Approaches and Strategies in Applied Behavior Analysis for Children with Autism Spectrum Disorder

Otizm Spektrum Bozukluğu Olan Çocuklar İçin Uygulamalı Davranış Analizinde Yaklaşımlar ve Stratejiler

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ABSTRACT

The main goal of applied behaviour analysis is to increase behaviours that are positive and helpful and decrease behaviours that affect learning negatively or are harmful. Behaviour analysis has been studied and used for decades and it has been shown that its methods can help many kinds of learners gain different skills. Therapists have been using applied behaviour analysis to help children with autism spectrum disorder and other related developmental disorders for a long time. Applied behaviour analysis can be adapted to meet the needs of each child and also be provided in different environments like school, home, and community. It can involve one-to-one teaching or group instruction and is effective at teaching skills useful in everyday life. In this paper, firstly approaches and strategies used to implement applied behaviour analysis on children with autism spectrum disorder are presented. Then, challenges related to these and emerging opportunities and software applications serving for applied behaviour analysis are reviewed. Finally, future research directions are presented.
Keywords: Autism spectrum disorder, applied behaviour analysis, software applications

ÖZ

Uygulamalı davranış analizinin temel hedefi, olumlu ve faydalı davranışları artırmak, öğrenmeyi olumsuz etkileyen veya zararlı davranışları azaltmaktır. Davranış analizi onlarca yıldır araştırılmış ve kullanılmıştır ve yöntemlerinin birçok türden öğrencinin farklı beceriler kazanmasına yardımcı olabileceği gösterilmiştir. Terapistler, otizm spektrum bozukluğu ve diğer ilgili gelişimsel bozuklukları olan çocuklara yardımcı olmak için uzun süredir uygulamalı davranış analizi kullanmaktadır. Uygulamalı davranış analizi, her çocuğun ihtiyaçlarını karşılayacak şekilde uyarlanabilir ve ayrıca okul, ev ve toplum gibi farklı ortamlarda da sağlanabilir. Bire bir öğretimi veya grup öğretimini içerebilir ve günlük yaşamda yararlı olan becerileri öğretmede etkilidir. Bu makalede, öncelikle otizm spektrum bozukluğu olan çocuklara uygulamalı davranış analizi uygulamak için kullanılan yaklaşımlar ve stratejiler sunulmaktadır. Daha sonra bunlarla ilgili zorluklar ve ortaya çıkan fırsatlar ve uygulamalı davranış analizine hizmet eden yazılım uygulamaları gözden geçirilmektedir. Son olarak, gelecekteki araştırma yönleri ortaya konmaktadır.
Anahtar sözcükler: Otizm spektrum bozukluğu, uygulamalı davranış analizi, yazılım uygulamaları

Introduction

Behaviour analysis is carried out to understand how behaviour works, how the environment affects behaviour and how learning process takes place (Overskeid 2018). Applied behaviour analysis (ABA) is a method of studying and managing behaviour to bring about change (APA 2017). It relies on applying different techniques based on learning principles to change behaviour. ABA therapies aim to understand and change behaviour, this way they can help to decrease problem behaviours, improve social skills, focus, attention, memory, and academic skills, and increase language and communication skills (Lovaas 1987). ABA therapists collect and analyse data based on careful observation of learner behaviour and then design behaviour intervention plans to reduce problem behaviours in children (National Center on Intensive Intervention 2023). ABA can be provided in different settings and be tailored to meet the needs of each unique person (da Silva et al. 2023). ABA programs first clarify what happens before behaviour occurs (antecedent(s)) and what happens after the behaviour (consequence(s)) (Meadan et al. 2016). An antecedent can be verbal or physical, and may be internal or come from another person or the environment (Morrison et al. 2011). After an antecedent, the person can take an action, give a verbal response or does something else. Then, ABA therapists apply different strategies, such as positive reinforcement

of the desired behaviour, or no reaction for incorrect or inappropriate responses to achieve meaningful behaviour change after an antecedent (DeLeon et al. 2001). Positive reinforcement is one of the most common strategies that ABA therapies rely on. It relies on a well-known fact that if a person's behaviour or skill is followed by a reward, the person is more likely to continue using that behaviour or skill (Johnston et al. 2006). Gradually, this approach encourages positive behaviour change.

ABA applications have been found useful for different conditions or disorders such as Dementia, cognitive impairment, borderline personality disorders, Autism spectrum disorder (ASD), anxiety disorders, anger issues, substance abuse, and eating disorders (Slocum et al. 2014). ABA involves analysing the dynamics between a person's behaviour and his/her environment, with the goal of helping him/her develop socially acceptable alternatives to problem behaviours (Slocum et al. 2014). ABA is widely used in special education (Newcomb and Hagopian 2018), because children with various learning disabilities may also have behaviour disorders or problems (Simonoff 2005), such as attention-deficit hyperactivity disorder, and such kind of disorders or problems can lead them to be disruptive at home, at school, or in their interactions with peers and friends (Ogundele 2018). Children without disabilities may benefit from behaviour analysis, too.

This paper presents approaches and strategies used to implement ABA on children with ASD. In addition, it reviews challenges, opportunities, and future research directions in this domain. The rest of this paper is organised as follows. The following section presents information about ABA. Section 3 reviews the use of ABA for children with ASD and presents approaches and strategies used in this. Section 4 presents challenges and opportunities, and reports future research directions in the use of ABA for children with ASD. Finally, this paper is concluded in Section 5.

ABA Techniques

An ABA process relies on various psychological assessments and techniques with the goal of helping an individual acquire skills he/she can apply to modify certain behaviours (Smith 2013). Antecedent, behaviour, consequence (ABC), positive reinforcement, negative reinforcement, fading, generalisation, and analysis of actions are most popular ABA techniques (Moore 2023).

1. ABC: This technique helps to find out how a specific behaviour manifests and understand its effects (Eckert et al., 2005). What happens just before the behaviour that needs to change, the antecedent, is identified by using this technique (Autism Speaks 2023). By this way why the behaviour takes place can be explained. Then the behaviour and the consequences of the behaviour are identified. After the key components of the behaviour are understood, it needs to be determined how the person can change patterns (Eckert et al. 2005). Typical strategy here is to replace the natural behaviour with a different type of behaviour (Johnston 2006).

2. Positive Reinforcement: It is known that when a person's particular action of behaviour is followed by a reward, the person is more likely to repeat the action of behaviour (Hilgard and Bower 1966). After a while, even when the reward is removed, the person will possibly repeat it, due to the fact that he/she begins to associate that specific behaviour with the reward even when it is not present (Morris et al. 2005). In time, this technique can cause considerable change in the person's behaviour.

3. Negative Reinforcement: This technique relies on approaches such as time-out or not allowing doing something the person typically likes doing (Iwata 1987). When the person fails to act desirably, something favourable is removed from the person's environment. This way, the person is motivated to learn faster and achieve the desired results to get back the reward (Moore 2023).

4. Fading: This technique is generally utilised for individuals with acute mood or impulse control disorders (Oliver et al. 1998). It is also used for some types of ASD. The therapist probes the person with ASD to unlearn an adverse behaviour and replace it with the positive one (Schlichenmeyer et al. 2015).

5. Generalisation: This technique uses rules that are mostly successful in all situations and is proved to help children learn faster. It works outstandingly well for children with ASD (Wong et al. 2007), because it minimises the effort of learning while maximising its effects.

6. Analysis of Actions: Based on feedbacks from the person with ASD and parents, this technique evaluates how efficient therapy and assessments are (Parsonson 2012), and then at each step of the therapy it reviews the progress.

ABA Principles

As developed by Baer et al. (1968), ABA has seven key principles. The first one is ABA treatment is an applied one. Its clear goal is to help a person change his/her incorrect or inappropriate behaviour for his/her benefit (Helton and Alber-Morgan 2018). Therefore, it is applied to understand why a person has been doing the behaviour, and then determine what is needed to modify it. The second one is that ABA is behavioural-based. It mainly focuses on the characteristics of a person's behaviour; therefore, the behaviour must always be analysed by correlating with the social environment of a person in order to find out what the negative impact of this behaviour is (BACB 2014).

The third one is that ABA is analytic. Because it relies on understanding how the behavioural patterns demonstrated affect a person, and figuring out how they can be changed. Therefore, in order to control its effects, there is a need to measure the behavioural change reliably (LeBlanc et al. 2015). The fourth one is that ABA is technological. Everything in an ABA process must be explicitly defined (Ponticorvo et al. 2020). In this way, all professionals can understand and apply it in different settings. The fifth one is that ABA should not be viewed as an intervention leading to change or at least shift a specific behavioural pattern. Instead, it should be conceptually systematic (LeBlanc et al. 2015).

The sixth one is that it must be evident that an ABA therapy is effective and leads to improvement in a person's life after it has been applied (Johnston et al. 2006). Finally, ABA treatment should be generalisable. Even when the environment setting of a person is changed, the change in behaviour must be permanent and sustainable.

Additionally, Heward (2005) suggested five potentially new characteristics to be added to ABA. The first one is that ABA should be accountable. Based on repeated measures of success, it must be demonstrated that its methods are effective (Denne et al. 2015). The second one is that the results of ABA interventions must be fully and freely accessible by researchers. They must be public. The third one is that any ABA intervention should be feasible. ABA interventions must be fairly easy to be implemented on people who need them (Helton and Alber-Morgan 2018). The fourth one is that ABA should be empowering. ABA interventions should be encouraging and their effectiveness should be provided to its practitioners with feedback (Leaf et al. 2022). The last principle is that ABA is optimistic. As ABA interventions are not also important for individuals themselves but also for society. When all of these characteristics are considered, it can be seen that although ABA relies on a set of criteria, therapists can easily adapt its practices and methods to meet each individual's requirements. In addition, they can apply ABA interventions in different settings.

ABA for ASD and Common Approaches Used in Interventions

An ABA program is designed and directly supervised by a qualified and trained behaviour analyst. It is customised so that it fits to each learner's needs, skills, preferences, interests, and family situation. Therefore, first, each learner's skills and preferences are assessed in detail. Then, based on this assessment and including family goals and preferences, specific treatment goals are identified. Families with a child diagnosed with ASD have a lot of challenges, most of which can be addressed through timely, appropriate intervention (Hus and Segal 2021). For children with ASD, ABA can play a significant role in teaching skills that they will need in their lives (Rojas-Torres et al. 2020). Although ABA can be applied as group instruction, for children with ASD, it is generally applied as one-to-one teaching (Tanet et al. 2016). ABA programs designed for ASD are prepared based on the needs of each learner (Gitimoghaddam et al. 2022). The aim of this approach is to help each child work on skills they will need to become more independent and successful, not only in short term but also in the future.

Treatment goals are defined based on the age and ability level of the person with ASD and can focus on one or more different skills such as communication and language, social, motor, learning and academic, self-care, and play and leisure (Aishworiya et al. 2022). Each of these skills is broken down into small, concrete steps and an instruction plan is prepared. Each step of the plan is taught one by one, from simple ones to more complex ones. In each session, the analyst and therapists measure the person's progress by collecting data. The analyst regularly arranges meetings with parents and other family members and program staff so that information about progress can be reviewed timely. Then, teaching plans are made for the future and the plans and goals are adjusted whenever needed.

When an ABA program has been started, the person with ASD has got a lot of opportunities to learn and practice various skills each day in both naturally occurring and planned situations. During the sessions, enjoyable learning and positive social interactions are created and the learner receives a lot of positive reinforcement for demonstrating positive and/or socially appropriate behaviours and useful skills (Tarbox et al. 2020). The learner does not receive any reinforcement for behaviours that are harmful or prevent learning. ABA therapists may also

demonstrate desired behaviours to children. Typically, parents are also involved in an ABA therapy and encouraged to use it at home (Dennison et al. 2019) so that consistent behavioural intervention is created between school and home.

ABA is accepted as a data-driven treatment approach and therapists deliver several hours of individual ABA treatment per week to reinforce developmentally appropriate behaviours and reduce inappropriate ones interfering with learning (Pagliaro 2023). Throughout the sessions, the therapists collect data that is helpful for refining teaching techniques and optimising the learner's progress. It was shown that early intensive behavioural intervention provided by ABA treatment can considerably improve developmental outcomes in young children with ASD (Reichow et al. 2018). Children who received early intensive behavioural intervention demonstrated significant improvements in IQ, language and adaptive behaviour compared to those who received standard alternative interventions or community care (Reichow et al. 2018). As presented in (Dillenburger et al. 2012), a study of parental and professional experiences was carried out in relation to two different settings: (i) schools that provided intensive ABA based interventions, and (ii) non-intensive ABA-based home programs. As the results given in (Dillenburger et al. 2012) demontstrated, parents whose children attend ABA-based schools were generally more satisfied with their child's educational provision and monitoring procedures than parents who were not offered ABA-based education in schools.

There are some controversies surrounding ABA's applications for children with ASD. Nevertheless, these controversies have more to do with how ABA is used by some practitioners, less with it as a form of therapy. These controversies mostly come from a practice called "punishment" (Leaf et al. 2022). It was a common practice in the past but in recent years it has been generally abandoned by ABA therapists. However, some commonly used ABA strategies used on children with ASD may seem too harsh in certain conditions (Shkedy et al. 2021), as they rely on a lot of repetition without any flexibility. For instance, if positive reinforcement is preferred, its practices must be applied in spite of what the child wants even if the child refuses to. On the other hand, most positive reinforcement therapies are play-based and focus on stimulating the child in addition to teaching positive behaviours (Hardy and McLeod 2020).

Discrete Trial Training

Discrete trial training (DTT) is possibly the most common approach used in ABA for early intervention. It focuses on pre-academic tasks of matching, sequencing, and categorising (Kasari et al. 2018). It also focuses on language skills, especially in verbal and receptive labels. Nevertheless, it does not consider gestures and play as important targets of early intervention (Kasari et al. 2018). Even if DTT is properly applied for many hours per week over several years, it was shown that 30% of children with ASD improve their skills considerably, but 50% of them make only moderate gains and 20% of them do not make any developmental gain (Eldevik et al. 2010). DTT offers less gain in social communication and spoken language compared to cognitive domains (Smith et al. 2000). Although DTT is beneficial for some target specific skills, it cannot address all core deficits of children with ASD (Kasari et al. 2018).

Functional Behaviour Assessment

ABA-based interventions designed for individuals with ASD typically rely on functional behaviour assessment and behaviour intervention plans (O'Neill et al. 2014; Fennell and Dillenburger 2018). The most commonly used behaviour analytic, evidence-based intervention package for individuals with ASD is positive behaviour support (Horner et al. 2002). Functional communication training (FCT) is a proven methodology to address communication problems (Battaglia 2017). It relies on shaping procedures to build appropriate communication repertoires, thereby eliminating the need for non-functional communication efforts (Carr and Durand, 1985). Another approach used to improve functional communication in individuals with ASD is picture exchange communication systems (Charlop-Christy 2002). Pivotal response training (PRT) is a verbal response prompting methodology for teaching communication skills to learners with ASD (Koegel et al. 1987). When these approaches are applied together consistently, individuals with ASD can improve their vocal and/or verbal communication skills (Schreibman and Stahmer 2014).

Challenges, Opportunities and Future Research Directions

Challenges

Although early intervention based on ABA is widely accepted as an effective treatment strategy for children with

ASD (Eikeseth et al. 2009) and generally results in improved cognitive, communication and social skills and improvements in challenging behaviour(s) of most children with ASD, great variability in outcome is seen (Choi et al. 2022). While some children with ASD make rapid and significant progress, other children's gains are limited (Eikeseth et al. 2009, Peters-Scheffer et al. 2012). In addition, both overprescribing and underprescribing ABA services are equally concerning (Pagliaro 2023). But it is long-term economically advantageous to avoid underprescription of ABA services, particularly for very young children with ASD (Jacobson et al. 1998; Peters-Scheffer et al. 2011).

Effective treatment of ASD cannot be realised without efficient, reliable and careful behavioural observations done by trained ABA practitioners, therapists or clinicians. Nevertheless, this requires collecting and analysing data, identifying the problem behaviours, conducting pattern analysis to categorise and predict categorical outcomes, hypothesising responsiveness to treatments, and detecting the effects of treatment plans. Considering the advantages offered by digital technologies, Ghafghazi et al. (2021) proposed an Artificial Intelligence-Augmented Learning and Applied Behavior Analytics (AI-ABA) platform to provide personalised treatment and learning programs to individuals with ASD and other intellectual and developmental disabilities. They proved that employing reinforcement-based virtual or augmented reality platforms AI-ABA can promote self-regulative behaviour and could help clinicians focus on increasing the quality of individualised interventions and making good data-driven decisions. The proposed approach can also be realised using mobile platforms.

Opportunities

It is widely accepted that for young children with ASD intensive intervention should be delivered as early as possible (Stone-Heaberlin et al. 2023). The Bridge Skill Development Program is a parent-mediated intervention that was designed to be delivered to the children waiting for intensive intervention. It provides a set of ABA teaching techniques, as well as the use of parent-mediated DTT, to foster skill acquisition of target behaviours (Stone-Heaberlin et al. 2023). Stone-Heaberlin et al. (2023) observed considerable improvements across four target behaviours taught to all participants. As a future work, they aim to gather data on the behaviour change of the caregivers that mediate the intervention so that procedural fidelity and rate of homework completion can be understood better. In addition, compared with psychologist-led data collection at the pre-treatment session, caregiver-led data collection at the post-treatment session may have affected the post-treatment increases in skill development; therefore, pre- and post- data collection by both the psychologist and caregiver could be included.

Most of the children with ASD have problem behaviours that interfere with social interaction and learning. Lindgren et al. (2020) carried out a randomised controlled trial compared treatment with FCT to treat problem behaviours in young children with ASD. In their study, FCT was carried out by parents with training and real-time coaching performed by behavioural consultants using telehealth method. At the end of the trial, FCT treatment via telehealth method achieved a mean reduction in problem behaviours of 98% in comparison to slight behavioural improvement in children who received the treatment during a period of 12 weeks. The results of their study show that parent-implemented FCT using telehealth method can reduce moderate to severe problem behaviours in children with ASD.

PRT can be delivered directly by trained therapists and be taught to parents. During the COVID-19 pandemic, the majority of clinical care for children with ASD was delivered via telehealth, because models for parent training had been established previously (White et al. 2021). Nevertheless, at that time, there was no model for direct clinician delivery of virtual PRT (VPRT). The model developed by (White et al. 2021) was provided to 17 families between April 2020 and May 2021 via telehealth. As it was proved in their study, the VPRT delivery model can be used as a guiding approach to engage children with ASD in meaningful social interaction and communication practice via video conferencing.

Sosnowski et al. (2022) examined the feasibility, acceptability, and effectiveness of a video game-based digital therapeutic that combines ABA techniques and gaze-contingent eye tracking to improve emotion recognition in children with ASD. Results of their study indicated that children in the intervention group achieved significant improvements in emotion recognition from pre- to post-intervention compared to children in the control group.

ABA is widely accepted as the primary way of teaching new skills or dealing with disruptive behaviours to individuals with ASD. Software application designed for ABA therapy enable teachers and therapists to evaluate a learner's current level of learning and set future goals, create a set of programs to achieve those goals, and measure progress each day, tweaking the programs frequently to maximise learning speed. For instance, Kohli et al. (2022) evaluated the performance of machine learning models using sociodemographic, assessment records and treatment effectiveness data in predicting ABA treatment programs for children with ASD. They

proved that machine learning models can successfully predict ABA treatment programs designed for children with ASD, with an accuracy of 80-85%. Their multi-model personalised recommendation algorithms offer personalised therapy recommendations to clinicians in order to serve children with ASD.

Verbal Behavior (VB) approach is a form of ABA, which is based on the B.F. Skinner's analysis of verbal behaviour and the principles of ABA (Barbera and Rasmussen 2007). It encourages individuals with ASD to learn communication and language by connecting words with their purposes and particularly works well with children with limited or no speech abilities (Barbera and Rasmussen 2007). The VB approach to ABA (ABA-VB) aims to demonstrate to the children with ASD the value of communicating in words. Because children's initial language typically serves their desire to obtain something from someone (Barbera and Rasmussen 2007). This approach is different from traditional ABA because ABA does not focus on if the learner is interested or not. In contrast to ABA, ABA-VB focuses specifically on verbal communication rather than performing the desired behaviour (Leblanc et al. 2006).

Software Applications

In recent years, mobile therapy technology has become a popular way of helping people get access to health care (Ventola 2014, Moore 2023). As a result, tablets and smartphones have started to help therapists apply ABA principles quickly (Moore 2023). It has been shown that digital tools are better than traditional, face-to-face ABA in many aspects, because using them allows accommodating each child's individual requirements by considering preferred learning styles, requirements, or task difficulties (Allen et al. 2016).

Technology can aid ABA interventions supporting psychologists, teachers, and parents as well as patients (Trevisan et al. 2019); however, software applications designed for ABA therapy are generally used by educational facilities and therapists. Educational facilities have been integrating those software applications into their practices in order to make sure that they can collect data accurately, efficiently and timely and coordinate care between multiple therapists, teachers and caregivers. Since ABA depends on repetition, software applications are quite valuable (Artoni et al. 2013). Some software applications can even automatically adjust their settings based on how a person uses them.

As individuals with ASD like enjoying themselves and being engaged when interacting with computers, tablets and smart phones (Valencia et al. 2019), applications can be quite useful for different purposes in ABA therapies. Way of Life (Way of Life 2023) can help individuals with ASD promote appropriate behaviours and habits and stop inappropriate ones. Therapists use it to help individuals keep track of their behaviours and realise their impact. Built-in motivators of the application can help the individuals embrace new behaviours. In addition, the application can recognise negative behaviours and help to prevent these behaviours become habits. Similarly, Habitica (Habitica 2023) can help individuals with ASD build good habits by gamifying their tasks and goals. By gamifying tasks into little monsters an individual has to conquer, Habitica is a promising tool to help users with behavioural issues in a non-clinical setting (Moore 2023). Its built-in communities enable users to interact with each other as well as assist in each other to accomplish tasks (Moore 2023). As children like being awarded, by creating categories on the behaviours to be monitored and awarding stars for successful actions, iRewardChart is a useful tool to give positive reinforcements to a child (LearningWorks for Kids 2015, Moore 2023). T2 Mood Tracker (Bush et al. 2014) is a useful tool for people with emotional disorders, because it supports a set of pre-loaded issues; namely, general wellbeing, stress, anxiety, depression, head injury, and post-traumatic stress disorder (Bush et al. 2014). Using the application, learners can keep track of their emotional states and using the results they can discuss their behavioural patterns with their therapists (Moore 2023).

As tracking their own progress is important for learners (Nagy 2016), using Behavior Tracking Pro (Behavior Tracker Pro 2023the learners can select specific actions that they need to modify and track their progress by recording them (Moore 2023). Similarly, Autism Tracker Pro (Autism Tracker Pro 2011) is a useful tool to find out not only negative but also positive behaviour patterns and keep track of all the changes in these patterns viewed during ABA interventions (Moore 2023). It provides features that help to improve motor functions, eye contact, speech, and aggression (Moore 2023).

Activity based software applications, particularly video games, allow learners to improve their various skills (Adipat et al. 2021). For instance, ABA Kit provides a set of principles in its teaching kit to help children with ASD. It consists of 14 programs (Help Autism 2023). The materials in the ABA kit help to stimulate and improve both the cognitive and verbal skills of children with ASD (Moore 2023). Similarly, by providing activities and settings, First Then Visual Schedule offers behavioural support to children with poor communication and social skills (First then visual schedule 2010). Using it, children can understand and express themselves easier (Moore 2023).

Practice management software plays a key role for therapists in organising their processes and tasks (Davey and Davey 2015). A well-known example of practice management software is ClinicSource (ClinicSource 2023). It is a therapy management software application designed to help therapists of all types. It integrates practice management, documentation, scheduling and therapy billing in an easy-to-use interface with the goal of saving the therapists' time. As well as practice management, clinical data collection is essential for therapists. Thread Learning (Thread Learning 2020) provides authorised users with end-to-end tools to track and achieve progress for individuals with ASD and various developmental disabilities. It enables therapists to manage learners and staff, set up programs and curriculum, and collect data on various skills and behaviours. Most users prefer a complete system that include practice management and clinical data collection to standalone ones (Fraser and Blaya 2010). CentralReach's ABA Practice Management and Data Collection Software (Central Reach 2023) enable therapists to standardise treatment plans and ABA service delivery. Using it, therapists can individualise care using digital binders, complete with mastery criterion to auto-advance or regress targets, phases, and prompts. It has also other standard functions found in practice management and data collection tools. A similar application is Total Therapy (Total Therapy 2022). It is designed for physical, occupational, speech, ABA and other behavioural therapies. It consists of practice management module, data collection tools, billing options and a patient portal. Its clinical module enables therapists to create assessments, track attendance, monitor progress, analyse trends, and review client behaviour. It has also scheduling and billing functionalities as well as a parent portal that allows two-way communication.

Future Research Directions

Socially assistive robots are promising tools that could assist in supporting intervention delivery for children with ASD and increasing the number of children with ASD that can receive therapy. Therefore, Louie et al. (2021) investigated the efficacy of applying commonly used ABA techniques to a robot-mediated listening comprehension intervention delivered to children with ASD. It was shown that all of the children with ASD receiving the intervention improved in the skill being taught by the socially assistive robot. During the sessions, engagement of all the children was high, and interacting with the socially assistive robot was enjoyable for them. As a future work of their study, Louie et al. (2021) proposed to modify their intervention. Before delivering interventions by a socially assistive robot, targets at the participants' skill level must be identified. This can be achieved using a tool such as the Verbal Behavior Milestones Assessment and Placement Program supporting skills protocol (Sundberg 2008). In addition, Louie et al. (2021) used a robot that only utilises the core ABA techniques for implementing DTT. Nevertheless, as a future work, motivational ABA techniques may be utilised during human-facilitated DTT sessions. Moreover, more socially valid targets can be implemented on the socially assistive robot so that efficient and effective ABA-based interventions can be delivered and children's behaviour during long-term interactions with the socially assistive robot and changes in performance in addition to behaviour over multiple different interventions can be investigated (Louie et al. 2021).

Kohli et al. (2022) proved that the selection of a corresponding treatment plan by machine learning models is more objective than through the subjective experience of conventional therapists and clinicians. However, the subjective experience of conventional therapists and clinicians can still be more effective in practice (Fairburn and Patel 2017). Consequently, there is a need to evaluate the degree to which machine learning models-selected outcomes are in harmony with desired goals, and the degree and significance of the difference (Kohli et al. 2022).

Lim and Draper (2011) tried to compare a common form of ABA-VB approach and music incorporated with ABA-VB approach as part of developmental speech-language training in the speech production of children with ASD. They tried to explore how the perception of musical patterns incorporated in ABA-VB operants affected the production of speech in children with ASD. 22 children with ASD, age range 3 to 5 years, who were verbal or pre-verbal with presence of immediate echolalia were participants of the study. The participants were randomly assigned a set of target words for each of the three training conditions: (i) music incorporated ABA-VB, (ii) speech (ABA-VB) and (iii) no-training. The results of the study showed that both music incorporated training and speech training were helpful for production of the four ABA verbal operants; nevertheless, the difference between the music incorporated training and speech training was very limited. In addition, the results showed that music incorporated ABA-VB training was the most effective in echoic production, and speech training was the most effective in tact production. Therefore, music can be involved in ABA-VB training strategies and musical stimuli can be used to enhance the functional verbal production in children with ASD.

Most of the individuals with ASD are non-verbal but they are still able to communicate via augmentative and alternative communication tools. Cooper and Ireland (2018) presented the design of an augmentative and alternative communication application with embedded artificial conversational agent. The embedded conversational agent called Alex was designed to run on Android devices. Alex is able to engage with its user on

a variety of topics using images and symbols and can easily be programmed by ordinary users without specialised computer skills (Cooper and Ireland 2018). This application offers a novel approach for ABA therapies and can be further developed using state-of-the-art machine learning approaches.

Conclusion

ABA aims to increase behaviours that are positive and helpful and decrease behaviours that are harmful or negatively impact learning. It has been well studied and used for decades and helped many kinds of learners of all ages gain different skills. On the other hand, it can only be successful if its methodology is developed considering the particular needs of each person whose behaviour needs changing. It cannot be provided using a one-size-fits-all based therapy solution and should be thought of as a set of principles or a framework. It must be realised by delivering personalised, science-based interventions that drive lasting, positive behaviour change. Since the 1960s it has been used to help children with ASD and other related developmental disorders. It can be adapted to meet the needs of each child with ASD and be provided in various locations in the form of one-to-one teaching or group instruction. In case of children with ASD, it is generally used to teach skills essential in everyday life by positive reinforcement. If applied appropriately, positive reinforcement encourages positive behaviour change in children with ASD.

ABA is criticised for being too tough on children. Nevertheless, most therapists apply it by using play-based programs to create a fun and super animated learning environment. It is also criticised that its practitioners are too focused on eliminating problem behaviours rather than developing skills. But a part of this criticism has to do with a sense that ABA tries to make children with ASD indistinguishable from their typically developing peers. ABA mainly aims to enable independence rather than taking away the neurodiversity of children. It focuses on behavioural change, not about trying to change the person, how they think, or how they feel. In recent years, it has become much more individualised compared to the past. Its practitioners typically make custom programs that take into account the specific needs and goals of each child with ASD.

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