

A Literature Review of How Visual Aids Promote Behavioral Change for Children with Autism

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Abstract

Compared with typically developing children, children with ASD seem to show more prevalent and severe forms of challenging behaviors, which seriously impedes both their family- and school life. This study aims to explore the efficacy of different methods used to tackle the issue of challenging behaviors for children with ASD. Five types of visual aids (activity schedules, symbol exchange, social narratives, contingency map and cues cards) that are used to help reduce challenging behaviors are explored through investigating the research frequency of the visual aids, their context and settings and through a comparison of their effectiveness.

A literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. Using the PRISMA framework I narrowed down 345 to 9 articles for my analysis. The results of the study found that visual aids were likely to be effective in correcting challenging behaviors for children with ASD. Among the 5 types of visual aids, social narratives seemed to have the most potential in correcting challenging behaviors. Combined visual aids also seemed to be effective while the results for activity schedules and symbol exchange were not conclusive. The results of this study can help practitioners to choose the most appropriate visual aid(s) for children with ASD. A research gap on contingency map was found and it is recommended to conduct further research on the topic.

Abbreviations

ASD	Autism Spectrum Disorder
DSM	Diagnostic and Statistical Manual
ERIC	Education Resources Information Center
LBBI	Literacy-based Behavioral Interventions
PDD-NOS	Pervasive Developmental Disorder - Not Otherwise Specified
PECS	Picture Exchange Communication System
PEM	Percentage of Data Exceeding the Median
PND	Percentage of Non-overlapping Data
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses

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1. Introduction

Anger and frustrations are common emotions experienced by human beings. Adults learn to tackle them by recognizing their emotions, self-control and building a support system. However, young children might not have the capacity to regulate their emotions as their social and emotional skills are not yet fully developed, due to this there are many moments when children lash out in anger and frustration. They display aggressive behaviors such as shouting, screaming, swearing and throwing objects (Pillay & Vieira, 2020). These challenging behaviors are problematic and can impede both family- and school life and they have also been linked to different forms of abusive parenting and adverse cognitive and social development (Dunlap et al., 2006; Lansford et al., 2011; Wagner, Cameto, & Newman, 2003). Seeing the negative impacts of challenging behaviors, this study aims to tackle the difficult issue by exploring the efficacy of different visual aids through a literature review.

While challenging behaviors is a common issue for typically developing children, research found that challenging behaviors tend to be more severe and more prevalent among children with Autism Spectrum Disorder (ASD) (Hutchins, & Prelock, 2014; Matson, Wilkins, & Macken, 2008; Reichow & Barton, 2014). Children with ASD are often more frequently engaged in serious challenging behaviors such as being aggressive to other children, violence towards caretakers and self-injuries (Martinez, Werch, & Conroy, 2016). Serious self-injuring behavior they might engage in includes head banging, self-punching, self-biting and self-scratching (Minshawi et al., 2014). Due to the greater severity of the challenging behaviors and the higher frequency of the episodes compared to typically developing children, the impacts of challenging behaviors of children with ASD are more far-reaching and come in a higher variety of forms. It affects the children's family and school life more seriously than challenging behavior among typically developing children. Comparing parents of typically developing children with parents of children with ASD shows that the latter reported increased risk of physical injuries, higher stress levels, lower quality of family life, higher loss of social life and work opportunities and a higher risk of being misunderstood by the public and experiencing fragile mental states (Matson et al., 2011; Bessette Gorlin, Mcalpine, Garwick, & Wieling, 2016; Dunlap & Fo, 1999; Larson, 2010). In addition, siblings of children with

ASD reported being neglected and suffered from mental issues as a consequence of the experienced neglect (Werner DeGrace, 2004). Teachers of children with ASD reported decreased teaching qualities, disruption in classroom, conflicts between peers, violence and aggression and increased risk of physical injuries due to severe challenging behaviors (Sigafoos, 2003). Research into the consequences of challenging behavior among children with ASD leaves little doubt that there is value in evaluating the effectiveness of methods that are meant to promote behavior change. I will go on to present some methods for behavior change that are presented by researchers.

Researchers have suggested many solutions to reduce challenging behavior for children with ASD. Koegel, Matos-Freden, Lang, & Koegel (2012) wrote a summary on interventions to reduce challenging behaviors in public schools. They suggested that function-based behavior interventions were a viable method to tackle challenging behaviors. This requires assessing the function or purpose of the challenging behavior that occurs to facilitate the creation of a behavioral intervention plan (Koegel et al., 2012). The intervention plans usually include giving rewards for desirable behaviors with the aim of reinforcing the desired behavior (Koegel et al., 2012). The summary also suggested modified assignment as a viable intervention to reduce challenging behaviors. This method is applicable when students find a task difficult and use challenging behavior as a mean to avoid the task. In the preceding situation the difficulty level of the assignment would be adjusted to allow the student to manage to complete the task and thus reduce the challenging behavior. Koegel et al. (2012) also suggested communication related interventions, such as Picture Exchange Communication System (Bondy & Frost, 1994) and Functional Communication Training as viable methods to promote behavior change (Carr & Durand, 1985). These two interventions usually target children with severe communication impairments and teach them to replace challenging behaviors with communication. In addition, other researchers focused on visual aids, cognitive therapies, speech therapies and positive behavior support as viable interventions (Kidder & McDonnell, 2017; Warren, 2011).

In this article I choose to focus on visual aids as one of the most helpful solution to reduce challenging behaviors for children with ASD due to its communicative nature. Since children with ASD often have communication impairments and struggle with processing auditory information, visual aids serves as an alternative source of information

and as such facilitates communication for children with ASD (Dooley, Wilczenski, & Torem, 2001). One of the strengths of visual aids is that it has many advantages when it comes to conveying information. For example, visual aids can be relatively permanent if it is printed on a paper as it allows children to re-read the information as many times as they wish. Also, the information given through visual aids is usually easy to understand as it is often constructed with simple symbols that are familiar for the children, such as people and items in their environment.

Dooley, Wilczenski, & Torem (2001) also found that visual activity schedules smoothed school transitions and reduced aggressive and disruptive behaviors during transition from one activity to another for children with ASD. In addition to the preceding, many others have conducted research on social stories and found that it might reduce problematic social behaviors for children with ASD (Agosta, Graetz, Mastropieri, & Scruggs, 2004; McGill, Baker, & Busse, 2015; Karkhaneh et al., 2010).

Visual aids are a popular theme when it comes to interventions that are geared towards reducing challenging behaviors for children with ASD. Many studies have focused on a single type of visual aids, such as social stories or activity schedule to investigate how and to what extent they reduce challenging behaviors (Dooley, Wilczenski, & Torem, 2001; Agosta, Graetz, Mastropieri, & Scruggs, 2004; McGill, Baker, & Busse, 2015; Karkhaneh et al., 2010). For example, Lequia, Machalicek, & Rispoli (2012)'s review paper gathered previous research on activity schedules and inspected its relationship with challenging behaviors. Other review papers followed the same trend in regards to focusing on a single type of visual aids and its relationship with challenging behavior. Both Picture Exchange Communication System (PECS) and social stories have been treated separately (Battaglia, & McDonalds, 2015; McGill, Baker and Busse, 2015). Thus these review papers can only tell us the effectiveness of one type of visual aids; however, they cannot provide us the overall picture of which type of visual aids are more widely used and to what extent they are effective when compared. Hence there is a research and knowledge gap that needs to be filled as to help teachers and parents to choose the appropriate visual aids to reduce challenging behaviors in children. This necessitates an inspection and comparison of the effectiveness of the different types of visual aids available. To achieve a meaningful comparison I will conduct a literature review, following the guidelines of the Preferred Reporting Items for Systematic Reviews and

Meta-Analysis (PRISMA) to study the research frequency of visual aids, their context and settings of implementation and their effectiveness.

1.1 Aim and Research Questions

The overall aim of this research is to provide an overview about how different types of visual aids reduce challenging behaviors for children with ASD. I hope this article can provide meaningful and practical information to teachers and educators so they can choose the appropriate visual aid that is needed to reduce challenging behaviors exhibited by children with ASD.

To fulfill the aim of this paper, I choose the following research questions:

1.1.1 Questions

1. What is the research frequency of the visual-aid interventions used to change challenging behaviors for children with ASD?
2. What are the settings and contexts of the visual-aid interventions used to change challenging behaviors for children with ASD?
3. What are the effect sizes of the visual-aid interventions used to change challenging behaviors for children with ASD?

1.2 Terminology

Before moving on to the main research content, I will explain the terms used in this research paper in detail to avoid confusion and to allow the reader to have a clear understanding of the different concepts that are used and discussed.

1.2.1 Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is an umbrella term that is used to describe a wide range of neurodevelopmental disorders characterized by impairments in social communication and a restricted, repetitive pattern of behavior (American Psychiatric Association, 2013).

1.2.2 Challenging Behaviors

Challenging behaviors of children with ASD is defined as engaging in physical aggression, verbal aggression and infliction of self-injuries (Martinez, Werch, & Conroy, 2016). Concrete examples of challenging behaviors exhibited by children with ASD include hitting, kicking, biting, spitting, yelling, screaming and hurting oneself (Agosta, Graetz, Mastropieri, & Scruggs, 2004; O'Reilly et al., 2005).

1.2.3 Visual Aids

Visual aids are defined as “concrete cues that provide information about an activity, routine, or expectation and/ or support skill demonstration” (Wong et al., 2014, p. 104).

From the above definition one can understand visual aids as a broad concept. Since I focus on school age children with ASD, I limit my visual aids definition to encompass visual materials and resources used in school, such as pictures, photos and drawings used as teaching materials.

To tackle the issue that visual aids is a broad concept consisting of many different strategies, I picked 5 visual aids strategies that are commonly used in school and other education settings in order to narrow down the scope. These 5 types of visual aids were chosen based on the suggestions given in a paper on visual aids to support behavior change for children with ASD (Kidder, & McDonnell, 2017). Narrowing down visual aids into 5 types: activity schedule, contingency map, cue cards, social narratives and symbol exchange allows me to explore the topic in a deeper and more concentrated way. In the following, I will explain the terminology of each type of visual aids.

Activity Schedule

Activity schedule can be defined as a timeline of upcoming events paired with visual stimuli (Akers, Higbee, Gerencser, & Pellegrino, 2018; Kidder, & McDonnell, 2017). The visual stimuli are usually presented in the form of pictures, photographs and words to prepare children for future change in activities (Kidder, & McDonnell, 2017). Activity schedule aims to increase the independence of children with ASD by equipping them with the skills to participate in a chain of activities without the assistance from adults (MacDuff, Krantz, & McClannahan, 1993).

Contingency Map

Contingency map is defined as a flowchart of behavior choices and their consequences (Brown & Mirenda, 2006). The flowchart consists of current behavior and alternative behavior with their corresponding consequences (Brown & Mirenda, 2006). It aims to help children with ASD in decision making by offering them an alternative behavior that has the same function but act more effectively (Kidder, & McDonnell, 2017).

Cue Cards

Cue cards are a series of cards that provide visual prompt or reminder for specific behaviors (Schmit, Alper, Raschke, & Ryndak, 2000). Through displaying a specific picture, it teaches the children to prepare for the upcoming tasks and sometimes it aims to stop the children's current behavior by making them aware of it (Kidder, & McDonnell, 2017).

Social Narratives

Social narratives are interventions that teach appropriate social behaviors. It usually manifests itself as a simple written description of appropriate social behaviors or responses to specific social situations (Morris, 1987). Parents or teachers usually write social narratives and it is individualized in accordance with the student's targeted behavior and his/her language level (Morris, 1987). Visual aids such as photos and drawings are commonly added in social narratives to enhance the reader's understanding.

While social narratives is the umbrella term that describe short written descriptions of social behaviors, social stories is one of the most popular type of narratives. Social stories follow specific guidelines by Gray (2000). It is written from the perspective from the child to illustrate a social situation they are in with social cues, choices and outcomes (Kidder, & McDonnell, 2017). Social stories aim to improve the child's understanding of how people behave and think and how to act appropriately in different social situations (Gray, 2000).

Symbol Exchange

Symbol exchange is defined as using visual symbols to express needs and desires (Kidder, & McDonnell, 2017). It aims to help children with language delays or non-verbal children to convey their needs and desires through symbols (Kidder, & McDonnell, 2017). One of the most commonly practiced systems of symbol exchange is The Picture Exchange Communication System (PECS). It is a well-established training system to help children to achieve functional communication through photos and symbols (Bondy & Frost, 1994, 1998).

1.3 Outline of the Thesis

This paper explores how visual aids reduce challenging behaviors for children with ASD in the format of a literature review of current research. First, it starts with an introduction chapter emphasizing the importance of the topic, aims, research questions and terminology. Following this, the literature review chapter provides an overview of the main concepts: ASD, challenging behaviors and visual aids followed by theoretical background and current state of literature. After that, the methodology chapter presents the PRISMA method in detail descriptions and how to apply it for data synthesis. Afterwards, the results chapter presents findings in accordance of the three research questions. Finally, a summary of the findings, discussion of the findings and limitations will be presented in the discussion chapter.

2. Literature Review

The literature review chapter is divided into 5 parts. The first three sections describe the related theories and importance of the three key concepts in this paper: ASD, challenging behaviors and visual aids. After that, theoretical background section and current state of literature are presented.

2.1 Autism Spectrum Disorder

Our target participants in this article are children with ASD that display challenging behaviors. Therefore, before finding out what types of visual-aid interventions can reduce challenging behaviors, it is important to have a picture of what autism is by looking into its definitions, its symptoms and prevalence to understand how and why visual aids can help them.

2.1.1 The Definition of Autism Spectrum Disorder

Autism Spectrum Disorder is one of the most researched child psychiatric disorders. In 1912, the term “Autism” was first suggested by Paul Eugen Bleuler, a Swiss psychiatrist who used it to describe schizophrenia and he explained the term as escaping from reality and social withdrawal (Holaday, 2012).

Over the years, Autism was considered to be a symptom of schizophrenia. It was not until 1980s that “infantile autism” was finally recognized in DSM III (American Psychiatric Association, 1980) as an independent diagnosis rather than symptoms of childhood schizophrenia. Later, autism related disorders were divided into 4 subcategories and they were Autistic Disorder, Asperger’s Disorder, Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) and Childhood Disintegrative Disorder (American Psychiatric Association, 1994). In DSM-V (American Psychiatric Association, 2013), the definition of autism changed again. Now the newest term is “Autism Spectrum Disorder”, which is an umbrella term and includes a spectrum of mental disorders that are characterized by impairments in social communication and a restricted, repetitive pattern of behavior (American Psychiatric Association, 2013).

2.1.2 Symptoms of Autism Spectrum Disorder and Its Prevalence

Children with ASD usually experience communication challenges. They demonstrate limited skills in verbal and nonverbal communication (Frederickson, & Cline, 2015). The communication ability of the children with ASD varies in different cases as it depends on the children's intellectual ability and social skills. However, children with ASD usually show certain degree of limitations in their communication skills. Its severity ranges from not being able to use speech to communicate their needs or wants, to knowing many vocabularies but do not communicate in accordance with social expectations or can only talk about certain topics in great details (Kasari, Brady, Lord, & Tager-Flusberg, 2013). In addition, even though some children with ASD know vocabularies, they usually have difficulties in understanding the meaning of the sentences, the rhythm, the tone of the speech, the body language, etc. (Kasari et al., 2013). Therefore, communication that combines much information from gestures, eye contact, facial expressions, spoken language and body language could be far too complex for children with ASD to comprehend.

Social challenges also accompany children with ASD. They often struggle with recognizing emotion, expressing emotion, showing empathy, understanding social rules, etc. (Kirk, Gallagher, Coleman, & Anastasiow, 2012). Wing (1988) described that the social challenges faced by individuals with ASD could be systematically divided into three levels. The first level is social recognition, that is, uninterested in others (Wing, 1988). The second level is social communication, which is described as having difficulties expressing oneself and understanding others (Wing, 1988). The third level is social understanding, which can be described as unable to understand others' feelings (Wing, 1988).

In addition, ASD is associated with restricted and repeated behaviors (Frederickson, & Cline, 2015). These behaviors manifest themselves in various ways, such as repetitive body movements including clapping, waving, rocking and banging; resistance to change including following same schedule, having same meal and putting on same clothes everyday; and repetitive play such as spinning wheels and lining up toys repeatedly (Watt, Wetherby, Barber, & Morgan, 2008).

As people are more aware of the symptoms of ASD and better diagnosis criteria of ASD are available now in DSM V, the diagnosis of ASD has been increasing all over the world. The prevalence of ASD for children and youth increased 119% between 2000 to 2010, and this upward trend has shown continuously (Baio, 2014). For this reason, ASD is one of the fastest increasing developmental disorders; the global prevalence estimate of ASD is 0.62% according to a meta-analysis (Elsabbagh et al., 2012).

2.2 Challenging Behaviors in Children with ASD

Challenging behaviors in children with ASD can cause a lot of distress in families and schools. In this section, I will look at the prevalence of challenging behaviors, its consequences and reasons behind challenging behaviors.

2.2.1 Prevalence of Challenging Behaviors

It is difficult to accurately predict the prevalence of challenging behaviors in children with ASD due to the diverse definition of challenging behaviors among researchers; however, there is certainly a trend showing that children with ASD are more likely to engage in challenging behaviors than other typically developing children (Hutchins, & Prelock, 2014; Matson, Wilkins, & Macken, 2008; Reichow & Barton, 2014). Current research reports that the prevalence of challenging behaviors among children with ASD is 38% to 94% (Baghdadli et al., 2003; Holden & Gitlesen, 2006; Matson, Wilkins, & Macken, 2008). The prevalence rate varies due to the diverse scope of challenging behaviors being examined, which ranged from self-injury behaviors, physical aggression to any form of challenging behaviors.

2.2.2 Consequences of Challenging Behaviors

Challenging behaviors can cause a lot of troubles for children with ASD. It impedes one's family life, school life and overall life qualities.

Regarding family life, challenging behaviors increase physical restraint (Matson, Sipes, Fodstad, & Fitzgerald, 2011). This is due to the fact that challenging behaviors pose as a risk factor for increased physical injuries to the children with ASD and also to the caretakers (Matson et al., 2011). Challenging behaviors burden the caretakers as it causes

high stress level (Bessette Gorlin, Mcalpine, Garwick, & Wieling, 2016). These stress usually come from the stigma and disgrace that the parents experienced because of the children's challenging behaviors and it is well reported that many parents felt misunderstood as the public sees the misbehavior of the children due to poor parenting skills rather than a developmental disorder (Farrugia, 2009). Challenging behaviors also creates imbalance in the family. It restricts the caretakers' social life and work opportunities as they need to commit substantial amount of time to attend to their children's severe challenging behaviors (Larson, 2010). Due to the significant amount of attention the parents' focus on the children with ASD, siblings suffer and feel neglected (Werner DeGrace, 2004).

Challenging behaviors impact the children's school life negatively. It interferes the learning activities for the children with ASD and other children in the classroom (Sigafos, 2003). Such interference prevents the children from acquiring adaptive behaviors and socially acceptable behaviors and limits their opportunities of participation in academic activities (Sigafos, 2003). Challenging behaviors can also cause serious conflicts between the children with ASD and their peers (Boyd, McDonough, & Bodfish, 2012; Sigafos, 2003). Conflicts such as physical aggression and verbal aggression between students destabilize the school and create disruption in the classroom. Challenging behaviors pose a threat to teachers by disabling them from performing teaching duties and shifting their attention and focus to regulate atypical behaviors. It may also increase the risk of physical injuries of the teachers (Sigafos, 2003).

As family experience and school experience are two major components of childhood, with both experience being impeded due to challenging behaviors, children with ASD is reported to suffer from low life quality (Dunlap & Fox, 1999; Carr et al., 2002). There is an immediate need to address this issue.

2.2.3 Reasons Behind Challenging Behaviors

The tendency of children with ASD developing challenging behaviors is higher than typically developing children and children with other disabilities (Hutchins, & Prelock, 2014; Matson, Wilkins, & Macken, 2008; Reichow & Barton, 2014). The reason behind

this high level of prevalence is due to the distinctive features of the developmental disorder.

Firstly, children with ASD usually have difficulty in communication (Dooley, Wilczenski, & Torem, 2001). Many with ASD are reported to suffer from serious impairments in verbal and non-verbal communication (Dooley, Wilczenski, & Torem, 2001; Frea, Arnold, & Vittimberga, 2001). Many researchers believe that children with ASD resolve to challenging behaviors due to frustration in expressing their needs and wants and to attract attention from others (Conroy, Dunlap, Clarke, & Alter, 2005). A vivid example of this is when children with ASD is feeling unwell, tired or hungry, communication impairments hinder them from expressing their needs, in order to gain attention and to express frustration, they often resort to challenging behaviors such as kicking, aggression, property destruction and self-injuries (Conroy et al., 2005).

Another reason is that children with ASD often show atypical development in social reasoning (i.e., confused about social situations) (Quill, 1995). This often leads to children with ASD having troubles understanding their surroundings (i.e., what is happening and what is meaning of non-verbal communication between people) (Rogers & Mesibov, 2013). The lack of understanding of surroundings can confuse children with ASD and lead to potential challenging behaviors. Another example of atypical development in social reasoning is that children with ASD often lack the ability to identify socially acceptable behaviors (Shulman, Guberman, Shiling, & Bauminger, 2012). Research has shown that individuals with ASD lack understanding in abstract social rules and are significantly inferior in distinguishing socially-acceptable behaviors in social situations than other regularly developed individuals (Shulman et al., 2012).

Furthermore, challenging behaviors could be a sign of high level of anxiety in the children with ASD (Bitsika, & Sharpley, 2016). Children with ASD could be quite rigid in their routines; any change and disturbance in their routines could lead to high anxiety and challenging behaviors (Kirk et al., 2012). Besides rigid routines, insecurity feeling in new environment, discomfort in social situation could trigger high stress level and challenging behaviors as well (Kirk et al., 2012).

In addition, children with ASD are often reported to be over-sensitive or under-sensitive to sensory stimuli (Kirk et al., 2012). Sensitivity to stimuli varies among individuals with

ASD as they show different degree of sensitivity to sights, sounds, smells, tastes and touches (Gillingham, 1995). Reports of sensory sensitivity by individual with ASD include noise that sounds like train rumbling through ears, smells that upsets, touches that pains, light that hurts, etc. (Gillingham, 1995). Too much information leads to stimuli overload, which could cause stress, challenging behaviors, withdrawal and meltdown among children with ASD.

2.3 Visual aids

Visual aids are an important strategy that may help change behaviors. Visual aids are especially useful due to its communication nature. In this section, I will look at the role of visual aids, how it can help children with ASD to communicate, its advantages and influential factors on the effectiveness of visual aids.

2.3.1 The Role of Visual Aids

Visual input is one of the most usual means to convey information. In everyday life, visual input from text, photography, motion pictures, videos and graphic arts provides rich information to process. Visual aids serve as a type of visual input that conveys information and a mean to strengthen communication. Visual aids are especially beneficial for children with ASD as they usually experience communication impairments (Dooley, Wilczenski, & Torem, 2001), visual aids can serve as an important tool to compensate their limitations in communication and to facilitate communication. To understand the role of visual aids, it is essential to look at the biological limitations and strength in children with ASD and how visual aids can help convey information.

Limitation and Strength in Information Processing of Children with ASD

As previously mentioned, children with ASD often experience communication impairments due to their problems in understanding auditory information (Dooley, Wilczenski, & Torem, 2001). Auditory information processing impairment manifests both behaviorally and biologically (O'connor, 2012). Biologically, auditory information processing impairment is associated with inability to distinguish pitch, loudness, tone,

stress, rhythm, etc. (O'Connor, 2012). Behaviorally, it is often associated with difficulties in reading, spelling, expressing, etc. (Catts, & Kamhi, 2005).

Even though many children with ASD experience difficulties in processing auditory information correctly and accurately, research found that children with ASD might have strength in nonverbal information processing to compensate for their weakness (Dooley, Wilczenski, & Torem, 2001). Nonverbal information includes text, photos, facial expressions, gestures, body languages, etc. In addition, among different types of nonverbal information, research found that children with ASD may have comparative strength in processing nonverbal nonsocial information and they tend to learn more effectively in nonverbal problem-solving than verbal ones (Dooley, Wilczenski, & Torem, 2001).

Visual Aids' Role in Conveying Information

Visual aids are a good source to convey nonverbal information. Visual aids come in various forms, such as objects, pictures, photos, graphs, postures, video clips, etc. (Rogers & Mesibov, 2013). Visual aids can facilitate children with ASD in receiving, creating and expressing meanings (Rogers & Mesibov, 2013).

Researcher also found that children with ASD are usually visual learners and tend to understand information explained in visual forms much better than verbal forms (Ashcroft et al., 2010). This is probably due to the fact that visual information is usually more straightforward and easier to process than verbal information. That is, visual information can be very direct, as one does not need to consider tones, stress, pitch and rhythm. Visual information is also stable and can be relatively permanent as learners can re-read the information anytime. Thus, seeing that verbal information cannot fulfill the communication needs for children with ASD, visual aids can serve as good alternative communicative resources for children with ASD.

2.3.2. Advantages of Visual Aids

In this section I will present the 4 main advantages of visual aids to show why it is beneficial to adopt them.

Visual Aids is Practical

Visual aids are a practical teaching tool that can be widely used in the classrooms. To create visual aids are relatively easy and do not require professionals (Rogers & Mesibov, 2013). Educators and teachers in school can create their own visual aids material with common resources. Visual aids are a strategy that can be implemented broadly in school, and it is beneficial not only to children with ASD but also to other students without the diagnosis (Zimmerman, Ledford, & Barton, 2017). Visual aids are also multi-purpose, teachers can use visual aids to help learners to achieve a variety of skills and promote behavior changes (Kidder & McDonnell, 2017).

Easy to Find

Visual aids materials are easy to find. It is diverse that a wide range of items can be used as visual aids, such as symbols, photographs, videos, pictures, drawings, words and real objects (Rogers & Mesibov, 2013). Visual aids materials can be found in a lot of books and journals, some of which are written specifically for children with ASD, such as Rogers & Mesibov (2013)'s book on visual supports for visual thinkers, Kidder & McDonnell (2017)'s paper on visual aids and positive behavior support, Ashcroft, Argiro and Keohane (2010)'s book on successful strategies for teaching kids with autism and more. Visual aids are also widely accessible on the internet. With a simple search, one can find visual aids materials on websites such as Autism Society of America, National Autistic Society and Autism Speaks websites and more.

Personalized

Visual aids can be personalized to fits one's interests and needs. For example, to make visual aids more attractive for students, it can be made into an item of interests (i.e., the shape of trains, rockets, etc.). In addition, to make visual aids realistic, one can use the photos of the school, the classroom and the peers. It is also possible to choose different types of visual aids for different purposes. For example, to use visual schedule for routines, symbols for communication, social stories for teaching adaptive social behaviors, etc. (Rogers & Mesibov, 2013).

Durable

Visual aids are durable. For traditional visual aids that are printed on a paper, it can last a long time with lamination. For visual aids with a concrete form such as a real object or a plastic version of the object, it can be relatively permanent. Nowadays with the technological advancement, many visual aids come in digital forms such as videos, digital photos, apps and they are lasting and can be transferred and used on any smartphone, tablets or computers.

2.3.3 Influential Factors on the Effectiveness of Visual Aids

Even though visual aids have many advantages, there are factors that may affect its effectiveness. As previously mentioned, visual aids are a concept with broad scopes. It has many different types and I focus on 5 types in this article. The types of visual aids could be a crucial factor in determining the effectiveness. To decide what types of visual aids to employ, one needs to look at the type of information to be conveyed. When the goal is to teach appropriate social behaviors, to understand others' feelings and to identify a challenging situation, researchers usually employ social narratives (Kidder, & McDonnell, 2017). However, when the goal is to teach the flow of a task or to show transitions between activities, researcher may look into activity schedules (Kidder, & McDonnell, 2017).

Besides the types of visual aids, the settings of the visual aids may affect the effectiveness of the intervention. For example, to construct a social story, researchers or teachers first follow the guidelines of Gray (2000), afterwards they determine the experimental settings such as when and where to read the social stories, how many times the children should read the social stories and who should read the social stories. Besides that, external factors like how the classroom is decorated, how many students are in the classroom and what kind of activities the student did before reading the social stories can all affect the effectiveness of the visual-aid intervention.

Therefore, to explore what types of visual aids are effective in reducing challenging behaviors, it is important to look carefully into the types of information to be conveyed, the settings of the experiment and the overall classroom setting outside the experiment so that one can fully understand what makes a visual aid effective and why.

2.4 Theoretical Background

The basic function of visual aids is to convey information and to support communication. To fully understand how visual aids work and its mechanism, one needs to take a look at the information processing theory.

2.4.1 Information Processing Theory

Information processing theory is proposed by Atkinson and Shiffrin in 1968. It is a theory that provides a theoretical framework for human memory.

Atkinson and Shiffrin (1968) proposed two types of categorization for human memory. The first categorization distinguishes structure and control processes of human memory (Atkinson and Shiffrin, 1968). Structure of the human memory refers to the permanent features of memory, which includes the physical structure of memory and the built-in process of memory (Atkinson and Shiffrin, 1968). The physical structure of memory and the built-in process of memory are inborn and unchangeable. They can be illustrated as a computer system in which the physical hardware and the built-in program of the computer are fixed features of the computer (Atkinson and Shiffrin, 1968). The control processes of the human memory, on the other hand, are changeable and constructed by subject (Atkinson and Shiffrin, 1968). It describes how the subject process the information is due to his personal history, the information available at hand, the setting of the information, etc. (Atkinson and Shiffrin, 1968). To illustrate the control processes in the example of computer, it can be seen as the subject's choice to modify the sequences of the program, to highlight particular information and to rehearse certain information (Atkinson and Shiffrin, 1968).

The other categorization of memory proposed by Atkinson and Shiffrin (1968) distinguishes the sensory register, the short-term store and the long-term store. The sensory register refers to the process of visual information first enters the sensory register where it stays for a few hundred milliseconds, then decays and is lost (Atkinson and Shiffrin, 1968). The short-term store can also be called the subjects' working memory. It receives information from both the sensory register and the long-term store and information in short-term store decays and is lost in about 30 seconds (Atkinson and Shiffrin, 1968). The long-term store refers to the relatively permanent memory that does

not decay or become lost (Atkinson and Shiffrin, 1968). Information in the long-term store can be recalled and retrieved by the subject on a fairly permanent base.

The two categorization of memory proposed by Atkinson and Shiffrin (1968) are closely related as control processes plays an important role in transferring information between sensory register, short-term store and long-term store. The transferring process does not mean that information will be removed from its original store and move to the other store; rather, it refers to a copying process of the information from the original store to the next store and the information remains in both stores (Atkinson and Shiffrin, 1968). The subject largely controls this information flow process across stores and it is multidirectional (Atkinson and Shiffrin, 1968).

As shown in Figure 1, the information flow usually begins as a visual stimuli being presented and registered as a sensory input. Then the subject scans the sensory input and codes the input with available information in the long-term store which result in a transfer of selective information from the sensory register into the short-term store (Atkinson and Shiffrin, 1968). The next step is the subject-controlled processes of transferring information from the short-term store to the long-term store. During this stage, the subject controls the information flow and only certain amount and certain form of information will be transferred (Atkinson and Shiffrin, 1968). Finally, information transfer from the long-term store to the short-term store is possible. This process is also self-controlled and often illustrates as problem solving, thinking, recalling, etc. (Atkinson and Shiffrin, 1968).

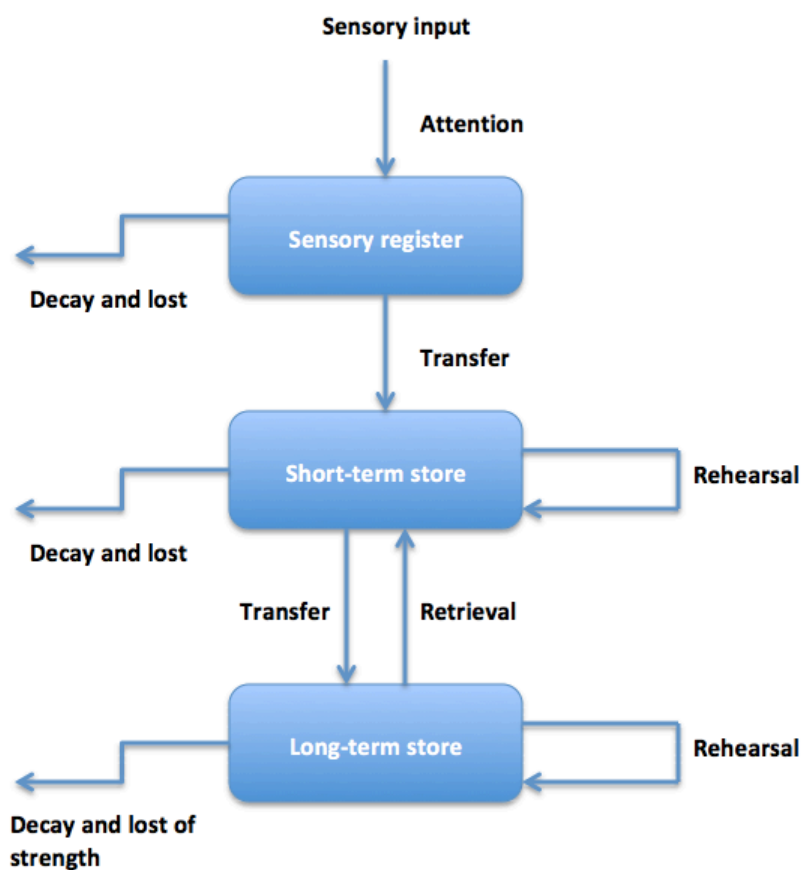
An important factor in information processing theory is rehearsal (Atkinson and Shiffrin, 1968). It is defined as repeating the information over and over in order to process information (Atkinson and Shiffrin, 1968). Rehearsal has two major purposes. The primary purpose is to lengthen the time the information stays in short-term store (Atkinson and Shiffrin, 1968). An example of this is to rehearse telephone numbers in order to remember it. By rehearsing telephone numbers, it expands the duration of time the numbers stay in the short-term store, prolongs the decay and allows more time for coding and transferring of the numbers to long-term store (Atkinson and Shiffrin, 1968). The other purpose of rehearsal is to strengthen information in the long-term store (Atkinson and Shiffrin, 1968). An example of this is when one wish to remember a

telephone numbers permanently, one rehearses the numbers multiple times (Atkinson and Shiffrin, 1968).

The information processing theory provides a good framework for using visual aids to promote behavior change. Visual aids are presented as stimuli then registered as a sensory input. Afterwards the stimuli will be transferred to the short-term store. Upon multiple rehearsals of the promoted behaviors, its time of decay will be prolonged which allows more time for coding and transferring the information to the long-term store. Later, rehearsal of the visual information/promoted behavior continues which increase the strength of the information in the long-term store. The information in the long-term store stays relatively permanent and the promoted behavior is learned.

Figure 1

The information flow in information processing theory



Note. This figure is adapted from “Human memory: A proposed system and its control processes,” by R.C. Atkinson, and R. M. Shiffrin, 1968, *The psychology of learning and motivation: Advances in research and theory*, 2, p. 89-195.

2.5 Current State of Literature in the Field

Regarding interventions for reducing challenging behaviors, Martinez, Werch, and Conroy (2016) did a systematic literature review on school-based interventions. Martinez et al. (2016)'s work focused on single case design studies that included children with ASD from 3 to 8 years old in school settings. They gathered 22 articles with a total of 44 children and calculated the effect size using Non-overlap of All Pairs and Tau-U methods. Their findings suggested that school-based interventions could likely reduce targeted challenging behaviors. Martinez et al. (2016) categorized school-based interventions into five categories. They were antecedent-based, function-based, reinforcement, instructional, or multicomponent. Among these five school-based intervention, visual aids were integrated as a component of the intervention packages. Martinez et al. (2016) described that social stories were the most frequently implemented method in function-based interventions and visual cues were commonly used in antecedent-based interventions. However, Martinez et al. (2016) did not explore the relationship between challenging behavior and visual supports exclusively. Visual aids were only one of the components in the intervention packages, but it was not necessarily the main component, and thus it is difficult to determine the effectiveness of visual aids on reducing challenging behaviors.

Many other reviews explored the relationship between visual aids and challenging behaviors in children with ASD. For example, Lequia, Machalicek, & Rispoli (2012) conducted a systematic review on the relationship between activity schedule and challenging behaviors. The findings suggested that activity schedules have positive effect on reducing challenging behaviors (Lequia, Machalicek, & Rispoli, 2012). However, the study only inspected one type of visual-aid interventions (i.e. activity schedule); therefore, the general effect of visual aids remains unknown. In addition, among the 18 studies Lequia et al. (2012) gathered, 60% took place in education settings and the rest took place in homes and communities; thus, it did not offer a deep inspection on visual aids in classroom settings. The article also adopted a relatively broad definition of challenging behaviors, which included disruptive behaviors, lack of engagement, self-injuries, lack of social initiation, on task behaviors, transition behaviors, play and compliance as behaviors of interests (Lequia et al., 2012). This relatively broad definition

did not allow a thorough examination of the relationship between visual aids and severe problematic behaviors such as aggression and self-injuries.

Battaglia, & McDonald (2015) conducted a literature review on PECS. It aimed to address the relationship between PECS and challenging behaviors in children with ASD. The article focused on maladaptive behavior (i.e., aggression, tantrums) and managed to yield 3 study with a total of 7 participants; however, only 4 of the participants showed a decrease in maladaptive behavior after introducing PECS, and thus the relationship between PECS and challenging behaviors in children with ASD was not conclusive (Battaglia, & McDonald, 2015).

There are also multiple reviews on social stories. For example, Karkhaneh et al., (2010)'s systematic review examined the relationship between social stories and social skills in children with ASD. He found 6 eligible participants where 5 of them showed significant increase in social skills after introducing social stories and therefore; he suggested that social stories has positive effect on the development of social skills; however, the other meta-analysis on social stories by McGill, Baker, and Busse (2015) did not find as positive results. The study inspected relationship between social stories and challenging behavior under two effect size indicators: percentage of non-overlapping data scores and the weighted effect size estimator. Inconsistent results were found between the two indicators and thus the effectiveness of social stories was not conclusive.

The above literature reviews made tremendous contribution to the field of visual aids; however, they only focused on one type of visual aids and thus the application is limited. In addition, it is not possible to compare the effectiveness of different visual aids between the review articles because they adopted different effect size calculation formulas and different definition of challenging behaviors. Therefore, there is insufficient information on the overall visual aids effectiveness and a comparison of the effectiveness of different visual aids. To close this gap, I will study 5 types of visual aids and compare their effectiveness in reducing challenging behaviors (i.e. physical aggression, verbal aggression, self-harm).

3. Methodology

The methodology chapter is divided into 4 parts. The first section describes the PRISMA method, which is used to derive data in this review. Following this the second section presents the literature selection procedure with inclusion and exclusion criteria.

Afterwards the third section describes the data extraction procedures. Finally, the last section presents the data synthesis procedures.

3.1 PRISMA

This study used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to derive data on the research frequency of visual aids used to reduce challenging behaviors, their context and settings and their effectiveness. PRISMA is a meta-analyses framework that has great significance in the field of healthcare (Moher, Liberati, Tetzlaff, and Altman, 2009). It is developed by David Moher and his colleague and it is often used as the basis to develop clinical practice guidelines (Moher et al., 2009). In health practice, a review study of the current medical situation usually serves as a starting point for policy change; however, as the quality of review studies vary a great deal, following the framework of PRISMA can increase the clarity of reporting and enable the readers to evaluate the review effectively (Moher et al., 2009).

Nowadays, PRISMA has expanded its popularity beyond the healthcare field. It is prevalent in psychology, education and many others because PRISMA allows systematic comparison of current journal articles of different topics. It provides a clear framework for reporting and it reduces the risks of reporting biases, such as avoiding the investigators' selective reporting base on personal opinion (Moher et al., 2009).

To improve PRISMA framework, 29 participants attended three-day meetings in Ottawa, Canada in June 2005 (Moher et al., 2009). In the meeting, the PRISMA checklist was proposed to revise and expand the PRISMA framework. The checklist consists of 27 items under title, abstract, introduction, methods, results, discussion and funding (Moher et al., 2009). This checklist helps the investigator to improve the quality of the reporting in literature reviews following PRISMA framework (Moher et al., 2009).

In this article, I followed the PRISMA workflow of “identification”, “screening”, “eligibility” and “included” for data charting and data analysis (Moher et al., 2009).

The first procedure “identification” means to identify relevant articles through database searching and other sources (Moher et al., 2009). To conduct a successful identification procedure, the researcher identifies relevant databases in the field then retrieve related articles on the database by searching relevant keywords.

The second procedure “screening” refers to the basic evaluation of the articles and the reviewer determines if the articles should be included or excluded (Moher et al., 2009). It starts with removing the duplicates from the search results. Then the reviewer read the abstracts of retrieved articles, check the articles against the inclusion and exclusion criteria and exclude articles that do not meet the inclusion criteria.

The third procedure “eligibility” refers to making a further and more comprehensive evaluation of the articles and determining if the articles should be included or excluded (Moher et al., 2009). It starts with a full text screening of the included articles from abstract screening, then the reviewer check the articles against the inclusion and exclusion criteria again, and finally exclude the articles that do not meet the inclusion criteria (Moher et al., 2009).

Finally, the “included” procedure shows how many articles are included for data analysis. (Moher et al., 2009).

To further illustrate the PRISMA framework, one can refer to the PRISMA flow diagram in the result section (Figure 4).

3.2 Literature Selection

Literature selection refers to the process of deriving data for analysis from existing literatures. To acquire high quality literatures for analysis, it is essential to determine where to search for the data, what kind of data are needed, how to extract the data, etc. In this chapter, I will present the literature selection procedures with detail steps to allow reader a clear understanding of the methodology. This chapter is divided into two parts. The first section presents the inclusion and exclusion criteria. The second section presents the literature selection procedures such as the databases and keywords used to search for data and how to sort the data.

3.2.1 Inclusion and Exclusion Criteria

The articles must meet all of the following inclusion criteria to be included

1. English journal articles
2. Participants are children with ASD between age 0 to 18
3. Adopted intervention is visual aids
4. The intervention aim to reduce challenging behaviors
5. The article offers first hand information

If the articles meet any of the following exclusion criteria, it will be excluded

1. The articles is a review paper
2. Participants are individuals older than 18 years old
3. Adopted interventions are not visual aids
4. Adopted interventions are visual aids in combination with other strategies

Setting up appropriate inclusion and exclusion criteria was critical because it determined the relevance of the included articles and the overall quality of the review paper. To set up appropriate inclusion and exclusion criteria, I referred to the aim of the paper, which was to examine the effectiveness of visual aids in reducing challenging behaviors for children with ASD. There were three main elements in this aim and they were children with ASD, visual aids and challenging behaviors, which corresponded to the second to

fourth inclusion criteria. In addition, this review aimed to examine the effectiveness of visual aids, therefore, in order to capture the effectiveness from visual aids used by itself, literatures on visual cues intervention packages, such as visual cues combined with behavior therapies, speech therapies and others would not be included and this corresponded to exclusion criteria 3 and 4. The reason for this is because it would be difficult to determine to what extent the change in behavior is due to visual aids when the intervention package includes both visual aids and other strategies.

3.2.2 Literature Selection Procedure

The literature selection procedure could be divided into 3 parts. Firstly, I will present the databases used in the review. Afterwards, I will present the keywords used to search articles and finally, I will describe the method to sort the articles.

Databases

The databases used for searching was ERIC, PSYCINFO and MEDLINE.

The reason for choosing them was because they are popular databases in the fields. ERIC is a database for education science with more than 50 years of history. It is widely used by academics, researchers, educators, policymakers, and the general public (ERIC, 2014). It has over 1.4 million records (ERIC, 2014) and it can provide relevant articles in education field.

In addition, PsycINFO is one of the largest databases in psychology. It is run by the American Psychological Association for more than 50 years. It contains more than 3 million records (Beebe, 2010). PsycINFO can provide articles related to ASD in psychology field.

Finally, MEDLINE is a well-known database for life sciences and biomedical information. It is established for more than 50 years and has more than 25 million records (U.S. National Library of Medicine, 2019). Using MEDLINE will enable me to find relevant articles in the field of medicine and health care.

Search Keywords

After choosing the databases, the next step was to find relevant keywords to search on the databases. Since all three databases were available on OVID search platform, I was able to use the same keywords to search on all the databases.

They keywords for searching could be broken down into 3 levels as below:

Level 1: autis* OR autism spectrum dis* OR autistic* dis* OR Asperge* OR pervas* develop* dis* OR PDD OR ASD

Level 2.1: activit* schedule* OR visual schedule* OR picture* schedule* OR photo* schedule* OR visual prompt* OR picture prompt*

Level 2.2: contingency map* OR consequence* map* OR behavior* map*

Level 2.3: cue* card* OR note card* OR script card* OR visual cue* OR photo* cue*

Level 2.4: social narrative* OR social stor*

Level 2.5: symbol* exchange OR picture* exchange OR icon* exchange OR photo* exchange OR PECS OR picture* communication OR symbol* communication OR photo* communication OR icon* communication

Level 3: misbehav* OR misconduct* OR behavior*

These 3 levels of keywords corresponded to three elements in my research questions. The first level represented the participants in my research question, which were children with ASD between ages 0 to 18. The second level represented the interventions that I was inspecting, which were 5 types of visual aids and each type of visual aids corresponded to level 2.1 to 2.5. Finally, I examined how to reduce challenging behavior, which corresponded to level 3 of the search keywords.

Finding the correct keywords was crucial to the search. I used two methods to find keywords. First, I used the “Map Term” search tool on the OVID platform. This function would automatically match my keywords to the subject headings in the platform. Under the subject headings, a list of related terms (also called Thesaurus) would be shown. An

example of Thesaurus on ERIC OVID platform is showed in Figure 2. Then I carefully examined the definition and scope of each of the terms and picked relevant terms to be included as my keywords. I was able to use this method to find relevant keywords on Level 1. However, this method was only applicable to pre-defined vocabulary and terminology (i.e. autism). To find relevant keywords for level 2 and 3 via this method were not possible because 5 types of visual aids were not pre-defined terminologies. Therefore, I used another methods, which was to screen all the subject headings in relevant papers to sort out appropriate headings that were used in the field for 5 types of visual aids.

Figure 2

Thesaurus for Autism in ERIC OVID

Ovid®

Thesaurus for **Autism**

Combine with:

Select Term(s)	Subject Heading	Hits
<input type="button" value="▲"/> [Back up in List]		
<input type="checkbox"/> Authoritarianism ▼		815
	Authority Control (Information) (2004) ▼	
	Authority Files (2004) ▼	
	Authority Structure ▼	
<input type="checkbox"/> Authors ▼		5054
<input checked="" type="checkbox"/> Autism		13859
	[Broader Terms]	
<input type="checkbox"/>	Pervasive Developmental Disorders	8068
	[Related Terms]	
<input type="checkbox"/>	Anxiety Disorders	838
<input type="checkbox"/>	Applied Behavior Analysis	8
<input type="checkbox"/>	Asperger Syndrome	1104
<input type="checkbox"/>	Behavior Disorders	5778
<input type="checkbox"/>	Developmental Disabilities	5074
<input type="checkbox"/>	Emotional Disturbances	8686
<input type="checkbox"/>	Interpersonal Relationship	24503
<input type="checkbox"/>	Personality Problems	961
<input type="checkbox"/>	Schizophrenia	1153
<input type="checkbox"/>	Theory of Mind	749
<input type="checkbox"/>	Withdrawal (Psychology)	625
	Autism Spectrum Disorders ▼	
	Autistic Psychoopathy ▼	
	Autistic Savants ▼	
	Auto Body Repairers (2004) ▼	
	Auto Body Repairmen (1966-1980) (2004) ▼	
<input type="checkbox"/> Auto Mechanics ▼		1031
<input type="button" value="▼"/> [Forward in List]		

Note. Screen capture from ERIC OVID platform as of December 2019.

As shown in the keywords for searching, there are some special symbols and they represent certain functions of the databases. The symbol asterisk (*) was used frequently. It indicated that unknown character(s) could be placed at the end of a word (Case Western Reserve University, 2019). For example, using the search keyword “autism*” could retrieve records of autism, autistic, etc. Using the asterisk symbol allowed me to expand the search results.

Besides that, I used the OR and AND function. When terms were connected by AND, the database would retrieve records containing both terms; however, when the terms were connected by OR, the database would retrieve records containing either terms (Case Western Reserve University, 2019).

The search on ERIC OVID is shown in Figure 3. In short, it can be summarized as below:

(Level 1) AND (Level 2.1 OR Level 2.2 OR Level 2.3 OR Level 2.4 OR Level 2.5) AND (Level 3)

Figure 3

Search keywords on ERIC OVID

<input type="checkbox"/>	# ▲ Searches	Results	Type	Actions	Annotations
<input type="checkbox"/>	1 (autis* or Autism spectrum dis* or autistic* dis* or Asperge* or pervas* develop* dis* or PDD or ASD).mp. [mp=abstract, title, heading word, identifiers]	15074	Advanced	Display Results More ▾	
<input type="checkbox"/>	2 (Activit* schedule* or visual schedule* or picture* schedule* or photo* schedule* or visual prompt* or picture prompt*).mp. [mp=abstract, title, heading word, identifiers]	290	Advanced	Display Results More ▾	
<input type="checkbox"/>	3 (contingency map* or consequence* map* or behavior* map*).mp. [mp=abstract, title, heading word, identifiers]	37	Advanced	Display Results More ▾	
<input type="checkbox"/>	4 (Cue* card* or note card* or script card* or visual cue* or photo* cue*).mp. [mp=abstract, title, heading word, identifiers]	560	Advanced	Display Results More ▾	
<input type="checkbox"/>	5 (social narrative* or social stor*).mp. [mp=abstract, title, heading word, identifiers]	212	Advanced	Display Results More ▾	
<input type="checkbox"/>	6 (Symbol* exchange or Picture* exchange or Icon* exchange or Photo* exchange or PECS or Picture* communication or Symbol* communication or Photo* communication or Icon* communication).mp. [mp=abstract, title, heading word, identifiers]	224	Advanced	Display Results More ▾	
<input type="checkbox"/>	7 (misbehav* or misconduct* or behavior*).mp. [mp=abstract, title, heading word, identifiers]	200360	Advanced	Display Results More ▾	
<input type="checkbox"/>	8 2 or 3 or 4 or 5 or 6	1299	Advanced	Display Results More ▾	
<input type="checkbox"/>	9 1 and 7 and 8	197	Advanced	Display Results More ▾	
<input type="checkbox"/>	10 limit 9 to english language	197	Advanced	Display Results More ▾	

Note. Screen capture from ERIC OVID platform as of December 2019.

How to Sort the Articles

After gathering all the articles from the databases, I started sorting the papers. The first step of sorting the papers was putting all the citations into the ENDNOTE program. With the help of the program, I deleted all the duplicated records.

After that, I did a basic screening of the data. Following the guideline of PRISMA, I conducted abstract screening of all the search results. I compared the search results against all the inclusion criteria and exclusion criteria and only studies that fulfilled all the inclusion criteria and did not meet any exclusion criteria were included.

The next step was to conduct full text screening, where I read the full text of the included articles from abstract screening. During full text screening, I compared the article against all the inclusion criteria and exclusion criteria just as in the abstract screening procedure, and only articles that fulfilled all the inclusion criteria and did not meet any exclusion criteria were included. Full text screening was crucial because it increased the chance of finding the correct articles to answer the research questions as abstract screening relied on limited information in the abstracts so there might be missed information or incorrect interpretation during the process.

After full text screening, all the included articles were proceeded for further analysis.

3.3 Data Extraction

Data extraction procedures followed the full text screening procedure. During this procedure, I extracted information from the included articles on participants, targeted behaviors, interventions employed and their context and the research settings. In the following, I will present how I extracted each of these information.

Regarding participants' information, I extracted them from the participant chapter in the included articles. I gathered information on characteristics of the participants in regard of their age, sex, diagnosis, conditions and number of participants. Extracting participants data was essential because it showed whether the participants chosen could best inform the research questions and whether the data could help understand the phenomenon being studied (Sargeant, 2012).

After that, I extracted information on target behaviors. Target behaviors were the types of challenging behaviors that the researchers aimed to reduce for their participants. This information could be found in the methodology or research aims chapter in the articles. Information on target behaviors was relevant as it showed the prevalence on the types of challenging behaviors among children with ASD.

In addition, I extracted information on intervention context. I inspected what types of visual aids were conducted and their context from the included articles. These information could be found in the methodology chapter as well. The information was important because it allowed a clear inspection on visual-aid interventions in regards of their types, characteristics and setups and they may help to interpret the function and effectiveness of visual aids.

Finally, I extracted information on research setting. Upon reading the methodology chapter, I collected information on the experimental design, the setting of the experiment, materials used in the experiment, procedures of the experiment and data collection methods in the experiment. These information is important as it tells the rigor and quality of the papers and whether the analysis was trustworthy.

3.4 Data Synthesis

Data synthesis refers to pulling together the extracted results and evaluating them to allow a comparison of different studies to produce the outcomes for review papers (Baxter, Cooper, Hedges, & Valentine, 2009). Data synthesis is commonly used in systematic reviews to generate outcomes and new knowledge. There are two main types of data synthesis methods: qualitative data synthesis and quantitative data synthesis (Seers, 2012; Lau, Ioannidis, Schmid, 1997). Both of them were employed in this review paper.

3.4.1 Qualitative Data Synthesis

Qualitative data synthesis is usually used in reviewing qualitative research papers to generate new data. While quantitative synthesis method is well established, qualitative synthesis is a relatively new method and currently in the process of development (Seers, 2012). The main difference between these two data synthesis methods is that quantitative

synthesis involves summarizing numerical findings, while qualitative data synthesis involves drawing findings and analysis from qualitative data (Lau, Ioannidis, Schmid, 1997). Qualitative data synthesis is important as it recognizes the importance of qualitative data such as participants' perspectives, preferences and values, which serves as a support for quantitative findings (Lau, Ioannidis, Schmid, 1997). It also provides a descriptive outcomes and it is good in answering what and how research questions (Lau, Ioannidis, Schmid, 1997).

In this article, I did not limit the application of qualitative synthesis to retrieve data from qualitative research only. I used qualitative synthesis to extract qualitative data from quantitative research. Qualitative synthesis was suitable in collecting data on intervention context, research settings, participants' features, etc. By collecting these data, I was able to answer the first and second research questions, which were the research frequency of visual aids used to change challenging behaviors for children with ASD and the settings and contexts of the interventions.

3.4.2 Quantitative Data Synthesis

To answer my third research question, that is, what are the effect sizes of visual-aid interventions used to change challenging behaviors for children with ASD, I employed quantitative data synthesis. As previously mentioned, quantitative synthesis involves summarizing numerical findings, which is effect size in this article (Lau, Ioannidis, Schmid, 1997). I calculated the effective size of all the included articles using the Percentage of Non-overlapping Data (PND) method and the Percentage of Data Exceeding the Median (PEM) method. By comparing the effect size, I hope to inspect the effectiveness of the interventions.

The reason for adopting two-effect size indexes was to allow researchers and readers to interpret the effectiveness of the interventions more accurately. Even though both indexes reflected the effectiveness of the interventions, they measured effectiveness from different perspectives and have different mathematical formulas (Şen, & Şen, 2019). I will explain what they measured in detail in section 3.4.2.1 and 3.4.2.2. By comparing two indexes, it could increase the interpretation accuracy of effectiveness. For example, when both indexes indicate the same level of effectiveness then the data tend to be

reliable. On the contrary, if they indicate different level of effectiveness, then I will further inspect the data to find out the reason behind the differences.

In the following section, I will introduce and explain these two effect size indexes employed in the article.

Percentage of Non-overlapping Data (PND)

PND is proposed by Scruggs, Mastropieri, & Casto (1987) as an effect size index for single subject design studies. It is defined as the proportion of observations in intervention phase that exceed the maximum baseline value (Scruggs, Mastropieri, & Casto, 1987). PND is an easy method, which is commonly used among researchers to calculate effect size index. It does not requires raw data, and thus it is a popular choice for review studies. The calculation of PND are described in the following steps:

1. Determine the highest value in baseline stage in the graph
2. Determine the number of data points in the intervention stage that exceeds the highest value mentioned above
3. Divide the number of data points mentioned in step two by the total number of data points in the intervention stage, and multiply it by 100

PND values range from 0 to 100. According to Scruggs, Mastropieri, & Casto (1987), a PND value over 90 represents a “very effective” intervention, a value between 71 to 90 represents an “effective” intervention, a value between 50 to 70 represents a “questionable” effect and a value under 50 represents an “ineffective” intervention.

PND index has many advantages. Firstly, it is easy to calculate since it has a very simple mathematical formula (Ma, 2006). Secondly, it is easy to interpret as PND value can represent different level of effectiveness as mentioned in the previous paragraph (Scruggs, Mastropieri, & Casto, 1987). Thirdly, PND index does not require raw data and it is possible to calculate from the graph, which allows other researchers to adopt in their review studies (Scruggs, Mastropieri, & Casto, 1987).

However, PND also has some drawbacks. Firstly, PND only takes account of the highest (or lowest) value in the baseline level and ignores the other values and thus affect its

representativeness (Şen, & Şen, 2019). Secondly, PND cannot reflect effectiveness when there is a floor (0) or ceiling (100) value presented in the baseline level (Ma, 2006). This is due to its mathematical limitation that PND index will always be 0 when a floor or ceiling value is presented regardless of how the rest of the data are distributed (Ma, 2006). To solve these problems, I adopt another effect size index PEM along PND as PEM takes account of the median in the baseline level and is less affected by the floor and ceiling values.

In addition, PND's drawbacks also includes that it does not reflect the p value, the changes within the baseline level and intervention level or the sample distribution (Şen, & Şen, 2019). However, since I am not trying to find a linear relationship between the intervention and outcomes (problem behaviors) or the significance of the intervention, thus these values are not necessary to answer my research question.

Percentage of Data Exceeding the Median (PEM)

PEM is proposed by Ma (2006) as an alternative method to calculate effect size index in single subject design studies. It is defined as the proportion of observations in intervention phase that exceed the median baseline value (Ma, 2006). The calculation of PEM can be described as the following steps:

1. Determine the median value in baseline stage in the graph
2. Determine the number of data points in the intervention stage that exceeds the median value mentioned above
3. Divide the number of data points mentioned in step two by the total number data points in the intervention stage, and multiply it by 100

PEM values range from 0% to 100%. According to Ma (2006), a PEM value between 91% and 100% represents a “very effective” intervention, a PEM value between 70% to 90% represents a “moderately effective” intervention, a PEM value between 50% to 70% represents a “questionably effective” intervention and a PEM value below 50% represents an “ineffective” intervention.

PEM index shares many same advantages with PND, such as it is easy to calculate and interpret and possible to calculate from the graph. Additionally, PEM is less affected by the ceiling or floor values in the baseline level than the PND index (Ma, 2006).

However, PEM index also has some drawbacks. Firstly, it only takes account of the median in the baseline level and ignores the data points above it (Ma, 2006). This problem can be tackled by introducing the PND index, which takes account of the highest (or lowest) value in the baseline level. The other drawback is that PEM index does not indicate changes within the baseline level and the intervention level (Ma, 2006).

However, these values are not relevant for my research because I am not trying to find a linear growth or decrease of challenging behaviors.

4. Results

I will present my research findings in this chapter. The results chapter is divided into 4 parts. They are the flow-chart of the study selection (4.1), study description (4.2), answer to research questions on the frequency of visual-aid interventions for changing challenge behaviors for children with ASD, settings and contexts of the interventions and effectiveness of the interventions (4.3 to 4.5).

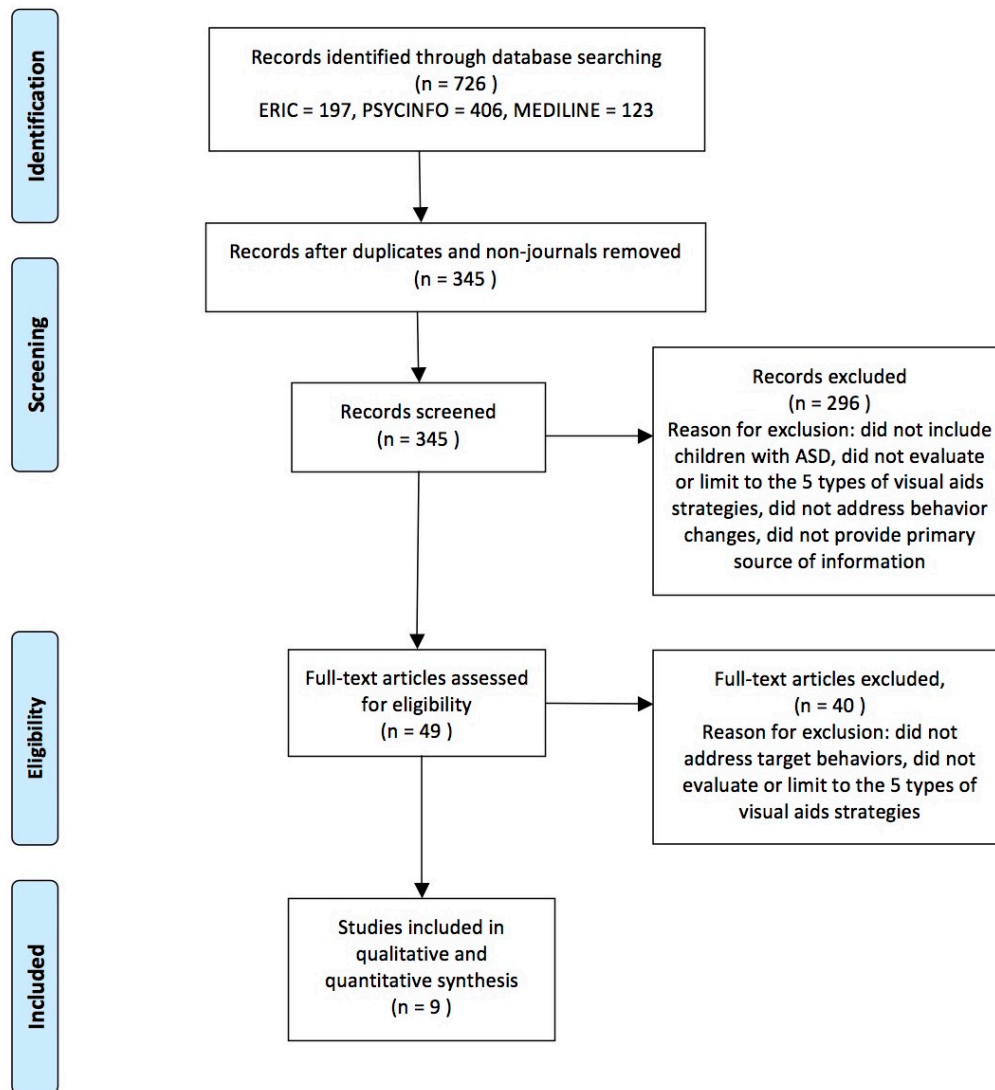
4.1 Flow-chart of Study Selection

This study adopted the PRISMA framework as the research design. The flow-chart of the study selection process in accordance with the PRISMA method is presented in Figure 4.

In addition, the table used for abstract screening and full text screening with detailed inclusion and exclusion criteria is presented in Appendix A and the full list of the screened articles with references is presented in Appendix B.

Figure 4

PRISMA flowchart of the study selection process



Note. This flowchart is adapted from “Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.” by D. Moher, A. Liberati, J. Tetzlaff, D. G. Altman, The PRISMA Group, 2009, *PLoS Med*, 6(7): e1000097. doi:10.1371/journal.pmed1000097

4.2 Description of Study

As shown in the PRISMA flowchart, I was able to identify 726 articles from databases ERIC, PSYCINFO and MEDLINE. After removing duplicate and non-journal articles, 345 articles remained. These articles were screened by abstract and 296 articles were excluded. 49 articles remained and they were furthered screened by full text and 9 articles remained which would be analyzed for this review article.

4.3 Research Frequency of the Visual-Aid Interventions

My first research question is: what is the research frequency of different visual-aid interventions used in changing challenging behaviors for children with ASD. To answer this question, I looked into the 9 included articles to find out the number of times the visual-aid interventions were adopted and calculated their percentage. The results are presented in Table 1. In addition, there are 12 visual interventions in total as showed in the table. This is due to 3 included articles adopted more than one types of visual interventions.

Table 1
The Number of Visual-Aid Interventions Used in the Included Articles

Intervention Type (N=5)	Total number of visual intervention used	Number of Intervention in Percentage
	No. of interventions (N=12)	100
Social Narratives	6	50%
Symbol Exchange	4	33%
Activity Schedule	2	17%
Cues Cards	0	0%
Contingency Map	0	0%

4.4 Settings and Contexts of the Visual-Aid Interventions

My second research question is: what are the settings and contexts of the visual-aid interventions used in changing challenging behaviors for children with ASD. To answer this question, I inspected the participants' characteristics, targeted behaviors, interventions' employed, intervention context and settings in 9 included articles. My findings are summarized into Table 2.

4.4.1 Participants' Characteristics

The sample size ranged from 1 to 3 participants in the included articles with a total number of 18 participants in the studies, among which 13 participants met the inclusion criteria for analysis. 5 participants were excluded because they did not meet the inclusion criteria regarding autism diagnosis (Anderson, et al., 2016; Okada, et al., 2008; Scattone, et al., 2002)

Among the 13 participants that met the inclusion criteria, all were diagnosed with autism and 2 were described to have moderate range of intellectual disability while the others' intellectual levels were not mentioned. These 13 participants' age ranged from 3 to 12 years old. Among them, 2 were female (15%) and 11 were male (85%). Regarding language abilities, 2 were described to be non-verbal, 6 were described to have language impairment, 3 were described to have concrete verbal skills, and 2 were not reported.

Table 2*Summary and analysis of included articles in terms of intervention context and settings*

Included studies	Participants' characteristics	Targeted Behaviors	Intervention employed	Intervention Context	Intervention Settings
Agosta et al. (2004)	N=1/1 1 male (Autism, described as non verbal, delay in all development areas) 6 years old	Verbal aggression: screaming	Social narratives and symbol exchange: social stories combined with the picture communication symbols	<ul style="list-style-type: none"> • Two social stories were developed for the participant • The social stories were illustrated with pictorial icons to help the student to understand • Social stories consisted of three descriptive sentences, one directive sentences and one perspective sentence. • Social stories matched the guidelines from Gray (1994) 	<p>Setting</p> <ul style="list-style-type: none"> • Single subject design • Special education classroom in mainstream school • Teacher involvement <p>Procedures</p> <p>Baseline was compared to social stories intervention:</p> <ul style="list-style-type: none"> • Training: teacher was trained to read the social stories to students • Baseline stage: screaming was recorded when loud and distressing noises occurred within 15-s interval during targeted time • Intervention stage 1: teacher read the first social story to the participants. Tangible rewards were given to the children for sitting quietly for 5-minute. Screaming was recorded. • Intervention stage 2: teacher read the second social story to the participants. Verbal reward was given to the children for sitting quietly for 5-minute. Screaming was recorded. • Intervention stage 3: Only verbal reminder and verbal praise are given to the child. Screaming was recorded.
Anderson et al. (2016)	N=2/3 1 Male, 1 Female (Autism, described as verbal but have speech language impairment) 5 to 6 years old	Physical aggression: yelling or screaming at adults and/or other students, hitting, kicking, biting, spitting, or throwing desks and/or chairs	social narratives: literacy-based behavioral interventions (LBBI)	<ul style="list-style-type: none"> • LBBI is a story that describes a situation, skills, or behaviors to help a person to understand specific situations. • LBBI in this research is presented in the format of PowerPoint story • LBBI in this research contained photographs of people and areas in the school, the time period where the behaviors occurred, and a strategy for the student to use to avoid an undesired situation 	<p>Setting</p> <ul style="list-style-type: none"> • Single subject design • Carried out three times a day at special education preschool and at home • Teacher involvement <p>Procedures</p> <p>Baseline was compared to LBBI intervention:</p> <ul style="list-style-type: none"> • Baseline stage: the number of episodes of physical aggression during the targeted time period was recorded • Training: students received training from the special education teacher about how to read his/her LBBI. • Intervention stage: students read his/her narrated story at home (7:15-7:45am), before the target time period (lunch or writing) and at the end of the school day. The number of episodes of physical aggression during the target time period was recorded.

Table 2 (continued.)

Included studies	Participants characteristics	Targeted Behaviors	Intervention employed	Intervention Context	Intervention Settings
Dooley et al. (2001)	N=1/1 1 male (PDD, described as having sufficient nonverbal reasoning abilities but with impairments in communication) 3 years old	Verbal aggression: loud and distressed crying and screaming Physical aggression: hitting, kicking or biting	symbol exchange and activity schedule: A PECS-based schedule	<ul style="list-style-type: none"> • A PECS-based schedule with pictures • The schedule consisted of line drawings representing daily activities and locations. 	<p>Setting</p> <ul style="list-style-type: none"> • Single subject design • Special education preschool • Teacher involvement <p>Procedures</p> <p>Baseline compared with PECS-based schedule intervention:</p> <ul style="list-style-type: none"> • Baseline stage: the number of episodes of problem behaviors during targeted time period was recorded • Intervention stage: the teacher and the student reviewed the activity schedule together. The participant took the first picture out from the schedule and was taken to the first activity. The participant received a pretzel as a reward after activity. After 6 days, the PECS-based schedule continued without the reward. The number of episodes of problem behaviors during target time period was recorded everyday.
Freia et al. (2001)	N=1/1 1 Male (Autism, moderate range of Intellectual disability, described as nonverbal) 4 years old	Physical aggression: biting, kicking or hitting	symbol exchange: PECS	<ul style="list-style-type: none"> • PECS board consisted of four picture symbols. They were drink, cracker, bubbles and fruit bar • PECS board was placed in the center of the classroom. 	<p>Setting</p> <ul style="list-style-type: none"> • Single subject design • General education preschool classroom • Teaching assistant involvement <p>Procedures</p> <p>Baseline was compared with PECS intervention:</p> <ul style="list-style-type: none"> • Baseline stage: the number of disruptive behaviors during targeted time period was recorded • Training: Two 1 hour training session were conducted by the assistant to teach the participants how to use the PECS prior to the intervention • Intervention stage: PECS was introduced to the Home Living center. The number of disruptive behavior was recorded. After an effect was observed, PECS was then introduced to the Manipulatives center. The number of disruptive behavior was recorded.
Mancil et al. (2009)	N=3/3 2 male 1 female (ASD, described as having concrete verbal skills) 6 to 9 years old	Physical aggression: pushing, grabbing, touching and shoving other children	Social narratives: social stories that follows Gray's (2000) guidelines	<ul style="list-style-type: none"> • Social stories in paper and computer format • Social stories in paper format included pictures of students, classroom locations, etc. • Social stories Computer format were presented in PowerPoint format with the same pictures and text as the paper format. But it had interactive text with changing colors. 	<p>Setting</p> <ul style="list-style-type: none"> • Single subject design • General education classroom • Teacher involvement <p>Procedures</p> <p>Baseline is compared with intervention:</p> <ul style="list-style-type: none"> • Baseline: teachers counted the targeted behavior occurrence during the targeted time period • Training stage: participants were trained by the teachers to read the social story. Questions were asked to ensure his/her understanding of the social stories. • Intervention stage: students read social stories in paper format at desk, the number of targeted behavior occurrence was recorded. Students read PowerPoint format social stories at the computer located at the back of the classroom, the number of targeted behavior occurrence was recorded. • Generalization: To test the generalization ability of intervention to other environment, the number of targeted behavior occurrence was recorded during recess.

Table 2 (continued)

Included studies	Participants characteristics	Targeted Behaviors	Intervention employed	Intervention Context	Intervention Settings
Okada et al. (2008)	N=1/3 1 Male (ASD, moderate range of intellectual disability) 12 years old	Verbal aggression	Social narratives: social stories that follows Gray's (2000) guidelines	<ul style="list-style-type: none"> • Social stories with icons, internet photos and perspective sentences. • Social stories with icons and internet photos, but without perspective sentences. 	<p>Setting</p> <ul style="list-style-type: none"> • Single subject design • Special school classroom • Teacher involvement <p>Procedures</p> <p>Baseline was compared with intervention:</p> <ul style="list-style-type: none"> • Baseline stage: the number of participants' aggressive verbal behaviors in targeted time period was recorded. • Stage 1: Social Stories without perspective sentences was read by teachers to the student. The number of aggressive verbal behaviors was recorded. • Stage 2: Social Stories with perspective sentences was read by the student. The number of aggressive verbal behaviors was recorded.
Scattone et al. (2002)	N=1/3 1 Male (ASD, described as not able to read independently) 7 years old	Verbal aggression: shouting	Social narratives: social Stories that follows Gray's (2000) guidelines	<ul style="list-style-type: none"> • Social Stories were eight pages in total and printed on paper. It consisted of targeted situation and expected behaviors from the participant. 	<p>Setting</p> <ul style="list-style-type: none"> • Single subject design • Special education classroom in mainstream school • Teacher involvement <p>Procedures</p> <p>Baseline was compared with intervention:</p> <ul style="list-style-type: none"> • Baseline: the number of occurrence of episodes of challenging behaviors in targeted time period was recorded • Intervention stage: when the intervention is first introduced, teacher read the Social Stories to the participants and asked questions related to the Social Stories to check comprehension. Afterwards, teacher read the Social Stories to the student every morning before class began. The number of occurrence of episodes of challenging behaviors in targeted time period was recorded.
Kuttler et al. (1998)	N=1/1 1 male (ASD, limited language skills which estimated to be in the range from 2 to 5 years old) 12 years old	Verbal aggression: screaming and cussing Physical aggression: dropping to the floor	Social narratives and symbol exchange: social stories (that follows Gray's 1994 guidelines) combined with the picture communication symbols	<ul style="list-style-type: none"> • Two social stories were introduced for two settings. • Each social stories consisted of 5 to 7 pages. Each page had 1 to 2 short sentences paired with an icon. 	<p>Setting</p> <ul style="list-style-type: none"> • Single subject design • Special classroom (school type not specified) • Teacher involvement <p>Procedures</p> <p>Baseline was compared with intervention:</p> <ul style="list-style-type: none"> • Baseline: the number of occurrence of targeted behaviors in two settings in target time period were recorded • Intervention: social stories were read to the students by classroom staff. The number of occurrence of targeted behaviors in both morning work time and lunchtime were recorded.

Table 2 (continued)

Included studies	Participants characteristics	Targeted Behaviors	Intervention employed	Intervention Context	Intervention Settings
Waters et al. (2009)	N=2/2 2 male (ASD, described as verbal but have speech language impairment) 6 years old	Physical aggression: hitting, kicking, biting, scratching the therapist, throwing objects, pushing furniture over and falling to the floor	activity schedule	<ul style="list-style-type: none"> The activity schedules were made of a set of pictures with text for each activity (music, computer, work) to cue the participants to engage in an sequence of activities. A binder with hook-and-loop tape was used to facilitate the cueing. 	<p>Setting</p> <ul style="list-style-type: none"> Single subject design Special education classroom in mainstream school <p>Procedures</p> <ul style="list-style-type: none"> Baseline was compared with intervention: Baseline: the number of problem behaviors during transition was recorded Intervention: the therapist conducted activity schedules with the participants and recorded the number of problem behaviors during transition

Note. N: number of participants included in this review/total number of participants in study

4.4.2 Target Behaviors

Across the studies, target behaviors were divided into 3 types. They were verbal aggression, physical aggression and self-harm. Among the 13 participants, 3 had verbal aggression as targeted skill with interventions designed to improve behaviors such as shouting, screaming and loud and distress crying (Agosta, et al., 2004; Dooley, et al., 2001; Okada, et al., 2008; Scattone et al., 2002). 8 participants had physical aggression as targeted skill with interventions designed to improve behaviors such as hitting, kicking, biting, spitting, pushing, grabbing, touching or throwing desks and/or chairs, and shoving other children (Anderson, et al., 2016; Dooley, et al. 2001; Frea, et al. 2001; Mancil, et al. 2009). 2 participants had both verbal aggression and physical aggression as targeted skills (Dooley, et al., 2001). 0 had self-harm as targeted skill.

4.4.3 Interventions Employed and Their Context

Social narratives, symbol exchange and activity schedules were employed as interventions in the included articles.

The most popular visual intervention was social narratives, which was used 6 times in the studies. Among these, 5 times were social stories following the guidelines from Gray (1994 & 2000) and 1 time was literacy-based behavioral interventions (LBBI). In the studies, social stories were written from the perspective of the children with pictorial icons, internet-photos and pictures to help illustrate a situation or a skill (Agosta, et al., 2004; Kuttler, et al., 1998; Mancil, et al., 2009; Okada, et al., 2008; Scattone, et al., 2002). Some social stories were also developed specifically for the participants with the help of the teachers (Agosta, et al., 2004). All the social stories followed Gray (1994 & 2000)'s guidelines and they consisted of a few of the following sentences: descriptive sentences, directive sentences, perspective sentence, affirmative sentences, control sentences, cooperative sentences or partial sentences. LBBI on the other hand is also a type of social narratives. It is a story that describes a situation, skills, or behaviors to help a person to understand specific situations (Anderson et al., 2016). In the included studies, LBBI contained photographs of people and areas in the school, the time period where the behaviors occurred and a strategy for the student to use to avoid an undesired situation (Anderson et al., 2016). LBBI did not follow Gray's guideline and thus did not have

specific requirements on the ratio between cooperative, descriptive, perspective and control sentences (Anderson et al., 2016).

Symbol exchange was the second most popular intervention in the studies, which was used 4 times. Among them, 2 times were PECS and 2 times were the picture communication symbols. In the studies, PECS helped participants to achieve functional communication through photos and symbols representing daily activities, locations and items while the picture communication symbols interventions used pictorial icons to help the student to understand situations (Agosta, et al., 2004; Kuttler, et al., 1998; Dooley, et al., 2001; Frea, et al., 2001). Both PECS and the picture communication symbols were very similar in terms of functions and format. They both strengthened communication but with different established systems that consisted of their own set of communication pictures and symbols.

Activity schedule came after symbol exchange. It was used twice in the studies (Dooley, et al., 2001; Waters, et al., 2009). Dooley, et al. (2001)'s study used a schedule consisted of line drawings representing daily activities and locations. The participant in the study reviewed the schedule board with the teachers or assistants and then removed the first picture and went to that activity (Dooley, et al., 2001). While in Waters, et al. (2009) study, pictures representing the current and future activities were used and activity schedule was conducted by a therapist.

When it comes to adopting only one type of visual aids or combined visual aids, among the 9 included studies 4 adopted only social narratives, 1 adopted only symbol exchange, 1 adopted only activity schedule, 1 adopted symbol exchange in combination with activity schedules and 2 adopted social narratives in combination of symbol exchange (Agosta, et al., 2004; Dooley, et al., 2001; Kuttler, et al., 1998; Okada, et al., 2008; Scattone et al., 2002; Anderson, et al., 2016; Frea, et al. 2001; Mancil, et al. 2009; Waters, et al., 2009). Therefore, it was possible to combine 2 or more visual aids and it seemed like symbol exchange was the easiest and most popular one to be combined with other types of visual aids.

4.4.4 Intervention Settings

In this intervention settings section, I will describe the experimental design, experimental location, teacher involvement and training in the included articles.

Regarding experimental design, all included studies adopted single subject design, which is defined as an experiment that uses the participant as his/her own control (Horner, & Spaulding, 2010). Single subject design is very common in the field of psychology and education (Horner, & Spaulding, 2010). It is very suitable for research on visual aids in promoting behavioral change for children with ASD because single subject design is very sensitive to individual differences and allows an easy comparison of the individual differences before and after the visual-aid intervention. Regarding the included articles, their research procedures involved comparing baseline data (data before intervention) with after-intervention data. This comparison was done by comparing the number of episodes of challenging behaviors occurred in targeted time period during baseline stage with after intervention (i.e. Scattone, et al., 2002). The intervention stage might be further divided into 2 or more stages if the intervention was carried out in multiple steps to control for variables (i.e. Agosta, et al., 2004; Okada, et al., 2008). Detail research procedures are presented in Table 2.

In regards of the experimental location, classroom was the most popular setting. Among the included articles, 8 studies were carried out in classroom setting (i.e. Agosta, et al., 2004; Frea, et al., 2001; Kuttler, et al., 1998; Mancil, et al., 2009; Scattone, et al., 2002; Dooley, et al., 2001; Okada, et al. 2008; Waters, et al., 2009) and 1 study was carried out in both classroom and home settings (i.e. Anderson, et al., 2016). Apart from that, school type was taken into consideration. Among the 9 studies, 5 studies took place in mainstream school, among which 3 were in special education classroom (i.e., Agosta, et al., 2004; Scattone, et al., 2002; Waters, et al., 2009) and 2 were in general classroom (i.e. Frea, et al., 2001; Mancil, et al., 2009) while 3 other studies took place in special school (i.e. Anderson, et al., 2016; Dooley, et al., 2001; Okada, et al. 2008) and 1 study took place in special classroom but the school type was not specified (Kuttler, et al, 1998). Thus, it seemed like school type did not play a crucial role in this research topic.

Regarding teacher involvement, 8 studies involved teacher (or teaching assistant) and researcher partnership. However, the degree of involvement differed. 5 studies had

teachers' active involvement during the intervention stage (i.e., Agosta, et al., 2004; Dooley, et al., 2001; Okada, et al., 2008; Scattone, et al., 2002; Kuttler, et al, 1998). In these studies, teachers played a crucial role in the intervention stage such as reading the social stories to the participants or reviewing activity schedule with the student (Agosta, et al., 2004; Dooley, et al., 2001). However, the other 3 studies only had teachers' involvement in pre-training the students to read/use the visual-aid intervention but not actively carrying out the visual-aid intervention during the intervention stage. Rather, they had the participants' reading/practicing the intervention by themselves (i.e., Anderson, et al., 2016; Frea, et al., 2001; Mancil, et al., 2009). 1 study did not involve teacher at all. It employed a therapist in conducting the intervention (Waters, et al., 2009).

The degree of pre-training provided also differed among the studies. 4 studies introduced the training section before the intervention (i.e., Agosta, et al., 2004; Anderson, et al., 2016; Frea, et al., 2001; Mancil, et al., 2009). However, the other 5 studies did not have a training section prior to the intervention (i.e., Dooley, et al., 2001; Okada, et al., 2008; Scattone, et al., 2002; Kuttler, et al, 1998; Waters, et al., 2009).

4.5 Effectiveness of the Visual-Aid Interventions

My third research question is: what are the effect sizes of visual-aid interventions used to change challenging behaviors for children with ASD. To answer this question, I calculated the effect size of each included articles into PND and PEM indexes and presented them in accordance with the intervention type. The results are showed in Table 3 to 7 below.

In addition, I will discuss the effect size of each types of visual aids in terms of PND and PEM indexes. I will explore what the indexes represent and if there is any discrepancy between the indexes.

4.5.1 Effect Size of Social Narratives

There were 4 articles that adopted social narratives by itself as the intervention to promote behavior change. The effect size of each article is presented in Table 3.

Regarding the PND index, with a total number of 7 participants in 4 articles, social narratives were very effective for 5 students, effective for 1 student, and questionable for 1 students.

As for the PEM index, social narratives were very effective for all 7 students.

There were discrepancies between PND and PEM indexes. First, there was a difference in the degree of effectiveness in Anderson et al. (2016)'s article. One of the participants, Jessica's PND index was 73,3% which indicated that the intervention was effective while her PEM index was 100% which indicated that the intervention was very effective. However, the discrepancy between these two effect sizes was small as both indicated that the intervention was effective but had a slight difference in the degree of effectiveness. The other discrepancy was found in Scattone et al. (2002)'s article where the PND index was 50% while the PEM index was 90%. PND indicated that the intervention was questionable, while PEM index indicated that it was effective. To explain this discrepancy, I examined the original data. The PND index was not very reliable in this case because the data in the baseline stage was very unstable as it increased and decreased dramatically that the lowest value in baseline was close to 0. This created a floor effect (a close to 0 value) that the PND tended to underestimate the effectiveness of the intervention due its mathematical limitations (Ma, 2006). The PEM value was more reliable in this study, which indicated that the intervention was effective.

Overall, the results showed that social narratives were likely to be effective in reducing challenging behaviors for children with ASD.

Table 3*Effect size of social narratives*

Intervention Employed	Included studies	Effect Size	Findings	
Social narratives	Anderson et al. (2016)	Henry: PND = 100% PEM = 100%	<ul style="list-style-type: none"> • positive: both students showed decreased physical aggression after implementing social narratives (LBBT) • PND index: indicated that LBBT was effective and very effective respectively for two students • PEM index: indicated that LBBT was very effective for both students 	
		Jessica: PND = 73,3% PEM = 100%		
	Mancil et al. (2009)	Victor PND = 95% PEM = 100%		<ul style="list-style-type: none"> • positive: after implementing social stories, physical aggression decreased in classroom settings • PND indication: social stories were very effective for all 3 participants in classroom setting, • PEM indication: social stories were very effective for all 3 participants in classroom setting
		Billy PND = 100% PEM = 100%		
		Denise: PND = 100% PEM = 100%		
Okada et al. (2008)	PND = 100% PEM = 100%	<ul style="list-style-type: none"> • positive: verbal aggression decreased after implementing social stories • PND index: indicated that social stories was very effective • PEM index: indicated that social stories was very effective 		
Scattone et al. (2002)	PND = 50% PEM = 90%	<ul style="list-style-type: none"> • positive: a decrease in verbal aggression was detected after implementing social stories • PND index: indicated that effectiveness of social stories was questionable • PEM index: indicated that social stories was effective 		

4.5.2 Effect Size of Symbol Exchange

There was one article adopting symbol exchange by itself as the intervention. The effect size is showed in the Table 4.

Regarding the PND effect size, it indicated that symbol exchange was ineffective in both home living setting and manipulative setting.

As for the PEM effect size, it indicated that symbol exchange was very effective in both home living setting and manipulative setting.

There was a discrepancy between the two indexes. Both PNDs were 0% and both PEMs were 100%. To explain the differences, I inspected the data and found that PND failed to behave as an effect size value in this study because multiple 0 values were presented at the baseline level. Due to the mathematical limitation of PND, when there was a 0 value presented at the baseline level, it would result in a 0% PND index, and therefore, PND could not accurately reflect effect size in this case. Therefore, only PEM should be used as the indication of the effectiveness of the intervention in this case.

Overall, the findings showed that symbol exchange was likely to be very effective. However, the result was not conclusive due to limited sampling.

Table 4

Effect size of symbol exchange

Intervention Employed	Included studies	Effect Size	Findings
symbol exchange	Frea et al. (2001)	Home living setting: PND = 0% PEM = 100% Manipulatives setting: PND = 0% PEM = 100%	<ul style="list-style-type: none"> • positive: the participants physical aggression behavior decreased when PECS was introduced to his daily play routines • PND index: indicates that PECS was ineffective • PEM index: indicates that PECS was very effective

4.5.3 Effect Size of Activity Schedule

There was one article adopting activity schedule by itself as the intervention. The effect size is showed in Table 5.

Regarding the PND and PEM indexes, both indicated that the intervention was ineffective for both participants.

There was no discrepancy between the two indexes, which showed that activity schedule seemed ineffective in changing problematic behaviors for children with ASD. However, this result was not conclusive due to limited sampling.

Table 5

Effect size of activity schedule

Intervention Employed	Included studies	Effect Size	Findings
Activity schedules	Waters, et Vern al. (2009)	PND = 0% PEM = 0%	<ul style="list-style-type: none">• negative: the participants physical aggression behavior did not decrease after activity schedule was introduced• PND index: indicated that activity schedule was ineffective• PEM index: indicated that activity schedule was ineffective
	Jimmy	PND = 0% PEM = 0%	

4.5.4 Effect Size of Social Narratives and Symbol Exchange as a Combined Intervention

There were two articles adopting combined social narratives and symbol exchange as their intervention. The effect size is showed in Table 6.

Regarding the effect size, PND indicated that social narratives and symbol exchange combined were effective for 1 participant and very effective for the other 2.

As for PEM, it indicated that social narratives and symbol exchange combined were very effective for all 3 participants.

The discrepancy between PND and PEM was small as both indexes indicated that the intervention was effective. The only difference was that the degree of effectiveness varied from effective to very effective. Therefore, it could be concluded that combined social narratives and symbol exchange were likely to be effective in changing challenging behaviors.

Table 6

Effect size of social narratives and symbol exchange as a combined intervention

Intervention Employed	Included studies	Effect Size	Findings
Social narratives and symbol exchange	Agosta et al. (2004)	PND = 80% PEM = 90%	<ul style="list-style-type: none"> • positive: the number of screams decreased and the length of quiet behavior increased during all stages • PND index: indicated that social narratives and symbol exchange combined were effective • PEM index: indicated that social narratives and symbol exchange combined were effective
	Kuttler, et al. (1998)	Morning work time setting: PND = 100% PEM = 100% Lunch time setting: PND = 91% PEM = 100%	<ul style="list-style-type: none"> • positive: the number of verbal and physical aggression decreased after introducing the intervention • PND index: indicated that social narratives and symbol exchange combined were effective • PEM index: indicated that social narratives and symbol exchange combined were very effective

4.5.5 Effect Size of Symbol Exchange and Activity Schedule as a Combined Intervention

There was one article adopting symbol exchange and activity schedule as its intervention. The effect size is showed in Table 7.

Regarding the effect size, both PND and PEM indicated that symbol exchange and activity schedule combined were very effective. There was no discrepancy between the PND and PEM index.

As previously mentioned that combined social narratives and symbol exchange also seemed to be effective, my findings suggested that combined visual aids in general were likely to be effective in changing challenging behaviors.

Table 7

Effect size of symbol exchange and activity schedule as a combined intervention

Intervention Employed	Included studies	Effect Size	Findings
symbol exchange and activity schedule	Dooley, et al. (2001)	PND = 100% PEM = 100%	<ul style="list-style-type: none">• positive: the number of disruptive behaviors decreased and compliance increased after introducing the intervention• PND index: indicated that symbol exchange and activity schedule combined were very effective• PEM index: indicated that symbol exchange and activity schedule combined were very effective

5. Discussion

In this chapter, I will discuss and interpret the findings of my research questions (5.1 to 5.3). Thereafter I will present the reliability and validity of the findings (5.4). Before moving on to discuss the limitations of the chosen research method and the resulting findings(5.5). Finally, I will discuss the implications of my research findings, which I divide into potential implications for practitioners and potential implications for researchers (5.6).

5.1 Research Frequency of the Visual-Aid Interventions

The results of my study showed that the most popular visual intervention was social narratives, followed by symbol exchange and activity schedule; while contingency map and cue cards were not found in any of the included articles in my study. Therefore I will discuss why social narratives seemed to be the most popular intervention, why symbol exchange and activity schedule were relatively popular and why contingency map and cue cards were not.

Social Narratives

I believe that one of the reasons that social narratives was the most popular form of visual aids is because it is a well-established method with clear definition (Morris, 1987; Gray, 2000). Social narratives offer concrete guidelines that both researchers and educators can follow to write a proper narrative. This is for example especially true when it comes to Gray's (2000) social stories, which are written from the perspective of children to illustrate a situation they find themselves in. It has clear guidelines on how long the social stories should be and rules about the proportion of descriptive sentences, perspective sentences, directive sentences and so on. The mixture of emphasising children's perspectives with clear guidelines on how to craft social stories makes social stories a popular option for researchers compared to other forms of visual aids.

Another reason that contributes to the popularity of social narratives could be that it is a functional-based intervention (Martinez et al., 2016). Gray (2000) describes that before

constructing a social story, educators or researchers first identify a behavior that is problematic in the student. Afterwards they construct a social story that is written from the child's perspective and the situation he is in to teach the child appropriate social behaviors. The goal of changing challenging behavior is thus achieved by helping the children to understand others' feeling or a situation (Kidder, & McDonnell, 2017). Therefore social narratives are functional-based intervention written to change behaviors matches with the reducing challenging behaviors focus of this study and thus makes it a popular option for researchers (Martinez et al., 2016).

Symbol Exchange and Activity Schedule

In addition, symbol exchange and activity schedule were relatively popular because they were considerably systematic methods. For example, symbol exchange strategy includes well-established methods like PECS, the picture communication symbols and others (Kidder, & McDonnell, 2017). The previously mentioned methods all have well-established systems, which use specific sets of symbols for communication. Much in the same way as symbol exchange activity schedule is also clearly defined (Akers, Higbee, Gerencser, & Pellegrino, 2018; Kidder, & McDonnell, 2017). However activity schedule is more flexible than social narratives because its definition serves more as a framework and a core idea that researchers can follow, but it does not have specific guidelines on how to construct the schedule in terms of its sentences length and types and so on.

However, my findings showed that symbol exchange and activity schedule were not as popular as social narratives and I believe that it might be due to their diverse functions. As previously mentioned in the literature review section, the type of information one wishes to convey affects what type of visual aids can be employed (Kidder, & McDonnell, 2017). Social narratives focus on teaching appropriate social behaviors (Kidder, & McDonnell, 2017), while activity schedule focuses on transitioning from one activity to another and symbol exchange focuses on facilitating communication (Kidder, & McDonnell, 2017). Therefore one can argue that activity schedule and symbol exchange serve to change challenging behaviors in a more indirect way compared to social narratives. In addition social narratives have a more explicit emphasis and focus on behavior change. Thus I believe the more direct and explicit focus on behavior change could be the reason why social narratives is a more broadly researched topic when it comes

to behavior change compared to activity schedule and symbol exchange. It is important to note for both researchers and educators that methods that do not explicitly emphasize behavior change might still be viable tools for behavior change.

Cue Cards

On the other hand, cue card was not a popular topic when it came to behavioral change research. I suspect this might be because cues cards are not as systematic as the other types of visual aids available. (Schmit, Alper, Raschke, & Ryndak, 2000). For example it does not have pre-established systems like PECS or picture communication symbols and therefore makes it more difficult for researchers to study cue cards systematically. In addition the focus of cue card centres around conveying information and facilitating communication rather than changing behaviors. Therefore cue cards are not a popular topic among research articles that explores behavioral changes (Schmit, Alper, Raschke, & Ryndak, 2000). Most of the research on cue cards target either regular students or students with learning disabilities (Conderman, and Hedin, 2011 & 2015). Therefore it seems like cue card is a popular research topic in general education, but it is not as popular in the field of ASD research as of yet.

Contingency Map

Contingency map on the other hand has well-defined definition and focuses on correcting behaviors therefore it is reasonable to assume that it should be a popular research topic on changing problematic behavior. However it was very surprising to find out that contingency map was rarely researched within the theme of changing problematic behavior. I suspect that one of the reasons behind this is that contingency map is relatively new in the field of ASD research. I found only one peer reviewed article on contingency map and ASD in my literature review (Brown & Mirenda, 2006). In addition the only article I found dealing with contingency map focused on task completion rather than problematic behaviors, and therefore I had to exclude it from my research as it did not fit my predefined criteria's for inclusion. Nonetheless I believe that contingency map is a topic that could have a lot of potential, mainly due to its focus on direct behavior and therefore I expect it to become a popular research topic in the future.

5.2 Settings and Contexts of the Visual-Aid Interventions

My finding points to there being both similarities and differences in the articles I reviewed regarding interventions' context and settings such as participants' characteristics, research design, intervention process and so on. In this section, I will first discuss the similarities and thereafter move on to discuss the differences.

Similarities

One of the similarities was participants' characteristics. My results found that most participants were 3 to 12 years old males. This matched with the previous findings that showed ASD as more prevalent in boys than girls, the ratio was estimated to be 4:1 according to a research (Loomes, Hull, & Mandy, 2017). The findings that most participants were 3 to 12 years old showed the trend that most intervention focuses on young children with ASD in the timespan from pre-school to primary school. I believe the reason of age similarity between participants might be related to early intervention, which there is a general consensus that it is considered more beneficial and effective to implement an intervention at an early age than older (Lang, Hancock, & Singh, 2016).

Another similarity among the articles that my study reviewed was that all the research were single subject design. This might be due to single subject design uses the participant as the research controller (Horner, & Spaulding, 2010). It compares the data before and after the intervention in the subject; and thus, the data is very sensitive to individual differences and can be easily used to determine the effectiveness of the intervention (Horner, & Spaulding, 2010). Nonetheless it should be pointed out that there is a possibility that individual differences across subjects might be unaccounted for in regards to the effectiveness of the interventions.

The preceding mentioned potential weakness might be tackled through another similarity across the articles I have examined, namely that all interventions were individualized and tailored specifically for students in regards to their behavior. This might be due to the fact that ASD is considered to be a wide spectrum (American Psychiatric Association, 2013). Since every child with ASD is considered to be different from other children with ASD, and therefore there is no unified type of visual aids that suits everyone's need. For visual

aids to work properly and effectively it requires the researcher to be able to identify problematic behaviors, students' needs and abilities and more in order to develop a suitable intervention for a child with ASD.

Differences

Regarding the settings and contexts of the visual aids research, one of the differences I found in my review was that the types of symbols and photos used across interventions were different. Some studies used photos of a school and the different people in said school, some used pictures and symbols representing daily activities, locations and items, while others used drawings representing daily activities and locations. The differences described can usually be attributed to the preference of the students, the ability of the students, and if the visual aids system is pre-established. It is possible that photos of the nearby environment allow the children to understand information quicker, while symbols and line drawings may work better in delivering abstract ideas. In addition other picture communication systems like PECS already have a pre-established set of symbols for the student to use and there is therefore less room for individualization. It is important to note that the types of photos may affect the effectiveness of the interventions as it influences how well the students understand the information given.

Another difference across the articles reviewed was that some articles adopted only one type of visual aid, while the others adopted combined visual aids. This might be related to the behavior focus of the different articles. For example, it might require more than one type of visual aids to correct complex behaviors such as physical aggression and verbal aggression. As these behaviors can represent multiple problems such as communication, lack of understanding of social rules and more and thus using combined visual aids can cover these problems more comprehensively. In addition, my findings seemed to point towards symbol exchange being the most easy and common type of visual aid to be combined with other visual aids. I believe it is because symbol exchange systems focus on facilitating communication, and thus it can facilitate the communication and functioning of other visual aids as well. However it is unsure whether using combined visual aids is better than using only one type of visual aids.

In addition, teacher involvement differed in the articles. In some research, teachers were involved in the whole research process, from the development of the tools to the

implementing and evaluation of the intervention. While in other research teachers were not actively involved at all. I believe that teacher involvement might be an influencing factor when it comes to the effectiveness of the implementation of the different interventions, as teacher's involvement helps children to get used to the intervention. Furthermore, teacher involvement in research encourages teachers to take an active role in the intervention research rather than solely relying on the researcher. This might have the added benefit that it helps teachers to renew both their knowledge and practice, which could prove beneficial to the students in the long run (Chow, Chu, Tavares, & Lee, 2015).

The last difference across the research articles included in my study relates to the differences in the degree of pretraining. In some of the research conducted some children received training before the actual intervention was implemented while in others children did not receive pretraining at all. I believe this affects the result of the research conducted as the participants might not be familiar with the conditions of the intervention without training. Thus there is a danger that the data gathered in the beginning of research without pretraining might not reflect the true effect of the intervention in question.

5.3 Effectiveness of the Visual-Aid Interventions

In this section, I will discuss the overall effect size of the different visual aids, the individual effect sizes of each visual aid, their differences and the possible reasons for the differences.

Effectiveness

My research found that most visual aids seemed to be effective in reducing challenging behaviors. The findings suggested that social narratives and combined visual aids were effective in reducing challenging behaviors. In addition, symbol exchange seemed to be effective while activity schedule seemed to be ineffective. However, the results for symbol exchange and activity schedule were not conclusive due to small sample size.

Effect Size: Social narratives

The resulting effect size found in this study for social narratives showed that the strategy was either effective or very effective as an intervention. The data used to calculate the

effect sizes came from 4 articles with 7 participants in total. The calculated effect size was relatively reliable and showed that social narratives has a general trend of being effective in changing problematic behavior for children with ASD. The reason why social narratives were effective might be due to the method being a functional-based intervention (Martinez et al., 2016). It focuses on a specific behavior and the narrative is written specifically with the aim to correct said behavior. The method consists of explaining the reasoning behind the need to change the different problematic behaviors and aims to help the children to understand and behave in a more appropriate way. Thus it might be the functional focus that gives social narratives great strength in correcting behaviors. In addition, children with ASD usually lack or struggle with social skills. They have difficulties in recognizing emotion, expressing emotion, showing empathy, understanding social rules, etc. (Kirk, Gallagher, Coleman, & Anastasiow, 2012). As social narratives describe social situations and through the situation it teaches children social rules, their own emotions, the others emotions and more; therefore, social narratives are good tools to teach social skills and encourage children to behave in socially accepted ways and this might results in a decrease in challenging behaviors.

Effect Size: Symbol exchange

Symbol exchange was also found to be effective in this literature review, however its effect size was only calculated from 1 article with 1 participant in total. Therefore the effect size of symbol exchange was not as reliable as the effect size of social narratives. Nonetheless my findings did match with the findings from Battaglia & McDonald (2015)'s literature review that symbol exchange had a positive relationship in reducing challenging behaviors. I believe that symbol exchange is effective because it is an intervention that helps students to communicate better. As previously mentioned many children with ASD have impairments in communication, many can only say few words while others do not have verbal language at all (Frederickson, & Cline, 2015). Thus children with ASD usually have difficulties in understanding the meaning of the sentences, the tone of the speech, the body language, the rhythm of speech, etc. (Kasari et al., 2013). It is possible that children with ASD engage in challenging behaviors in order to communicate their needs. Thus, by providing them a symbol exchange system helps them to express themselves through communication alternative and this can explain some of the reason behind its effectiveness. As the children manage to express themselves by

mastering the symbol exchange system, then they do not need to resort to challenging behaviors to express their needs and it will likely result in higher life qualities (Matson et al., 2011). Therefore symbol exchange system can be a helpful long-term tool for children with ASD.

Effect Size: Combined Visual Aids

Combined visual aids are found to be effective or very effective. The effect sizes were calculated from 3 articles with 3 participants in total. The effect size was relatively reliable and showed that combined visual aids were effective in reducing challenging behaviors for children with ASD. It also seems possible that combined visual aids are more likely to be useful and effective in comparison to only using one type of visual aid. The reason being that combined visual aids possibly offers a more comprehensive form of help compared to single visual-aid interventions. For example combined visual aids aims to take care of the children's social ability, language ability, difficulty in transition, etc. Therefore combined visual aids can be argued to facilitate the children in a more comprehensive way and therefore be more likely to work effectively in correcting behaviors.

Effect Size: Activity Schedule

Activity schedule was the only visual aid in this review that was found to be ineffective. The effect size was calculated from only 1 article with 2 participants in total and thus the effect size was not treated as conclusive. My finding is different from Lequia et al. (2012)'s article which found that activity schedule is likely to be effective in reducing challenging behaviors. However my research is fundamentally different from Lequia et al. (2012)'s, primarily because my study has a much more narrow definition of challenging behaviors. In addition I only investigated the effectiveness of activity schedule used by itself while Lequia et al. (2012)'s study inspected activity schedule in combination with videos, written scripts, etc. To further explain the differences I also examined the included article by Waters et al. (2009)'s, to explore why activity schedule was ineffective in his study. I believe that the activity schedule was ineffective in the study primarily due to the lack of reinforcement. In Waters, et al. (2009)'s study they described how activity schedule was used in the classroom before the experiment. I believe that this

explains the reason for why the strategy is ineffective when the therapist introduce the same strategy to the students as part of the experiment. It was not until after introducing reinforcement that the children showed a decrease in physical challenging behaviors (waters et al., 2009). Therefore it is possible that using activity schedule by itself is not useful, but that combining it with reinforcement can make it effective in promoting behavior change. Another possible explanation for the lack of effectiveness of activity schedule can possibly be found in Atkinson and Shiffrin (1968)'s information processing theory. I suspect that when activity schedule was introduced to the students in Waters, et al. (2009)'s study, it only served as a sensory input that was not consciously registered by the students. That is, the activity schedule did not receive attention from the students, and therefore it turned out to be ineffective. However, after the introduction of reinforcement the activity schedule received attention from the students and was then registered as information input that they should follow. Afterwards, through multiple rehearsals, students became familiar with the instructions, that is, the information transferred to short-term store which increased the effectiveness of activity schedules.

5.4 Reliability and Validity of This Review

Reliability and validity are important factors that determine the quality of a research paper. In this section, I will discuss the reliability and validity of my research review in detail and how I secured them in my study.

5.4.1 Reliability

Reliability refers to the consistency of a research instrument (Price, et al., 2017). A reliable research instrument is one that can produce consistent results. There are different types of reliability such as test-retest reliability, parallel forms reliability, inter-rater reliability and more (Price, et al., 2017). However, different types of reliability and validity are usually measured in quantitative research (rather than qualitative research) to determine the quality of a test. Nonetheless, I tried to make my literature review as reliable and valid as possible in the following ways.

In the following I will discuss about how I ensured that my study is both reliable and valid. To ensure reliability in my study I decided to use the PRISMA method when

collecting data. PRISMA is a well-established method in the field of health care that has increasingly been used in research in other fields (Moher, Liberati, Tetzlaff, and Altman, 2009). I argue that I ensure reliability across studies because it follows a strict framework, which provides clear guidelines to researchers that ensures that they can produce consistent results over time. Using PRISMA increases the clarity of reporting and enables the readers to effectively evaluate the review based on known criteria's. In addition I ensured reliability by adopting PND and PEM indexes when calculating the effect sizes of the different research articles. Both indexes have clear definitions and formulas that researcher can follow to ensure that they can get the same results across different times. In addition they also provide transparency for other researchers to evaluate the quality of the studies that have used PND and PEM indexes. In addition I have also tried to ensure reliability akin to the concept of parallel forms reliability, which refers to when researchers administrate two similar versions of an instrument they get similar results (Salkind, 2010). There is a requisite that these two instruments needs to measure the same thing. In my study I employed both PND and PEM to calculate effect size to ensure that the results could be argued to have a form of parallel forms reliability. While they both measure effect size but they do so from different perspectives. PND measures the data points exceeding the lowest baseline level, while PEM measures the data points exceeding the median of baseline level (Scruggs, Mastropieri, Casto, 1987 & Ma, 2006). Thus to ensure a form of parallel forms reliability, I compared the results from PND and PEM indexes to explore both their similarities and differences and to be able to explain the reason behind the differences I found. Thus the data gathered in this study can be considered more reliable since it comes as a result of two different indexes.

5.4.2 Validity

Besides reliability it is also important to ensure the validity of the results of the research conducted. Validity refers to what extend does a research instrument measures what it is trying to measure (Price, et al., 2017). Alternatively one can also understand it as dealing with to what extent the study is producing valid answers to the formulated research questions.

To tackle the issue of validity I adopted PND and PEM to measure the efficiency of behavioral change interventions through calculating their effect sizes across studies. Both

methods are well established in meta-analysis papers (Şen, & Şen, 2019), Since they are considered reliable as a simple way to measure efficiency by measuring the data points exceeding the median of baseline level or the lowest point of baseline level. Using both PND and PEM ensured that I could engage the data collected through PRISMA on a larger scale than what would be usual when just using one calculation index. Thus both similarities and differences were discovered in effect sizes, as mentioned in the reliability section, this allows a broader investigation that would not be possible if only one method was used. Thus one can argue that the usage of two indexes rather than only one has helped to give more credibility that the results of my study can be considered valid to an extent. In addition I also used multiple databases in this article to ensure more valid results. The databases I used are PYSCinfo, ERIC and Medline. All three are well known databases that provide relevant articles for my chosen topic of interests. I also included only peer-reviewed articles in this literature review. As these articles are approved by other experts in the field, they tend to be representative and can considered to be valid data for my analyses.

Finally, I ensure validity by making sure that my research instruments cover all perspectives of the research questions. Since I set out to study the effectiveness of visual aids in changing challenging behaviors of children with ASD. I ensured validity through investigating 5 different types of visual aids, calculated their effectiveness based on two indexes and I made a comparison and discussed the results. By doing this my article offered a comprehensive overview of the different types of visual aids and provided measurement of effectiveness of visual-aid interventions from two perspectives. Thus my study offers a comprehensive analysis of the visual aids in question from multiple perspective and it can be argued that this ensures that the validity of the research.

5.5 Limitations

I have discussed how this research paper can be understood as both reliable and valid in many aspects, and how it contributes important knowledge to the field of special education. Nonetheless it is important to point out that this study still has some limitations and I will in this section discuss the limitations of my study.

The first possible limitation of this study is that I am the only reviewer, and thus my personal judgments may affect the validity of the study. For example, I made the decision about the inclusion and exclusion criteria's, database keywords, categorization of 5 types of visual aids and also decided which articles that should be included. Since these decisions were made by one reviewer it could be argued that there is a probability that my findings are prone to personal bias. There is also a possibility that the findings could be different if two or more researchers conducted a similar study because researchers could have different understanding of the methodology. To make my research more valid and precise it might be better to have two or more reviewers. Therefore I have taken steps to ensure that it is possible to repeat my study for future researchers through documenting the methods and processes used in clear steps to facilitate further research based on my findings.

Another possible limitation of this article is that I found few articles that could be included in my analysis. Despite the fact that I used three databases to search for articles, I was still only able to obtain 9 articles for analysis. The limited amount of articles could affect the validity of both the data and the results of my review. Therefore I suggest that future research should use as many databases as possible to find more articles to include in the analysis to strengthen the validity of the results and findings. Nonetheless this limitation is a result of limited time and resources for this study and are mediated through the use of different methods and frameworks as discussed in the reliability and validity discussion.

Moreover, there is also some limitation when it comes to the tools used to calculate the effect sizes in the study. As earlier mentioned I used both the PND and PEM index to calculate the effect sizes of the different forms of visual aids. And even though both methods are easy and quite popular among review articles, they are limited when it comes to the scope of the results of the indexes. For example, they do not offer information about the significance of the result or how much change has occurred within the baseline stage and the intervention stage. PND is also prone to mathematical limitations like the earlier explained floor and ceiling error (Ma, 2006).

Finally an important limitation is that I have only investigated English articles, and thus my results might not represent the overall general effect of visual aids in non-English

speaking countries. Thus there is a need for researchers to conduct research in non-English speaking countries as language and culture may be factors that influence the effectiveness of visual aids.

5.6 Implications

This research explores how visual aids change behaviors for children with ASD and hopefully can make contributions to the special education field. In this section I will discuss the practical implication and scientific implication of my research, before going on to offer some conclusion.

5.6.1 Implication for Practitioners

This study compared 5 types of visual aids in terms of their popularity, settings and context and regarding their effectiveness in changing problematic behaviors for children with ASD. It has made several contributions that can be valuable for practitioners working in the field.

Firstly this study introduces different types of visual aids to practitioners. Thus it contributes to raise awareness of the importance of visual aids for practitioners working with children with ASD. It offers them an overview of visual aids and encourages them to explore different types of visual aids and to gain a deeper understanding on them. Additionally the results presented in this review shows the importance of adopting and implementing visual aids as an intervention when handling problematic behaviors in children with ASD.

Secondly this research equips practitioners with knowledge about how to choose the correct type of visual aid in accordance with the behavior in question. For example, by comparing the effectiveness of 5 types of visual aids, the study suggests that social narratives are likely to be effective in correcting problematic behaviors while PECS is likely to be effective in correcting communication problems. In addition the results of this study show the importance and efficiency of using a combination of visual aids to change problematic behavior and thus facilitate the various needs of children with ASD.

5.6.2 Implication for Researchers

This article also contributes a lot to the field of the research. I will discuss a few of the implications here.

Firstly my study found that visual aids are likely to be effective in reducing challenging behaviors in children with ASD. It helps scholars and researchers within the fields that deal with children with ASD to be aware of the importance of visual aids, and to further encourage examination of different types of visual aids strategies. For future directions, I suggest researchers to follow the same direction of exploring the relationship between visual aids and challenging behaviors. But in order to make the study more reliable I would recommend the inclusion of two or more reviewers. In addition it would be beneficial to consider adopting a more comprehensive effect size formula or conduct a meta-analysis.

Secondly I have observed that the most researched visual aids are social narratives, followed by symbol exchange and activity schedule, while contingency map is rarely researched. However, contingency map is a behavioral focused intervention and thus holds a potential that has not been mapped out when it comes to changing the behavior of children with ASD. As there was only one peer-reviewed article on contingency map and ASD at the moment of my review, there is a need for future researcher to look into this topic.

6. Conclusion

The goal of this research was to explore the inverse relationship between visual aids and challenging behaviors in children with ASD. To answer this question, I looked into 5 types of visual aids and compared their research frequency, settings and context and their effect size in current literature. I used the PRISMA method to conduct literature screening. It allowed me to screen articles systematically and to narrow down 345 to 9 articles for analysis. I also used PND and PEM index to calculate effect size. They allowed a direct and easy comparison of the effect sizes between different visual aids. My findings suggested that social narratives were the most researched visual aids and it was likely to be effective in changing challenging behaviors for children with ASD. The results also suggested that combined visual were likely to be effective. However, the results for symbol exchange and activity schedule were not conclusive due to limited sampling.

The findings of this study can hopefully contribute to practitioners working in the special education field to find appropriate visual-aid interventions to reduce challenging behaviors for their students with ASD. For future research directions, I suggest that future researchers follow the direction of exploring relationship between visual aids and challenging behaviors but employ more comprehensive effect size calculations or conduct a meta-analysis involving two or more reviewers. I also suggest that future researchers should look into contingency map as it is rarely researched on and it has great potential in changing challenging behaviors.

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Appendices

Appendices A: Articles Screening Process with Detail Inclusion and Exclusion Criteria

Abstract screening (n=346)											Full text screening (n=49)					
No. (n=345)	Author	Children with ASD (n=298)	Visual Aids					Behavior focused intervention (n=80)	Primary source (n=270)	Comments	Records to be included after abstract screening		Problematic behavior focused intervention (n=9)	Records to be included after full- text screening		Comments
			Activity schedule (n=52)	Contingency map (n=2)	Cues (n=41)	Social narratives (n=119)	Symbol exchange (n=88)				No / Excluded (N=296)	Yes / Included (N=49)		No / Excluded (n=40)	Yes / Included (N=9)	
1	Adams et al. (2004)	Y	N	N	N	Y	N	Y			1					
2	Agosta et al. (2004)	Y	N	N	N	Y	N	Y	Y			1	Y		1	
3	Ahlers et al. (2017)	Y	N	N	N	Y	N	N	Y		1					
4	Akers et al. (2018)	Y	Y	N	N	N	N	N	Y		1					
5	Akers et al. (2016)	Y	Y	N	N	N	N	N	Y		1					
6	Akers et al. (2019)	Y	N	N	N	N	Y	Y	Y			1	N	1		
7	Al zyoudi et al. (2016)	Y	N	N	N	Y	N	N	Y		1					
8	Ali et al. (2006)	Y	N	N	N	Y	N	N	N		1					
9	Al-Nasser et al. (2019)	N	N	N	N	N	N	N	Y		1					
10	Al-Qabandi et al. (2011)	Y	N	N	N	N	N	N	Y		1					
11	Amin & Oweini (2013)	Y	N	N	N	Y	N	N	Y		1					
12	An et al. (2017)	Y	N	N	N	N	Y	N	Y		1					
13	Anderson et al. (2007)	Y	N	N	N	N	Y	Y	Y			1	N	1		
14	Anderson et al.	Y	N	N	N	N	N	N	Y		1					

	(2016)															
15	Anderson et al. (2016)	Y	N	N	N	Y	N	Y	Y			1	Y		1	
16	Arntzen et al. (1998)	Y	Y	N	N	N	N	Y	Y			1	N	1		
17	Ballan et al. (2017)	Y	N	N	N	Y	Y	N	N		1					
18	Banda et al. (2014)	Y	N	N	N	N	Y	N	N		1					
19	Banda & Grimmett (2008)	Y	Y	N	N	N	N	N	N		1					
20	Barlow et al. (2013)	Y	N	N	N	N	Y	N	Y		1					
21	Barry et al. (2004)	Y	N	N	N	Y	N	N	Y		1					
22	Battaglia & McDonald (2015)	Y	N	N	N	N	Y	Y	N		1					
23	Bauminger-Zvieli & Kugelmass (2013)	N	N	N	N	N	N	N	Y		1					
24	Beaver et al. (2017)	Y	Y	N	N	N	N	Y	Y			1	N	1		
25	Bedford et al. (2016)	Y	N	N	N	N	N	N	N		1					
26	Belisle et al. (2019)	Y	N	N	N	N	Y	N	Y		1					
27	Bellini & Peters (2008)	Y	N	N	N	Y	N	N	Y	Involves non-visual aid interventions	1					
28	Ben Chaabane et al. (2009)	Y	N	N	N	N	Y	N	Y		1					
29	Benish & Bramlett (2011)	N	N	N	N	Y	N	N	Y		1					
30	Bennett et al. (2011)	Y	Y	N	N	N	N	Y	Y			1	N	1		
31	Bentivegna et al. (1983)	Y	N	N	N	N	N	N	Y		1					

32	Berkowitz (1990)	Y	N	N	N	N	N	Y	Y		1					
33	Bernard-Opitz et al. (2001)	Y	N	N	N	N	N	N	Y		1					
34	Betz, et al. (2008)	Y	Y	N	N	N	N	N	Y		1					
35	Bevan-Brown et al. (2008)	Y	N	N	N	Y	N	N	Y	Involves visual aids other than the 5 types	1					
36	Bledsoe et al. (2003)	Y	N	N	N	Y	N	Y	Y			1	N	1		
37	Boesch et al. (2013)	Y	N	N	N	N	Y	N	Y		1					
38	Boesch et al. (2013)	Y	N	N	N	N	Y	N	Y		1					
39	Bohlande et al. (2012)	Y	N	N	N	Y	N	N	N		1					
40	Bondy (2012)	Y	N	N	N	N	Y	N	N		1					
41	Bondy & Frost (2001)	Y	N	N	N	N	Y	N	N		1					
42	Bondy et al. (2004)	Y	N	N	N	N	Y	N	N		1					
43	Bondy & Frost (1998)	Y	N	N	N	N	Y	N	N		1					
44	Bopp et al. (2004)	Y	N	N	N	N	N	N	N		1					
45	Boutot (2009)	Y	N	N	N	Y	N	N	Y		1					
46	Brady et al. (2012)	N	N	N	N	N	N	N	Y		1					
47	Breitfelder (2008)	Y	N	N	N	N	Y	N	N		1					
48	Breslin & Buchanan (2014)	N	Y	N	N	N	N	N	Y		1					
49	Brodhead et al. (2014)	Y	Y	N	N	N	N	N	Y		1					
50	Brown & Mirenda (2006)	Y	N	Y	N	N	N	Y	Y			1	N	1		
51	Brownell	Y	N	N	N	Y	N	Y	Y			1	N	1		

	(2002)															
52	Bruinsma et al. (2004)	Y	N	N	N	N	N	N	N		1					
53	Bryan & Gast (2000)	Y	Y	N	N	N	N	Y	Y			1	N	1		
54	Bucholz & Brady (2008)	N	N	N	N	Y	N	N	Y		1					
55	Buckley & Newchok (2005)	Y	N	N	N	N	Y	Y	Y			1	N	1		
56	Budzinska et al. (2014)	Y	Y	N	N	N	N	N	Y		1					
57	Burckley et al. (2015)	N	Y	N	Y	N	N	N	Y		1					
58	Caballero & Connell (2010)	Y	N	N	Y	N	N	N	Y		1					
59	Cafiero (2001)	Y	N	N	Y	N	N	N	Y		1					
60	Carlile et al. (2013)	Y	Y	N	N	N	N	N	Y		1					
61	Carnahan et al. (2009)	Y	N	N	Y	N	N	N	Y		1					
62	Carp et al. (2012)	Y	N	N	N	N	N	N	Y		1					
63	Carr & Felce (2007a)	Y	N	N	N	N	Y	N	Y		1					
64	Carr & Felce (2007b)	Y	N	N	N	N	Y	N	Y		1					
65	Carr et al. (1978)	Y	N	N	Y	N	N	N	Y		1					
66	Carson et al. (2012)	Y	N	N	N	N	Y	N	Y		1					
67	Casey (1977)	Y	N	N	N	N	N	N	Y		1					
68	Chaabane et al. (2009)	Y	N	N	N	N	Y	N	Y		1					
69	Chan & O'Reilly (2008)	Y	N	N	N	Y	N	N	Y		1					
70	Chan et al. (2011)	Y	N	N	N	Y	N	Y	Y			1	N	1		
71	Charlo et al. (2008)	Y	N	N	N	N	Y	N	Y		1					

72	Charlop et al. (1983)	Y	N	N	N	N	N	Y	Y		1					
73	Charlop-Christy et al. (2002)	Y	N	N	N	N	Y	N	Y		1					
74	Chen (2018)	Y	N	N	N	Y	N	N	Y		1					
75	Chohan & Jones (2019)	Y	N	N	N	N	N	N	Y		1					
76	Chung et al. (2016)	Y	N	N	N	N	N	N	N		1					
77	Cihak (2011)	Y	Y	N	N	N	N	Y	Y			1	N	1		
78	Cihak et al. (2012a)	Y	N	N	N	Y	N	Y	Y			1	N	1		
79	Cihak et al. (2012b)	Y	N	N	N	N	Y	N	Y		1					
80	Cihak et al. (2010)	Y	N	N	Y	N	N	Y	Y			1	N	1		
81	Collette et al. (2019)	Y	N	N	N	N	N	Y	Y		1					
82	Conroy et al. (2005)	Y	N	N	Y	N	N	Y	Y			1	N	1		
83	Cornelius Habarad (2015)	Y	N	N	N	N	Y	Y	Y	Involves non-visual aid interventions	1					
84	Couper et al. (2014)	Y	N	N	Y	N	Y	N	Y		1					
85	Crooke et al. (2016)	N	N	N	N	N	N	N	N		1					
86	Crozier & Tincani (2007)	Y	N	N	N	Y	N	N	Y		1					
87	Crozier & Tincani (2005)	Y	N	N	N	Y	N	Y	Y			1	N	1		
88	Cummings et al. (2012)	Y	N	N	N	N	Y	N	Y		1					
89	Daneshvar et al. (2019)	Y	Y	N	N	Y	N	N	Y		1					
90	Daou (2014)	Y	Y	N	N	N	N	N	N		1					
91	Dardennes et al. (2011)	Y	N	N	N	N	N	N	Y		1					

92	Daubert et al. (2015)	Y	N	N	N	Y	N	N	Y		1					
93	Dauphin et al. (2004)	Y	Y	N	Y	N	N	N	Y		1					
94	Delano & Snell (2006)	Y	N	N	N	Y	N	N	Y		1					
95	Delano & Stone (2008)	N	N	N	N	Y	N	Y	N		1					
96	Denne et al. (2018)	N	Y	N	N	N	N	N	Y		1					
97	Dodd et al. (2008)	Y	N	N	N	Y	N	N	Y		1					
98	Dogoe et al. (2010)	Y	N	N	N	N	Y	N	Y		1					
99	Doherty et al. (2018)	Y	N	N	N	N	Y	N	Y		1					
100	Domire & Wolfe (2014)	Y	N	N	N	N	N	N	N		1					
101	Dooley et al. (2001)	Y	Y	N	N	N	Y	Y	Y			1	Y		1	
102	Doyle & Arnedillo-Sanchez (2011)	Y	N	N	N	Y	N	N	Y		1					
103	Fees et al. (2014)	Y	N	N	N	Y	N	Y	Y			1	N		1	
104	Ferreira et al. (2017)	Y	N	N	N	N	Y	N	Y		1					
105	Fetherston & Sturmey (2014)	N	N	N	N	N	N	N	N		1					
106	Fienup et al. (2013)	Y	N	N	Y	N	N	N	Y		1					
107	Fittipaldi-Wert & Mowling (2009)	Y	Y	N	Y	N	Y	N	Y		1					
108	Fleury et al. (2014)	Y	N	N	N	N	N	N	Y		1					
109	Frea et al. (2001)	Y	N	N	N	N	Y	Y	Y			1	Y		1	
110	Frith & Hermelin (1969)	Y	N	N	Y	N	N	N	Y		1					

111	Gadaire et al. (2018)	Y	Y	N	N	N	N	N	Y		1					
112	Gadberry (2011)	Y	N	N	N	N	N	N	Y		1					
113	Ganz et al. (2005)	Y	N	N	N	N	Y	N	N		1					
114	Ganz et al. (2012a)	Y	N	N	N	N	Y	N	N		1					
115	Ganz et al. (2012b)	Y	N	N	N	N	Y	N	N		1					
116	Ganz & Flores (2010)	Y	N	N	Y	N	N	N	Y		1					
117	Ganz et al. (2013)	N	N	N	N	N	Y	N	Y		1					
118	Ganz et al. (2010a)	Y	N	N	N	N	Y	N	Y		1					
119	Ganz et al. (2010b)	Y	N	N	N	N	Y	N	Y		1					
120	Ganz et al. (2014)	Y	N	N	N	N	Y	N	N		1					
121	Ganz et al. (2009)	Y	N	N	N	N	Y	N	Y		1					
122	Ganz, Simpson & Lund (2012)	Y	N	N	N	N	Y	N	N		1					
123	Gerber et al. (2011)	N	N	N	N	N	N	N	Y		1					
124	Gerencser et al. (2017)	N	Y	N	N	N	N	N	Y		1					
125	Gevarter et al. (2014)	Y	N	N	N	N	Y	Y	Y			1	N	1		
126	Giles & Markham (2017)	Y	Y	N	N	N	N	N	Y		1					
127	Gillespie-Smith et al. (2014)	Y	N	N	N	N	Y	N	Y		1					
128	Gilroy et al. (2018)	Y	N	N	N	N	Y	N	Y		1					
129	Glaeser et al. (2003)	Y	N	N	N	Y	N	N	N		1					
130	Goldman et al. (2018)	N	Y	N	N	N	N	N	Y		1					

131	Gomi & Noro (2010)	Y	N	N	Y	N	N	Y	Y			1	N	1		
132	Goodman-Scott & Carlisle (2015)	N	N	N	N	Y	N	N	Y		1					
133	Graetz et al. (2009)	Y	N	N	N	Y	N	Y	Y			1	N	1		
134	Gray & Garand (1993)	Y	N	N	N	Y	N	N	Y		1					
135	Green et al. (2006)	N	Y	N	N	N	N	N	Y		1					
136	Greenberg et al. (2012)	Y	N	N	N	N	Y	N	Y		1					
137	Greenway (2000)	Y	N	N	N	Y	N	N	N		1					
138	Hagiwara & Myles (1999)	Y	N	N	N	Y	N	N	Y		1					
139	Halle et al. (2016)	Y	N	N	N	Y	N	N	Y		1					
140	Hanley-Hochdorfer et al. (2010)	Y	N	N	N	Y	N	N	Y		1					
141	Hanney et al. (2019)	Y	N	N	N	N	N	N	Y		1					
142	Harris et al. (1999)	Y	N	N	N	N	N	N	Y		1					
143	Hart & Banda (2010)	Y	N	N	N	N	Y	N	N		1					
144	Hartley & Allen (2015)	Y	N	N	N	N	N	N	Y		1					
145	Herbet et al. (2018)	N	N	N	N	N	N	N	N		1					
146	Hess et al. (2008)	N	N	N	N	N	N	N	Y		1					
147	Holmes et al. (2019)	N	N	N	N	N	N	N	Y		1					
148	Homlitas et al. (2014)	Y	N	N	N	N	Y	N	Y		1					
149	Hoyland et al. (2019)	N	N	N	N	N	N	N	Y		1					
150	Huang & Wheeler	Y	N	N	N	Y	N	N	N		1					

	(2007)															
151	Hutchins & Prelock (2005)	Y	N	N	N	Y	N	N	Y		1					
152	Hutchins & Prelock (2008)	N	N	N	N	N	N	N	N		1					
153	Hutchins & Prelock (2013a)	Y	N	N	N	Y	N	N	Y		1					
154	Hutchins & Prelock (2013b)	Y	N	N	N	Y	N	N	Y		1					
155	Hutchins & Prelock (2018)	Y	N	N	N	N	N	N	N		1					
156	Ikuse et al. (2018)	Y	N	N	Y	N	N	N	Y		1					
157	Ingvarsson & Hollobaugh (2011)	Y	N	N	Y	N	N	N	Y		1					
158	Ingvarsson & Le (2011)	Y	N	N	Y	N	N	N	Y		1					
159	Irvin et al. (2012)	Y	N	N	N	N	N	N	Y		1					
160	Iskander & Rosales (2013)	Y	N	N	N	Y	N	Y	Y			1	N	1		
161	Ivey et al. (2004)	Y	N	N	N	Y	N	Y	Y			1	N	1		
162	Jeekratok et al. (2014)	Y	N	N	N	Y	N	Y	Y	Involves non-visual aid interventions	1					
163	Johnson et al. (2015)	Y	N	N	N	N	N	N	Y		1					
164	Jull & Mirenda (2016)	N	N	N	N	N	N	N	Y		1					
165	Jurgens et al. (2009)	Y	N	N	N	N	Y	N	Y		1					
166	Jurgens et al. (2019)	Y	N	N	N	N	Y	N	Y		1					
167	Karayazi et al. (2014)	N	N	N	N	Y	N	N	Y		1					
168	Karkhaneh et al. (2010)	Y	N	N	N	Y	N	N	N		1					

169	Kassardjian et al. (2014)	N	N	N	N	Y	N	N	Y		1					
170	Kee et al. (2012)	N	N	N	N	N	Y	N	Y		1					
171	Kern et al. (2007)	Y	N	N	N	N	N	N	Y		1					
172	Khasakhala & Galava (2016)	N	N	N	N	N	N	N	Y		1					
173	Kidder & McDonnell (2017)	Y	Y	Y	Y	Y	Y	N	N		1					
174	Kishida et al. (2019)	Y	N	N	Y	N	N	N	Y		1					
175	Klett & Turan (2012)	Y	N	N	N	Y	N	N	Y		1					
176	Knight et al. (2015)	Y	Y	N	N	N	N	N	N		1					
177	Kodak et al. (2012)	Y	N	N	N	N	Y	Y	Y			1	N	1		
178	Koegel & Schreibman (1977)	Y	N	N	N	N	N	N	Y		1					
179	Koege et al. (1979)	Y	N	N	N	N	N	N	Y		1					
180	Kohler et al. (2007)	Y	N	N	Y	N	N	N	Y		1					
181	Kokina & Kern (2010)	Y	N	N	N	Y	N	N	N		1					
182	Koyama & Wang (2011)	Y	Y	N	N	N	N	N	N		1					
183	Krantz et al. (1993)	Y	Y	N	N	N	N	N	Y		1					
184	Krantz & McClannahan (1998)	Y	N	N	Y	N	N	N	Y		1					
185	Kravits et al. (2002)	Y	N	N	N	N	Y	N	Y		1					
186	Kroeger & Sorensen (2010)	Y	N	N	N	N	N	Y	Y		1					
187	Kuoeh & Mirenda	Y	N	N	N	Y	N	Y	Y			1	N	1		

	(2003)															
188	Kuttler et al. (1998)	Y	N	N	N	Y	Y	Y	Y			1	Y		1	
189	Landa & Hanley (2016)	Y	N	N	N	N	N	Y	Y		1					
190	Laprima & Dittrich (2014)	Y	N	N	N	Y	N	N	Y		1					
191	Leaf et al. (2016)	Y	N	N	N	Y	N	N	Y		1					
192	Lea et al. (2012)	Y	N	N	N	Y	N	N	Y		1					
193	Leaf et al. (2015)	Y	N	N	N	Y	N	Y	N		1					
194	Ledbetter-Cho et al. (2017)	Y	Y	N	N	N	N	N	Y		1					
195	Lee et al. (2019)	Y	N	N	Y	N	N	N	Y		1					
196	Lequia et al. (2012)	Y	Y	N	N	N	N	Y	N		1					
197	Lequia et al. (2015)	Y	Y	N	N	N	N	N	N		1					
198	Lerna et al. (2014)	Y	N	N	N	N	Y	N	Y		1					
199	Lerna et al. (2012)	Y	N	N	N	N	Y	N	Y		1					
200	Litras et al. (2010)	Y	N	N	N	Y	N	N	Y		1					
201	Lorah et al. (2014)	Y	N	N	N	N	N	N	Y		1					
202	Lorah et al. (2015)	Y	N	N	N	N	N	N	N		1					
203	Lorime et al. (2002)	Y	N	N	N	Y	N	Y	Y			1	N	1		
204	Loukrezi et al. (2010)	Y	N	N	N	Y	N	N	Y		1					
205	MacDuff et al. (1993)	Y	Y	N	N	N	N	Y	Y			1	N	1		
206	Machalicek et al. (2009)	Y	Y	N	N	N	N	N	Y		1					
207	Magiati & Howlin (2003)	Y	N	N	N	N	Y	N	Y		1					

208	Maglione et al. (2012)	Y	N	N	N	N	N	N	N		1					
209	Mah & Tsang (2016)	Y	Y	N	N	N	Y	Y	Y			1	N	1		
210	Malandraki & Okalidou (2007)	Y	N	N	N	N	Y	N	Y		1					
211	Malhotra et al. (2010)	Y	N	N	N	N	Y	N	Y		1					
212	Malmberg et al. (2015)	Y	N	N	Y	Y	N	N	Y		1					
213	Mancil et al. (2009)	Y	N	N	N	Y	N	Y	Y			1	Y		1	
214	Marion et al. (2016)	Y	N	N	N	N	N	N	Y		1					
215	Marshall et al. (2016)	N	N	N	N	Y	N	N	Y		1					
216	Martinez (2006)	Y	N	N	N	N	N	N	Y		1					
217	Martocchio & Rosales (2017)	Y	N	N	N	N	N	N	Y		1					
218	Matson et al. (1993)	Y	N	N	Y	N	N	N	Y		1					
219	McConkey et al. (2010)	Y	N	N	N	N	Y	N	Y		1					
220	McCoy et al. (2010)	Y	N	N	Y	N	N	Y	Y	Involves visual aids other than the 5 types	1					
221	McDonald et al. (2015)	Y	N	N	N	N	Y	N	Y		1					
222	McDuffie et al. (2012)	Y	N	N	N	N	Y	N	Y		1					
223	McGill et al. (2015)	Y	N	N	N	Y	N	Y	N		1					
224	McLay et al. (2017)	Y	N	N	N	N	Y	N	Y		1					
225	McLay et al. (2015)	Y	N	N	N	N	Y	N	Y		1					
226	Milley & Machalicek (2012)	N	Y	N	N	N	N	N	N		1					

227	More (2008)	Y	N	N	N	Y	N	N	N		1					
228	Morrison et al. (2002)	Y	Y	N	N	N	N	N	Y		1					
229	Mostofsky & Ewen (2011)	Y	N	N	N	N	N	N	Y		1					
230	Nam & Hwang (2016)	Y	N	N	N	N	Y	N	N		1					
231	Napolitano et al. (2006)	Y	N	N	Y	N	N	Y	Y	Involves non-visual aid interventions	1					
232	Nelson & Tarabochia (2018)	Y	N	N	N	Y	N	N	N		1					
233	Ninci et al. (2018)	Y	N	N	N	N	Y	N	Y		1					
234	Norris & Dattilo (1999)	Y	N	N	N	Y	N	N	Y		1					
235	O'Handley et al. (2015)	Y	N	N	N	Y	N	N	Y		1					
236	Okada et al. (2008)	Y	N	N	N	Y	N	Y	Y			1	Y		1	
237	Okada et al. (2010)	Y	N	N	N	Y	N	Y	Y			1	N	1		
238	O'Reilly et al. (2005)	Y	N	N	N	N	N	Y	Y		1					
239	Ozdemir (2008a)	Y	N	N	N	Y	N	Y	Y			1	N	1		
240	Ozdemir (2008b)	Y	N	N	N	Y	N	N	Y		1					
241	Ozuna et al. (2015)	Y	N	N	N	Y	N	N	N		1					
242	Paden et al. (2012)	Y	N	N	N	N	Y	N	Y		1					
243	Palmen et al. (2012)	N	N	N	Y	N	N	Y	N		1					
244	Pane et al. (2015)	Y	N	N	N	Y	N	Y	Y			1	N	1		
245	Park et al. (2011)	Y	N	N	N	N	Y	N	Y		1					
246	Pasiali (2004)	Y	N	N	N	Y	N	N	Y		1					

247	Perez-Fuster et al. (2019)	N	N	N	Y	N	N	N	Y		1					
248	Peter (2003)	Y	N	N	N	N	N	N	N		1					
249	Phelps et al. (2012)	Y	N	N	N	N	N	N	Y		1					
250	Pierce et al. (2013)	Y	Y	N	N	N	N	N	Y		1					
251	Plavnick (2012)	Y	N	N	N	N	N	N	Y		1					
252	Preston & Carter (2009)	Y	N	N	N	N	Y	N	N		1					
253	Quill (1995)	Y	N	N	Y	N	N	N	Y		1					
254	Quilty (2007)	Y	N	N	N	Y	N	N	Y		1					
255	Quirnbach et al. (2009)	Y	N	N	N	Y	N	N	Y		1					
256	Ramachandiran et al. (2015)	Y	N	N	N	N	N	Y	Y		1					
257	Reichow & Sabornie (2009)	Y	N	N	N	Y	N	N	Y		1					
258	Reid et al. (1991)	Y	N	N	Y	N	N	Y	Y			1	N	1		
259	Reynhout & Carter (2006)	Y	N	N	N	Y	N	N	N		1					
260	Reynhout & Carter (2007)	Y	N	N	N	Y	N	Y	Y			1	N	1		
261	Reynhout & Carter (2009)	N	N	N	N	Y	N	N	Y		1					
262	Reynhout & Carter (2011)	Y	N	N	N	Y	N	N	N		1					
263	Rhodes (2014)	Y	N	N	N	Y	N	Y	N		1					
264	Rinehart et al. (2006)	Y	N	N	N	N	N	N	Y		1					
265	Rispoli et al. (2011)	N	Y	N	Y	Y	Y	N	N		1					
266	Robison et al. (2019)	Y	N	N	Y	N	N	Y	Y	Involves non-visual aid interventions	1					
267	Rogers &	Y	N	N	N	Y	N	Y	Y	Involves	1					

	Myles (2001)									visual aids other than the 5 types						
268	Rosenwasser & Axelrod (2001)	Y	N	N	N	N	Y	N	N		1					
269	Rust & Smith (2006)	Y	N	N	N	Y	N	Y	N		1					
270	Ryan et al. (2008)	N	N	N	Y	N	N	N	Y		1					
271	Ryan et al. (2011)	Y	N	N	N	Y	Y	N	N		1					
272	Samuels & Stansfield (2012)	N	N	N	N	Y	N	N	Y		1					
273	Sandt (2008)	Y	N	N	N	Y	N	N	N		1					
274	Sani Bozkurt & Vuran (2014)	Y	N	N	N	Y	N	N	N		1					
275	Sani-Bozkurt et al. (2017)	Y	N	N	N	Y	N	N	Y		1					
276	Sansosti (2008)	Y	N	N	N	Y	N	N	N		1					
277	Sansosti & Powell-Smith (2006)	Y	N	N	N	Y	N	N	Y		1					
278	Sansosti & Powell-Smith (2008)	Y	N	N	N	Y	N	N	Y		1					
279	Sansosti et al. (2004)	Y	N	N	N	Y	N	N	N		1					
280	Sasson et al. (2017)	Y	N	N	N	N	N	N	N		1					
281	Scalzo et al. (2017)	Y	Y	N	N	N	N	N	Y		1					
282	Scattone (2008)	Y	N	N	N	Y	N	N	Y		1					
283	Scattone et al. (2006)	Y	N	N	N	Y	N	N	Y		1					
284	Scattone et al. (2002)	Y	N	N	N	Y	N	Y	Y			1	Y			1
285	Schertz et al. (2012)	Y	N	N	N	N	N	N	N		1					
286	Schmit et al.	Y	N	N	Y	N	N	Y	Y	Involves	1					

	(2000)									non-visual aid interventions						
287	Schneider & Goldstein (2010)	Y	Y	N	N	Y	N	Y	Y			1	N	1		
288	Schreibman et al. (1977)	Y	N	N	Y	N	N	N	Y		1					
289	Schreibman & Stahmer (2014)	Y	N	N	N	N	Y	N	Y		1					
290	Schwartzberg & Silverman (2013)	Y	N	N	N	Y	N	N	Y		1					
291	Sgado et al. (2018)	N	N	N	N	N	N	N	Y		1					
292	Shepley et al. (2018)	Y	Y	N	N	N	N	Y	Y	Involves visual aids other than the 5 types	1					
293	Sigafoos et al. (2009)	N	N	N	N	N	Y	N	Y		1					
294	Simacek et al. (2017)	Y	N	N	N	N	N	N	Y		1					
295	Simpson (1993)	N	N	N	N	Y	N	N	N		1					
296	Simpson & Myles (1998)	Y	N	N	N	Y	N	Y	N		1					
297	Smith (2001)	N	N	N	N	Y	N	N	Y		1					
298	Smith & Gillon (2004)	N	N	N	N	Y	Y	N	Y		1					
299	Smith et al. (2014)	Y	N	N	N	N	N	N	Y		1					
300	Soenksen, & Alper (2006)	Y	N	N	N	Y	N	N	Y		1					
301	Sokhadze et al. (2016)	Y	N	N	Y	N	N	N	Y		1					
302	Spencer et al. (2008)	Y	N	N	N	Y	N	Y	N		1					
303	Spriggs et al. (2015)	Y	Y	N	N	N	N	Y	Y	Involves visual aids other than the 5 types	1					

304	Sprinkle & Miguel (2013)	Y	Y	N	N	N	N	N	Y		1					
305	Srinivasan et al. (2015)	Y	N	N	N	N	N	Y	Y		1					
306	Stafford (2000)	Y	N	N	Y	N	N	N	Y		1					
307	Sary et al. (2012)	Y	N	N	N	Y	N	N	N		1					
308	Steele et al. (2015)	Y	N	N	Y	N	N	N	Y		1					
309	Sullivan et al. (2017)	Y	Y	N	N	N	N	Y	Y	Involves non-visual aid interventions	1					
310	Swaggart et al. (1995)	Y	N	N	N	Y	N	N	Y		1					
311	Tanner et al. (2015)	Y	N	N	N	N	Y	N	N		1					
312	Tarnai & Wolfe (2008)	Y	N	N	N	Y	N	N	N		1					
313	Thiemann & Goldstein (2001)	Y	N	N	Y	N	N	N	Y		1					
314	Thiemann-Bourque et al. (2016)	Y	N	N	N	N	Y	N	Y		1					
315	Thompson & Johnston (2017)	Y	N	N	N	Y	N	Y	Y			1	N	1		
316	Thompson & Johnston (2013)	Y	N	N	N	Y	N	Y	Y			1	N	1		
317	Tierney et al. (2012)	Y	N	N	N	N	N	N	Y		1					
318	Tierney et al. (2014)	Y	N	N	N	Y	Y	N	N		1					
319	Tincani (2004)	Y	N	N	N	N	Y	N	Y		1					
320	Torelli et al. (2016)	Y	N	N	N	N	Y	N	Y		1					
321	Torres et al. (2018)	Y	Y	N	N	N	N	Y	Y			1	N	1		
322	Travis &	Y	N	N	N	N	Y	N	Y		1					

	Geiger (2010)															
323	Uzuegbunam et al. (2018)	Y	N	N	N	Y	N	Y	Y	Involves visual aids other than the 5 types	1					
324	Valentino et al. (2015)	Y	N	N	Y	N	N	N	Y		1					
325	van der Mee et al. (2013)	Y	N	N	N	N	Y	N	Y		1					
326	van der Meer et al. (2014)	Y	N	N	N	N	Y	N	Y		1					
327	van der Meer et al. (2012)	Y	N	N	N	N	Y	N	Y		1					
328	van Niekerk et al. (2011)	N	N	N	N	N	N	N	N		1					
329	Vandermeer et al. (2015)	Y	N	N	N	Y	N	Y	Y			1	N	1		
330	Vedora et al. (2009)	Y	N	N	Y	N	N	N	Y		1					
331	Vedora et al. (2008)	Y	Y	N	N	N	N	Y	Y			1	N	1		
332	Wang & Spillane (2009)	Y	N	N	N	Y	N	N	N		1					
333	Watanabe & Sturmey (2003)	N	Y	N	N	N	N	N	Y		1					
334	Waters et al. (2009)	Y	Y	N	N	N	N	Y	Y			1	Y		1	
335	Watson & DiCarlo (2016)	Y	Y	N	N	N	N	Y	Y			1	N	1		
336	Wheeler & Carter (1998)	Y	Y	N	N	N	N	Y	Y			1	N	1		Unable to access full text
337	Whitehead (2007)	N	N	N	N	Y	N	Y	Y		1					
338	Whittingham et al. (2009)	N	N	N	N	Y	N	N	Y		1					
339	Wood et al. (2007)	N	N	N	N	N	N	N	Y		1					
340	Xin & Sutman (2011)	Y	N	N	N	Y	N	N	Y		1					

341	Yoder & Lieberman (2010)	Y	N	N	N	N	Y	N	Y		1					
342	Yokoyama et al. (2006)	Y	N	N	N	N	Y	N	Y		1					
343	Zimmerman & Ledford (2017)	N	N	N	N	Y	N	N	N		1					
344	Zimmerman et al. (2017)	N	Y	N	N	N	N	Y	Y		1					
345	Zwaigenbaum et al. (2013)	Y	N	N	N	N	N	N	N		1					

Note. Y:yes; N: no; 1: opinion of 1 reviewer; Problematic behavior focused intervention: interventions that focused on reducing physical aggression, verbal aggression and self-harm; The criteria for records to be included after abstract screening: children with ASD, one or more types of visual aids, behavior focused intervention and primary source; The criteria for records to be included after full text screening: included articles after abstract screening and problematic behavior focused intervention

Appendices B: Reference of All Articles Gathered for Abstract Screening

No. (n=345)	Articles' References
1	Adams, L., Gouvousis, A., VanLue, M., & Waldron, C. (2004). Social Story Intervention: Improving Communication Skills in a Child with an Autism Spectrum Disorder. <i>Focus on Autism and Other Developmental Disabilities</i> , 19(2), 87-94. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=psyc4&NEWS=N&AN=2004-15473-003 . doi: http://dx.doi.org/10.1177/10883576040190020301
2	Agosta, E., Graetz, J. E., Mastropieri, M. A., & Scruggs, T. E. (2004). Teacher-Researcher Partnerships to Improve Social Behavior through Social Stories. <i>Intervention in School and Clinic</i> , 39(5), 276-287.
3	Ahlers, K. P., Gabrielsen, T. P., Lewis, D., Brady, A. M., & Litchford, A. (2017). Supporting individuals with autism spectrum disorder in understanding and coping with complex social emotional issues. <i>School Psychology International</i> , 38(6), 586-607. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=psyc14&NEWS=N&AN=2017-53683-002 . doi: http://dx.doi.org/10.1177/0143034317719942
4	Akers, J. S., Higbee, T. S., Gerencser, K. R., & Pellegrino, A. J. (2018). An evaluation of group activity schedules to promote social play in children with autism. <i>Journal of Applied Behavior Analysis</i> , 51(3), 553-570. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=psyc15&NEWS=N&AN=2018-23220-001 . doi: http://dx.doi.org/10.1002/jaba.474
5	Akers, J. S., Higbee, T. S., Pollard, J. S., Pellegrino, A. J., & Gerencser, K. R. (2016). An evaluation of photographic activity schedules to increase independent playground skills in young children with autism. <i>Journal of Applied Behavior Analysis</i> , 49(4), 954-959. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med12&NEWS=N&AN=27283759 . doi: https://dx.doi.org/10.1002/jaba.327
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