE) Timespan: All years.	18

3	ProQuest Education Journals	AB(autis* OR PDD OR “pervasive developmental disorder*” OR “pervasive developmental delay*” OR “pervasive developmental 48sperger48y*” OR “global developmental delay*” OR 48sperger* OR ASD OR HFA OR HFASD OR HF-ASD OR Rett* OR “childhood disintegrative disorder*” OR “triad of impairments” OR “Fragile X” OR PDDNOS OR PDD-NOS OR PDD/NOS OR savant OR “reactive attachment disorder*” OR AS/HFA OR Kanner* OR aspies OR “childhood schizophrenia” OR “atypical personality development”) AND (“early intensive behavio* intervention” OR EIBI OR “comprehensive ABA-based early intervention” OR “intensive behavio* intervention” OR “early behavio* intervention” OR “early applie* behavio* intervention” OR “applied behavio* analysis” OR ABA OR “applied behavio* analysis” OR “ABA-based intervention” OR “behavio* analysis” OR “behavio* intervention” OR “behavio* treatment*”) AND (China OR Chinese OR “P.R.C.” OR “People’s Republic of China” OR “China” OR “Hong Kong” OR “Moocow”)	86
4	SCOPUS	ALL FIELD (autis* OR pdd OR “pervasive developmental disorder*” OR “pervasive developmental delay*” OR “pervasive developmental 48sperger48y*” OR “global developmental delay*” OR 48sperger* OR asd OR hfa OR hfasd OR hf-asd OR rett* OR “childhood disintegrative disorder*” OR “triad of impairments” OR “Fragile X” OR pddnos OR pdd-nos OR pdd/nos OR savant OR “reactive attachment disorder*” OR as/hfa OR kanner* OR aspies OR “childhood schizophrenia” OR “atypical personality development” AND “early intensive behavio* intervention” OR eibi OR “comprehensive ABA-based early intervention” OR “intensive behavio* intervention” OR “early behavio* intervention” OR “early applie* behavio* intervention” OR “applied behavio* analysis” OR aba OR “applied behavio* analysis” OR “ABA-based intervention” OR “behavio* analysis” OR “behavio* intervention” OR “behavio* treatment*” AND china OR 48sperge OR “P.R.C.” OR “People’s Republic of China” OR “China” OR “Hong Kong” OR “Moocow” AND (LIMIT-TO (DOCTYPE , “ar”)) AND (LIMIT-TO (LANGUAGE , “English”)) AND (LIMIT-TO (SRCTYPE , “j”)) AND (LIMIT-TO (SUBJAREA , “PSYC”) OR LIMIT-TO (SUBJAREA , “SOCI”))	38
5	PubMed	((autis*[Title/Abstract] OR PDD[Title/Abstract] OR “pervasive developmental disorder”[Title/Abstract] OR “pervasive developmental delay”[Title/Abstract] OR “pervasive developmental 48sperger48y”[Title/Abstract] OR “global developmental delay”[Title/Abstract] OR 48sperger*[Title/Abstract] OR ASD[Title/Abstract] OR HFA[Title/Abstract] OR HFASD[Title/Abstract] OR HF-ASD[Title/Abstract] OR Rett*[Title/Abstract] OR “childhood disintegrative disorder”[Title/Abstract] OR “triad of impairments”[Title/Abstract] OR “Fragile X”[Title/Abstract] OR PDDNOS[Title/Abstract] OR PDD-NOS[Title/Abstract] OR PDD/NOS[Title/Abstract] OR savant[Title/Abstract] OR “reactive attachment disorder”[Title/Abstract] OR AS/HFA[Title/Abstract]	15

		OR Kanner*[Title/Abstract] OR aspies[Title/Abstract] OR “childhood schizophrenia”[Title/Abstract] OR “atypical personality development”[Title/Abstract])) AND (“early intensive behavior* intervention”[Title/Abstract] OR EIBI[Title/Abstract] OR “comprehensive ABA-based early intervention”[Title/Abstract] OR “intensive behavior* intervention”[Title/Abstract] OR “early behavior* intervention”OR “early applied* behavior* intervention”[Title/Abstract] OR “applied behavior* analysis”[Title/Abstract] OR ABA[Title/Abstract] OR “applied behavior* analysis”[Title/Abstract] OR “ABA-based intervention”[Title/Abstract] OR “behavior* analysis”[Title/Abstract] OR “behavior* intervention”[Title/Abstract] OR “behavior* treatment*”[Title/Abstract])) AND (China[Title/Abstract] OR Chinese[Title/Abstract] OR “P.R.C.”[Title/Abstract] OR “People’s Republic of China”[Title/Abstract] OR “China”[Title/Abstract] OR “Hong Kong”[Title/Abstract] OR “Moocow”[Title/Abstract]))	
6	16 Journal Search*	All field (autism AND China)	112
7	CKNI (知网)	Title (自闭症 OR 孤独症) and (应用行为分析 OR ABA)	653
8	VIP (维普)	任意字段 (自闭症 OR 孤独症) and (应用行为分析)	154
9	WANFANG DATA (万方)	摘要(自闭症 OR 孤独症) and (应用行为分析)	82
Total			1,162

Note: No.1-No.5 are terms for English language databases; No. 6 are terms for journal searches; No.7-No.9 are terms for Chinese language databases.

*16 journals including: including *Journal of Applied Behavior Analysis*, *Journal of Early and Intensive Behavior Intervention*, *Analysis of Verbal Behavior*, *Journal of the Experimental Analysis of Behavior*, *Behavior Analysis in Practice*, *European Journal of Behavior Analysis*, *Behavior analyst*, *Behavioral Interventions*, *Behavior Analyst Today*, *Journal of Positive Behavior Interventions*, and *Behavior and Philosophy*. *Behavior Modification*, *Research in Autism Spectrum Disorder*, *Research in Developmental Disabilities*, *Research and Practice for Persons with Severe Disabilities*, *Journal of Autism and Developmental Disorder*.