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EFFECTIVENESS OF SOCIAL EMOTIONAL RECOGNITION APPS FOR CHILDREN
WITH AUTISM SPECTRUM DISORDER

KAYLEE MARIAH GRINDROD
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Reviewed and approved* by the following:

Catherine Mello
Assistant Professor of Applied Psychology and Rehabilitation and Human Services
Thesis Supervisor

Sandy Feinstein
Associate Professor of English
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

ABSTRACT

Difficulties with recognition of emotions during social interactions can cause problems in everyday socialization for children with autism spectrum disorder (ASD). By presenting social situations, technology, specifically apps, can be used to assist children with ASD with understanding facial expressions. The present study investigates apps that teach social-emotional recognition in the form of games. The study also critically analyzed *Outer Space*, an app developed for this study. The apps were assessed for generalizability, skills taught, usability, and elements of social-emotional recognition concern. The apps currently developed, including *Outer Space*, may not generalize skills learned to behaviors in real life situations. Future directions to test the generalization of social-emotional apps was developed and further explained.

TABLE OF CONTENTS

List of Figures	iii
List of Tables	iv
Acknowledgments.....	v
Chapter 1 Introduction	6
Chapter 2 Autism	8
Asperger Syndrome	11
Causes	11
Chapter 3 Social Interaction Deficits	14
Importance of Socialization	14
Challenges With Socialization	16
Chapter 4 Traditional Approaches	19
ABA	19
Technology Based Interventions.....	24
Chapter 5 Critical Analysis of Apps on the Market.....	26
Evaluation Criteria: Stimuli	26
Evaluation Criteria: Response.....	27
Evaluation Criteria: Reinforcement	27
Discussion of Apps	33
Autism Emotions & Feeling Cards	33
Mission Rescue Kloog	34
ABA DrOmnibus Pro.....	34
Summary	35
Chapter 6 Creating Outer Space	36
Research.....	36
Outer Space App.....	37
Chapter 7 Critical Analysis of Outer Space	39
Chapter 8 Conclusion.....	45
Appendix A Outer Space	48
Appendix B Facial Recognition Assessment	50
Appendix C Projected Procedures	52
Appendix D Social Emotional Questionnaire	54
Appendix E Social Emotional Vignettes	55
References.....	56

LIST OF FIGURES

Figure 1. Mini Game 2.....	48
Figure 2. Mini Game 1.....	48
Figure 3. Mini Game 3.....	49
Figure 4. Mini Game 4.....	49
Figure 5. Facial Expression Labeling	50
Figure 6. Facial Identity Matching.....	51
Figure 7. Facial Expression Matching	51

LIST OF TABLES

Table 1. Stimuli Used	29
Table 2. Response	30
Table 3. Reinforcement/Correction.....	31
Table 4. External Validity	32
Table 5. Stimuli Used (2).....	40
Table 6. Response (2)	41
Table 7. Reinforcement/Correction (2).....	42
Table 8. External Validity (2).....	43

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Chapter 1

Introduction

Children diagnosed with autism spectrum disorder (ASD) have many limitations that typically developing children (TD) do not. One of the most salient deficits associated with this disorder concerns socialization. Children with ASD may avoid eye contact, lack appropriate empathy during conversations, and misunderstand facial expressions. Without proper socialization skills, children with ASD may struggle within classrooms and their communities due to peer rejection, self-isolation, or difficulties establishing relationships.

Several approaches have been developed to help lessen the socialization deficit associated with ASD. Applied behavioral analysis (ABA) is an empirically based approach using the principles of learning to teach children with ASD various skills, including social skills such as making eye contact. Treatment approaches using ABA have received considerable empirical attention and are considered to be at the forefront of therapeutic and educational interventions for children with ASD (Vismara & Rogers, 2010).

While ABA practices have been around since the 1960's, advances in technology have enabled these practices to grow and evolve into new formats. Some more recently developed interventions for children with ASD incorporate computer programs, DVDs, and apps. While apps are typically used for recreational purposes, developers can use game-like features and activities to teach children in a less traditional manner.

Despite the growing number of apps for children with ASD on the market, there is currently little empirical research on their effectiveness. This project sought to address this gap by developing a framework to critically assess apps based on the principles of ABA and overall usability. Following research on elements featured in apps promoting social-emotional recognition skills, a new app was

created to incorporate successful design elements. The developed app was assessed using the same analysis as the other apps.

A common problem with the use of apps for social-emotional recognition is that children may not readily generalize the skills learned through the app to real-life situations. Future directions in social-emotional technology are discussed, including testing generalization of skills learned through these apps to real life behaviors.

Chapter 2

Autism

Autism spectrum disorder (ASD) is a wide umbrella term used to describe a neurodevelopmental disorder that encompasses various areas of functioning and abilities. The Centers for Disease Control and Prevention (CDC) estimate that ASD is found in 1 out of every 68 children in the United States (Christensen, et. al., 2012). Worldwide that number is 1 out of every 160 children diagnosed with ASD (WHO, 2017). The diagnosis of ASD occurs in 1 out of every 42 boys and 1 out of every 189 girls. ASD is four to five times more common in boys than girls (Kogan, et. al., 2007).

The core symptoms that characterize ASD, according to the DSM-5 (American Psychiatric Association, 2013), are difficulties in social interaction, repetitive and ritualistic behaviors, interests, activities, and verbal and nonverbal communication. Professionals must consider five criteria in order to diagnose children with ASD. Children can be diagnosed using developmental screenings and the Comprehensive Diagnostic Evaluation. Developmental screenings occur during regular doctor appointments. Children are assessed on basic skills appropriate to the children's age, such as movement, language, and behavior (Lord, et al., 2006). If there is concern regarding the developmental screenings, then the Comprehensive Diagnostic Evaluation is used to further evaluate the children. The screenings may include visual and hearing assessments along with genetic, neurological, and other additional medical assessments if deemed necessary (Lord, et al., 2006).

The first criteria for a diagnosis of ASD determined by professionals is persistent deficits in social communication and interactions, which could manifest in a lack of ability to understand and maintain the conversation, share interests, understand emotions, and a failure to respond appropriately to social interactions. There may also be deficits in nonverbal communication that may include irregularities in eye contact and body language, difficulties with understanding physical gestures, or an absence of

discernable facial expressions. Symptoms may appear in children as young as 12 months, but those who tend to be higher functioning, meaning cognitively more advanced than other children with ASD who have an IQ of 70 or higher, may not show signs until they are in school and parents become concerned about their child making friends or a teacher notices difficulties with peer interactions (Johnson & Myers, 2007). Children with ASD may face difficulties making and maintaining relationships with peers (Bauminger & Shulman, 2003). Those with difficulties socializing may find everyday interactions difficult, which can lead to isolation from peers and classmates.

The second criteria professionals explore are restricted or repetitive behaviors, interests, and ritualistic activities. Children with ASD may display stereotypical or repetitive motor movements, such as lining up toys instead of playing with them, hand flapping, and stimming, which refers to moving the body in a repetitive way that stimulates one or more of the senses. Children with ASD may repeat self-injurious behavior, such as hitting oneself, because it provides a comforting sensory stimulation (Lovaas, et al., 1987). Other symptoms in this category include being inflexible to changes in a familiar schedule, performing rituals such as eating the same food every day at the same time and expressing distress over small changes such as leaving the house, changing activities, or going somewhere new. Some children may be strongly fixated on a particular interest, for example, vehicles, animals, or even machines. This fixation may appear through constant talking about the topic. Sensitivity to sensory items, items that provide particular sensory input through the use of any of the five senses (touch, taste, sight, hearing, and smelling), may manifest in adverse reactions to certain sounds or textures, excessive touching of items, and/or a fascination with lights or movement. A common sensitivity is to certain clothing materials, which may cause discomfort that can lead to emotional distress (Allely, 2013).

The final three criteria for the diagnosis of ASD concern the onset, severity, and related diagnoses. The symptoms, as stated above, must have been present in the early developmental period. The fourth criteria of an ASD diagnosis is whether or not symptoms cause a significant impairment in social, occupational, or other areas of functioning. The fifth and final criteria used to diagnosis ASD is

specifying whether the child's symptoms could be explained by an intellectual disability, such as an intellectual developmental disorder or by a developmental delay. It is very common for intellectual disabilities and autism spectrum disorder to be comorbid (co-occurring disorders); about 50-70% of children diagnosed with ASD are also diagnosed with an intellectual disability (Matson & Shoemaker, 2009). It is important to evaluate whether the child's socialization is below what is expected for an intellectual disability if one is present.

The severity of ASD, or the level of functioning, can be categorized by three different levels of support. The first level, "requiring support," recognizes the difficulty in social communication, including difficulty initiating social interactions and lack of interest in having any social communication. Children who are categorized by the first level may face difficulties with transitioning between activities, organizing toys, schoolwork, and schedules, and being independent in social interactions and caretaking.

The second level, "requiring substantial support," recognizes the difficulty in social communication as well, but also includes deficits in verbal and nonverbal social communication skills, social impairments even with support, limited initiation of socialization, and atypical responses to social interactions. Children categorized as this level may speak in very simple sentences, hold narrow interests, and have limited nonverbal communication skills that lead to non-normative behaviors. Children categorized at this level also display difficulty coping with change, functioning in multiple contexts, changing focus and tend to repeat behaviors frequently (enough that a casual observer would notice),.

The third and final level, "requiring very substantial support," shows social communication deficits, including severe verbal and nonverbal communication problems that cause severe impairments in functioning, limited initiation of social interactions, and minimal responses to socialization. Those in this category may only socialize to meet needs and communicate only a few words of intelligible speech. Their behavior is marked by extreme difficulty coping with change, repetitive behaviors that interfere with functioning, and extreme distress when changing focus.

Asperger Syndrome

In May 2013, the newest DSM edition (DSM-5) changed the diagnostic criteria. In the previous edition of the DSM (American Psychiatric Association, 2000), autism-like disorders were categorized as autistic disorder, pervasive developmental disorder not otherwise specified (PDD-NOS), and Asperger syndrome, respectively. Due to the wide variety of behaviors and levels of functioning, ASD was created to better diagnose children who didn't fit neatly into any one category.

Individuals diagnosed with Asperger syndrome were considered by some to be on the higher end of functioning for autism because of less severe symptoms and a lack of speech and/or cognitive delay (Schopler, 1985). Children who were diagnosed with Asperger syndrome nevertheless face difficulties with social interaction, including difficulty making eye contact, awkward mannerisms, and even talking about themselves more than others (Asperger, 2013). Those diagnosed with Asperger syndrome typically had average or above average IQs, and some even displayed a wide knowledge of a particular field or area. All of the symptoms used to diagnose autism and Asperger syndrome in the DSM-IV were the same, except Asperger syndrome does not include any speech or intellectual delays. The Asperger diagnosis, however, is no longer used and does not exist in the latest DSM-5.

While the diagnosis of Asperger syndrome is no longer used in professional diagnoses, there are still individuals who identify themselves with Asperger syndrome. In a study researching whether participants supported the new DSM-5 proposal, results showed that most believed there were differences between Asperger syndrome and autism, and half of the participants did not support the proposed diagnostic changes (Kite, et al., 2013).

Causes

There is no definitive causal theory of ASD, however, theories based on genetic, environmental, and psychosocial risk factors have received considerable attention. To date, research suggests that there

are multiple factors, rather than a single identifiable cause, that affect a child's behavior and result in an ASD diagnosis (Landrigan, 2010).

The first suspected area of causation is through genetic risk factors. Most researchers agree that ASD stems from heritable genetic differences or mutations, with approximately 90% of cases linking to hereditary causes (Toriello, 2016). In support of this theory is the pronounced and consistent gender disparity in the differences in chromosome 17q11, which is predominantly a male-specific linkage to ASD (Stone, 2004). ASD is thought to be closely associated with the differences in the X chromosome (Chakrabarti & Fombonne, 2005). For instance, approximately 60-90% of identical twins were both diagnosed with ASD and up to 10% of fraternal twins were both diagnosed with ASD (Bailey, et al. 1995).

Outside of genetics, environmental factors have also been suspected of having an effect on children who are diagnosed with ASD. Some of the factors investigated to date include pre- and post-natal factors such as maternal illness, exposure to drugs, and exposure to toxins. Maternal illness during pregnancy has been researched and shown to be significant. Fevers and the influenza virus during pregnancy have been linked to different psychosis factors, including schizophrenia, depression and ASD (Bale et al. 2010, Kim et al. 2015). Exposure to certain drugs during pregnancy has also been an area of focus. A study of maternal anti-depressant intake during pregnancy highlighted significant increased risk between the mother's serotonin reuptake (when neurotransmitters are released from one nerve and absorbed by another nerve) in the second and third trimester and the likelihood of the child developing ASD (Boukhris, et al., 2016). Exposure to lead, polychlorinated biphenyls (PCBs), insecticides, automotive exhaust, hydrocarbons, mercury, and flame-retardants have been hypothesized to cause ASD (Landrigan, Lambertini, & Birnbaum, 2012; Shelton, Hertz-Picciotto, & Pessah, 2012). So far no specific environmental factors have been found to be the sole cause; however, when investigating environmental factors, it is very important to also address genetic factors and how the two may interact. In a recent study, the mothers of children with ASD who had both a certain genetic susceptibility of ASD and

experienced maternal infection or fever during pregnancy saw increased symptomology in their children (Mazina, 2015). The increased symptomology shows that there is indeed an interaction between environmental and genetic factors, which can make causal determinations difficult, as there can be many factors involved.

Chapter 3

Social Interaction Deficits

Socialization is an important part of identifying one's self and sharing resources or interests with others (Arnett, 1995). Interacting with others is essential for developing relationships. For children with ASD, socializing may not be an easy task and might come with problems. These problems include interpreting facial expressions, eye contact, and understanding empathy.

Not interpreting facial expressions appropriately can lead to misunderstanding the context of a conversation and can make effective communication difficult. Eye contact during social interactions is also important because it shows the other person that the individual is interested in the conversation and allows the individual to pick up nonverbal social cues, such as raising eyebrows to show confusion. Besides the physical factors of communication, empathy is an important key to understanding and creating a connection with individuals in order to create relationships. Socialization abilities, especially for those who are higher functioning, are important to be successful in social institutions such as school and work.

Importance of Socialization

Socializing is an important part of school and work because it allows individuals to establish a meaningful connection with another individual. This process of establishing a connection to another individual is not only important for those with ASD, but for everyone. Adolescents who have positive socialization with peers tend to have improved mental health, even if they only have one healthy peer relationship (Graber et al. 2015). Relationships can lead to better mental health, which is important because children and adults with ASD have a higher rate of psychiatric disorders than TD peers (Skokauskas & Gallagher 2010). Psychiatric disorders include schizophrenia, anxiety, depression, obsessive-compulsive disorder, etc.

Depression is one of the most prevalent psychiatric disorders found among those with ASD, with lifetime reported rates of over 50% (Hofvander et al., 2009). Depression is a significant risk factor in suicide ideation (thoughts about taking one's life), plans, attempts, and committing suicide (Slade et al., 2009). Other possible risk factors include social isolation or exclusion, peer victimization, interpersonal conflict, low self-esteem, or preoccupation with death (Cassidy et al. 2014, Gillberg 2002; Segers & Rawana 2014). Social isolation can cause feelings of loneliness, a subjective feeling that one is distant from others or has too few social relationships (Russell, 1996). Those who reported more symptoms of ASD on the Autism Spectrum Quotient (AQ-Short) also reported feeling lonelier (Hedley, 2018).

Peer victimization is also a problem because it occurs more frequently with children who often have social skill deficits, face repeated peer rejection, have fewer friends, and may hold lower social statuses (Greenham, 1999; Kavale and Forness 1996; Swanson and Malone, 1992). This victimization leads to an increase in bullying for those with ASD (Cappadocia et al., 2012). Children and adolescents, in grades K-12, who are included in regular education classes instead of special education classes have the highest rate of victimization and also face the most difficulty making friends; having even just one friend can protect against bullying for TD children and those with ASD (Gray, 2004; Nansel et al., 2001). Those who are in regular education classes, alongside those who are TD, face more problems making friends and fitting in than those who are in special education classes removed from TD peers (Gray, 2004).

Difficulty making friends can stem from problems with socialization. Individuals who face repeated rejection during socialization might lose motivation to keep trying, because the reward is no longer worth the risk (Lepore et al. 1989). This lack of motivation can cause lower self-esteem and prevent the child from making essential relationships with peers. Some children perceive the label of ASD as negative and wish to distance themselves from it, which causes lower self-esteem and more mental health issues (Macleod, Lewis, & Robertson, 2013).

Challenges With Socialization

Although socialization is important, those with ASD have many deficits that make socialization very difficult. One of the most prominent challenges children with ASD encounter in social communication and interactions reside in understanding the emotions of others. Some of these challenges involve misunderstanding others in social interactions, sometimes involving the misinterpretation of facial expressions. A person's facial expression is an outward expression of a person's emotional state (Ekman & Friesen, 1971). Children with ASD who have difficulty understanding a person's emotional intent in a conversation because they cannot adequately use this type of social cue would have a disadvantage socializing. A child's age is a factor in the skill development of interpreting facial expressions because the skill develops during adolescence.

The most differences interpreting facial expressions that occur between TD children and those with ASD may not be apparent until adolescence or young adulthood (O'Conner, Hamm, Kirk, 2005). The differences in abilities between TD children and those with ASD may only manifest in some contexts. Some studies have shown that children with ASD are not impaired when recognizing basic emotions presented in static photos (Castelli, 2005; Grossman et al., 2000; Ozonoff et al., 1990). However, differences appeared when children with ASD were shown more emotions using dynamic video stimuli (Rump et al., 2009, Smith et al., 2010). Complex emotions, which include pride or surprise, are not commonly recognized by children with ASD (Balconi, Amenta, & Ferrari, 2012).

Eye contact is an important part of socialization, which for many children with ASD can be a problematic area. Most individuals with ASD find it uncomfortable to make eye contact and do not understand the significance of eyes for understanding emotions (Joseph et al., 2008; Moriuchi, Klin, & Jones, 2016). In a study looking at eye gaze movement of children with ASD when shown faces depicting either a happy, neutral, or fearful expression, individuals moved their gaze away rather than to the eyes, showing an active avoidance of eye contact (Kliemann et al., 2010). One theory for gaze avoidance in ASD is that eye contact is linked to the amygdala, a brain structure that is responsible for the emotional

response and memory of emotions. Individuals with ASD show atypical amygdala response levels when looking at neutral faces; in fact, those who incorrectly labeled neutral faces as threatening were more likely to avoid eye contact (Tottenham, et al., 2014). The atypical amygdala response levels show that when children made an emotional connection to facial expressions (perceiving a face as threatening), they actively avoided eye contact. Individuals who have ASD and cannot maintain appropriate eye contact may have problems developing healthy relationships with peers.

Besides understanding facial expressions and making eye contact, empathy is an important part of appropriate socialization. Empathy can be divided into two categories, cognitive and emotional. Cognitive empathy is the ability to recognize emotions and perform perspective taking, while emotional empathy entails sharing the emotions of others in emotional congruency and emotional affection as brought on by an individual's situation (Blair 2005; De Waal 2008). Related to empathy, children with ASD face difficulties with "theory of mind" (ToM), that is the knowledge that yourself and other people have thoughts, feelings, beliefs, imagination and desires (Premack and Woodruff, 1978).

In a study on perception taking that compared TD children, children with ASD, and children with Down syndrome, only children with ASD were unable to understand that the perception of an individual is different from themselves (Baron-Cohen et al., 1985). These results demonstrated that IQ levels are not a factor in perception recognizing, as those with Down syndrome had lower levels of functioning, yet were able to understand how the perception of another individual differs from themselves. Since this first study, many others have replicated these findings and consistently shown that children with ASD have difficulty in attributing mental states to themselves and others (Tager-Flusberg, 2007). Difficulties with ToM often lead to others feeling a lack of empathy from the individual with ASD, which can hinder relationships.

Communicating is a large part of interacting with others, but for many children with ASD is an area of concern. Communication deficits may include delayed development of language, failure to compensate for lack of language by using nonverbal gestures, pronoun reversal, or inappropriate

responses in conversation (Prizant & Rubin, 1999). Communication deficits are a prominent feature of ASD and tend to be the most pervasive (Rutter, 1968; Rutter & Bartak 1971). Deficits in communication have been found to be the most common first concern of parents who seek assistance for an ASD evaluation (Kishore & Basu, 2011). In a study looking at the correlation between levels of effective communication and socialization deficits within children with ASD, results showed that a close relationship exists between these two factors and those who have problems with communicating typically experienced socialization problems (Hattier & Matson, 2011).

Chapter 4

Traditional Approaches

Social deficits have been a defining factor in the diagnosis of autism since Leo Kanner's first observations in his 1943 paper describing ten children with autism (Kanner, 1943). Since the discovery of these deficits, many approaches have been developed and implemented in treatment, such as applied behavioral analysis (ABA). ABA is a traditional treatment that is still used today to assist children with ASD in learning basic skills such as listening, looking at others when they are speaking, and maintaining eye contact. More complex skills such as reading, making appropriate conversation, and understanding another person's perspective can also be taught using ABA. More recently there has been an increase in approaches that incorporate technology such as video programs, computer programs, and virtual reality. Each of these approaches has been shown to be effective in increasing socialization skills.

ABA

Applied behavior analysis (ABA) is a process that focuses on the scientific principles of learning, one being that consequences control behavior, in order to best help each individual with ASD succeed by addressing their behaviors with an individualized plan. ABA is based on the theory that behavior is learned, so learning theory is used to help teach children with ASD in a clear, concise, and consistent manner because children with autism learn best if information is presented in a structured manner (Harris & Delmolino, 2002). Learning theory has four major principles in which it is believed that social learning stems. Identified by Albert Bandura (1977), effective learning includes attention, retention, reproduction and motivation. Attention must be given to the activity or lesson, or learning will not take place. After learning new information, it is important to retain it so one is able to use the information during an appropriate situation. Without retaining information, generalization is not possible. The last principle is

motivation, which is the desire to learn and retain information. Motivation is strongly influenced by rewards and punishments.

Some of the major behavioral targets of ABA areas include language and communication, challenging behaviors, ritualistic behaviors, self-injurious behaviors, and life skills. ABA practices track progress by identifying a baseline behavior and measuring change through clear and defined objectives. In order to start therapy, the therapist must select a behavior or behavioral skill deficit that he or she would like to change. It is important to identify a behavioral goal, such as listening to a person speak before interrupting, well-defined objectives, and what constitutes appropriate behavior or change, in order to reach that goal. After objectives are identified, a method of measuring the target behaviors must be established. An evaluation of the current level of performance, known as the baseline, must be established in order to evaluate progress. After a baseline is established, an intervention is designed and implemented to teach the new skill or reduce the unwanted behavior. As treatment progresses, continuous measurements of the child's behavioral changes are used to determine effectiveness. An ongoing evaluation of the effectiveness of the intervention will present any necessary modifications needed to maintain or increase the efficiency of the intervention (MADSEC, 2000).

Professionals who have been certified by an accredited institution implement ABA practices. There are two certification options, an assistant behavior analyst or a behavior analyst. Certifications are controlled by the Behavior Analyst Certification Board (BACB), a national non-profit. In order to become a board certified assistant behavior analyst, one would need to graduate with a bachelor's degree and complete 1000 hours of fieldwork (BCaBA, 2018). Assistant behavior analysts conduct behavioral assessments and interpret the results under the supervision of a certified behavior analyst. To become a board certified behavior analyst, one must graduate with a master's degree and complete 1500 hours of supervised fieldwork (BCBA, 2018). Behavior analysts conduct behavioral assessments and provide analytic interpretations of those behaviors.

Professionals using ABA practices use behavioral assessments to identify the function and reasoning behind behaviors deemed inappropriate by the therapist. There are multiple empirically based assessments used in ABA treatment. One of the most commonly used is the Functional Behavioral Assessment (FBA). The FBA is used to identify the meaning behind a child's behavior, that is, what the child is trying to communicate through his or her actions. One behavior might have multiple meanings depending on the situation. For example, a child may scream to avoid an unpleasant task or scream because the child enjoys the sound of it. It is important to assess the function of the behavior in order to best modify the behavior. FBA assessment allows the therapist to identify what the child is trying to convey by interviewing knowledgeable individuals about the occurrence of the behavior or through direct observation to gain information on when the behavior occurs most often or when the behavior subsides.

Once a behavior is identified through an assessment and goals are identified, there are many teaching methods available to ABA therapists. One of these includes discrete trial instruction (DTI) or Discrete Trial Teaching, based on the work of Lovaas (1987). This approach is most commonly used with young children receiving early intensive behavioral intervention, a program designed to help children as young as three receive intense comprehensive therapy, typically year round with 20-30 hours a week of structured sessions to reduce any unwanted behaviors and promote appropriate behaviors.

DTI presents information in an antecedent and consequent manner. The desired behavior, the antecedent (what comes before the desired behavior), and the consequent (what comes after the desired behavior) are essential components. The discriminative stimulus is an instruction, direction, or cue used to prompt a behavior. For example, an instructor may instruct the child to "Raise your hand." The child's behavior immediately after this directive is the response. If the child raises his or her hand in response to this cue, the instructor would provide the consequent immediately following the behavior; the consequent in this example might be "Good job!"

Each cycle of discriminative stimulus, response, and consequent is called a trial. The consequences following the response are considered either reinforcement or punishment. Reinforcement

is used when there is a desire to maintain that behavior. A child may be more likely to raise his or her hand when an instructor provides praise. Reinforcement could be social praise, smiles, treats, or favored toys (Harris, et al. 2002). A punishment is used if there is a desire to reduce the behavior. Incorrect responses with punishment consequences often come with a correction, and the child is given an opportunity to demonstrate the correct response.

DTI measures progress by collecting data of the child's performance from each trial or a sample of trials (called a probe). The data are recorded, summarized, and analyzed to monitor the development. The objectives, decided at the beginning of the program, include a clear classification of the discriminative stimulus and responses in order to ensure reliability with administration and data collection. The child's behavior is compared to the desired behavior as defined by the objectives. If the child's behavior consistently corresponds to the objectives then the treatment has been effective.

When executing the treatment, it is important to involve parents as partners and teach them how to communicate with their child in the most effective way (Harris, 1985; Koegel, et al., 1978). With continuous support at home as well as in the classroom, children with ASD have more opportunities to modify their behavior. Early intensive behavioral intervention, which includes approximately 20-30 hours per week of treatment for those diagnosed with ASD as young as 18 months, is beneficial, with studies showing a medium effect size for changes in the Adaptive Behavior Composite scores at the end of treatment compared to the beginning of treatment (Eldevik, et al., 2009). Children who spent 40 hours a week receiving one-on-one treatment for two years were more likely than children in a control group who only received 10 hours of treatment to learn in typical classrooms and have the same level of intelligence as TD peers (Lovaas, 1987).

ABA services may be provided at home or in a center or school. In the first model, a therapist comes to the house and works directly with the child and then teaches the family ABA skills so they can reinforce what the child is being taught with the therapist. In the center- or a school-based model, children receive ABA individually within a special program for children with ASD, a special education classroom,

or a regular education classroom with an aide. Both have advantages and disadvantages. In the home-based model, parents are highly involved in the curriculum and can engage with the children and therapist. However, this approach can also be difficult because not every parent has the time to devote to his or her child's treatment. In the center or school-based approach, parents are encouraged to be involved, but the responsibilities of implementing the program lay with a professional who has the skills and technical knowledge to help the child succeed. Centers or schools maintain the advantage of having a variety of staff, including occupational therapists, speech therapists, and physical therapists who can offer assistance if needed (Harris, et al., 2002).

Treatment approaches using ABA are considered to be at the forefront of therapeutic and educational interventions for children with ASD. There is a large amount of research to support ABA practices, the most effective being intense programs with at least 20 hours per week (Vismara & Rogers, 2010). Within ABA practices, DTI has been used widely throughout the education of individuals with ASD and has been shown to be an effective teaching method (Lovaas, 1987; McEachin, et al., 1993; Harris, et al., 1991).

ABA and another program, Treatment and Education of Autistic and related Communication Handicapped Children (TEACCH), are the most requested and implemented public school treatments used by educators, service providers, and parents (Choutka et al. 2004; Hess et al. 2008). In comparison studies of ABA and other eclectic approaches, which is a combination of treatment strategies, ABA has been shown to yield significant improvements in cognitive, language, and adaptive skills when delivered 30 hours a week with behavioral intervention (Cohen et al., 2006; Eikeseth et al., 2002; Howard et al., 2005; Zachor et al., 2007). ABA, especially involving early intensive intervention, is currently considered the most effective intervention for young children with ASD (Vismara, et al., 2010).

Technology Based Interventions

Technology, specifically computers and mobile devices including tablets, is beginning to be used more and more throughout the home and in schools and private practices (Dede, 2000). Both parents and professionals support the use of technology to teach developmental skills (Clark, et al., 2015; Volioti, et al., 2016). Also, emotion recognition skill programs that use technology have been found to be effective (Kouo et al., 2016).

Some of the interventions incorporating technology to help individuals with ASD include computer programs, DVDs, and apps designed to teach socialization skills and social-emotional recognition (Mitchell, et al., 2007). Visual activity schedules, for example, using pictures to help children understand upcoming changes in a schedule, and video modeling, videos showing appropriate social behavior, have been shown to be an effective way to teach children with ASD appropriate socialization (Wang et al. 2009, Springgs et al. 2015). Technology needs to help children learn to identify emotions, but also to generalize what they learn and identify the emotion that fits a given social situation.

Technology can be adapted in the classroom or in therapy sessions by using videos or animated series to teach emotion recognition. *The Transporters* is a DVD series featuring eight train characters with real-life actors' faces positioned onto the trains. Children with ASD enjoy watching vehicles because they are predictable, rule-based, and systematic (Baron-Cohen, 2006). *The Transporters* was created in the hopes that children who have trouble with ToM or empathy might enjoy the systematic motion of the trains. Furthermore, it was predicted that they would focus on the faces instead of avoiding them because the body of the train is less intimidating than a person who changes expressions and emotions at an unpredictable rate. Children with ASD who watched *The Transporters* over a 4-week period showed significant improvements in their ability to recognize and comprehend emotions, some individuals even achieving the same level of performance as their typically developing peers (Golan, et al., 2010).

Virtual reality (VR) was introduced more recently to allow individuals with ASD to experience more dynamic and real-life situations through a computer-based simulation of reality (Kandalajt, et al.,

2012). The effectiveness of VR in treating conditions such as anxiety, phobias, and post-traumatic stress disorder has already been demonstrated (Riva 2005; Anderson, et al., 2001; Cameirao, et al., 2010; Broeren, et al., 2008; Rothbaum, et al., 1999). VR is different from role-playing because it simulates real-life experiences and allows for repeated practice and exposure to social situations, which is important for children with ASD. VR also allows for interactions without high levels of stress, fear of mistakes or rejection that may be commonly found in real-life interactions with peers.

An investigation on the effects of VR to enhance social skills, social cognition, and social functioning in young adults with ASD, found that after 10 sessions, skills had significantly increased in areas of verbal and non-verbal recognition and theory of mind (Kandalaft, et al., 2012). The study used the Virtual Reality Social Cognition Training (VR-SCT) intervention to measure performance of social perception, emotion recognition, theory of mind, and social conversation. Recognizing emotions from faces was not the only significant improvement in the study, the participants also showed a significant improvement in recognizing emotions from voice (Kandalaft, et al., 2012).

Apps have been developed recently that focus on trying to improve emotion recognition. Some apps center not only on teaching children to identify the emotions but to generalize and choose the emotion that most appropriately fits a social situation.

Chapter 5

Critical Analysis of Apps on the Market

To effectively evaluate the app created for this research, a critical analysis was performed to research the effectiveness of current apps on the market aimed at improving social-emotional skills. The following features were used to evaluate the app: stimuli used, response to app, reinforcement and correction, and overall appearance and usability. The apps were found using the Play Store on a Galaxy tablet and the App Store on an iPad. The following phrases were used to search for apps: “emotional recognition,” “autism emotions,” and “autism.” All of the apps selected were available for free at the time of the study.

Evaluation Criteria: Stimuli

Stimuli: Type and Realism. Apps were evaluated with respect to the type of stimuli that were used to illustrate facial emotional expressions. Apps that use photos of real people promote more learning than animated drawings or computer-generated images, however without the real-life experience of socialization children may not experience the same physiological responses (brain activity) they normally would when interacting with a ‘live’ person (Myllyneva, et al., 2014). When someone is looking at an individual, he or she is likely to have feelings of being evaluated and experience more public awareness, the understanding that others can see and evaluate one’s actions, which one does not experience when looking at photos (Buss, 1980).

Auditory Stimuli and Prompts. Auditory and visual prompts are important for a child to understand instructions. Some children with ASD have auditory sensitivities and may need to listen to sound at a lower volume or instead might benefit from also having a visual prompt to read. For lower functioning children who may process information at a slower rate than others, having a visual prompt allows children the time to read the instructions and understand them within the appropriate time frame.

Not all children with ASD are able to read, but might respond well to verbal prompts. It is recommended that an app feature both of these elements to best address the needs of a variety of children.

Evaluation Criteria: Response

In each app, children are given activities or lessons to test the various categories of the skills taught. The verbal classification of emotions in pictures may be taught in multiple ways. The first is through a training period where children are taught how to identify emotions based on facial elements, including the eyes and the mouth. The second is through interactive practice. The child may be asked to identify an emotion by selecting the appropriate verbal description. Through a verbal description, children are given a prompt and must select the appropriate emotion from the choices available.

Evaluation Criteria: Reinforcement

Each app uses the DTI teaching model to offer reinforcement after each selection. After a correct response, all apps offer positive feedback through verbal praise or by earning a game or fun activity. After an incorrect response, all apps give verbal or visual feedback, and the child makes another selection. Every app allows the user to make another selection until the correct response is selected.

Skill generalization. Due to the changes in physiological responses when looking at actual individuals compared to photos of individuals, generalization of skills learned through the app to behaviors in real life may be hard to achieve. Apps can, however, promote and assess the generalization of skills to different stimuli from the ones used to initially teach the skill. Generalization of skills in an app typically takes the form of learning to identify the emotion of an individual and then being prompted to identify that same emotion in other individuals. Children who are able to complete a simple task, such

as correctly identifying an emotion, are then able to move on to more difficult tasks within the app (Hadwin, et al., 1996). The assessment looks at how much generalization of skills is built into the activities or how much variety there is within the stimuli.

Skills taught. The types of skills relating to emotional recognition taught by the app were categorized as follows: 1) selecting the appropriate verbal description for an emotion using photo as visual cue; 2) selecting the facial expression that appropriately reflects an emotion described verbally; 3) identifying the facial expression that appropriately correlates with a specific social context; 4) identifying nonverbal communication through focus on eyes and mouth; and 5) identifying multiple facial expressions that depict the same expression through a verbal cue . The first skill requires children to understand how each emotion manifests visually and then choose the appropriate verbal description. In contrast, the second skill requires children to choose the appropriate emotion shown in pictures based on the verbal description that is given. The third skill requires children to understand when each emotion is appropriate and match it to the correct situation. The fourth skill is recognizing emotions through the specific focus on the eyes and/or the mouth. Children are taught to view these features in order to identify the overall emotion of the individual. The fifth skill shows generalization because children must be able to identify an emotion based on a verbal cue and select each picture that depicts that emotion.

Table 1. Stimuli Used

Name of app, Maker Year developed	<i>Autism Emotions and Feeling Cards</i> ; KidsAppBaba; 2015	<i>Mission Rescue Kloog</i> ; Shine Center for Autism; 2015	<i>ABA DrOmnibus Pro</i> ; <i>DrOmnibus</i> ; 2018
Skills taught	1, 2, 3	2, 4	1, 2, 5
Emotions/States	Thinking, angry, surprise, sad, happy, scared, silly, excited, curious, bored, thirsty, and shy	Sad, surprise, scared, happy, bored, angry, worried, and neutral	Happy, sad, anger, surprise, disgust, and silly
Type of stimulus	Real photos, including close up, whole body, and some with multiple subjects	Animated monster face and animated human face	Choice of animated faces or photos of real expressions
Level of realism	Real photos, however most are not realistic in nature and may not transfer	Animation not very realistic, may not transfer to real situations	Animation is not very realistic, the real photos are much more realistic, but may not transfer to real situations
Auditory verbal material	Audio option available for each choice, audible reinforcements after each selection	Audio instructions included for each lesson	Only audio instruction included, must have volume on to understand prompts, sound effects used to reinforce selections

Table 2. Response

App	<i>Autism Emotions and Feeling Cards</i>	<i>Mission Rescue Kloog</i>	<i>ABA DrOmnibus Pro</i>
Verbal description of pictures	<p>Training session to identify emotions, including complex emotions, does not offer reinforcement, but offers self-paced study</p> <p>Activity allows children to choose correct emotion label from three choices</p>	<p>Interactive session, children must select appropriate emotion from eyes or mouth only</p> <p>In “Let’s Discuss” helper holds paper up to face covering everything but the eyes or the mouth and the child must choose the appropriate emotion that the helper is making</p>	<p>Training session, an emotion is taught by showing one photo of an emotion and repeatedly having the child select the photo after a verbal prompt is given, as in “Who is sad*?” *Insert desired emotion</p>
Selection of pictures matching verbal labels	<p>Activity tests abilities to choose the correct photo out of four choices</p>	<p>Activity tests ability to choose the correct photo out of four choices</p>	<p>Activity tests ability to choose the correct photo out of two choices</p> <p>After a few correct choices, must select from three choices</p>
Matching similar emotions (picture to picture)	<p>No activities for this category</p>	<p>No activities for this category</p>	<p>Children are given a verbal prompt, such as “Who is sad*? The child must select all of the faces (animated or real) which are appropriate for the prompt, normally two faces out of three</p>
Matching emotion to context	<p>Visual cue describes a situation in which children select the appropriate emotion from two choices, for example, “The job wasn’t easy. I was exhausted and thirsty. How do I look?”</p>	<p>No activities for this category</p>	<p>No activities for this category</p>

Table 3. Reinforcement/Correction

App	<i>Autism Emotions and Feeling Cards</i>	<i>Mission Rescue Kloog</i>	<i>ABA DrOmnibus Pro</i>
Correct response feedback	Verbal praise, followed shortly by new question	Response will turn green, followed shortly by new question After finishing a quiz, if children answer enough questions correctly, he or she is rewarded with a material (e.g. spark plug) necessary to repair the ship	With the selection of a correct response, a small colored ball appears at the bottom of the screen and verbal praise is given After 10 colored balls are collected, confetti appears along with praise and the child is rewarded with the choice of one game to play for 30 seconds
Incorrect response feedback	Verbal encouragement, such as “Let’s try again,” “keep going,” “really try”	Response will turn red, an animated alien appears at the bottom of the screen prompting the child to try again	Green boarder appears around the correct response
Response correction opportunities	Question remains and allows child to make another selection until the child makes the correct selection	Wrong response remains red and child makes another selection until the correct response is chosen	Green boarder appears around the correct response, when selected, a blank screen appears for a few seconds, then the child is given the same question to answer again

Table 4. External Validity

App	<i>Autism Emotions and Feeling Cards</i>	<i>Mission Rescue Kloog</i>	<i>ABA DrOmnibus Pro</i>
Generalization	Multiple pictures of the same emotions requires children to generalize learning, however children are never tasked to identify two photos of the same emotion at once	Animation may not generalize, however activities in “Let’s Discuss” performed with a helper in real life might be very helpful and could generalize to real situations	Children will use generalization to choose photos of the same emotion shown on multiple people
App interaction (Choices, customization, navigation, menus)	Children may choose four activities from the menu, they may also leave game using a small X in the corner, no further customization is available; they can use app independently, but may need assistance navigating ads, pictures are large and easy to select	Children can navigate through menu by choosing a mission, then a lesson within that mission, each lesson is easy to navigate with a bright green “Next” button at corner of screen, recommended for higher functioning children and requires a helper	Each child has individual profile that tracks progress, menu offers variety of lessons and games to play
Aesthetics	Pictures are large, yet some appear outdated and are not consistent (see type of stimulus), no apparent theme	Lots of small text that may be hard to read, theme is seen throughout app and might be motivating for children to use, especially when children are rewarded with materials after completing a lesson	Theme is consistent, lots of visual and verbal praise, games are well designed, yet simple to play
Sensory qualities	Both audio and visual cues used, ads in app may be distracting	Text used throughout, however lots of text may overwhelm those who aren’t strong readers and need a helper to read to children	Instructions are only verbal, which can cause frustration if children are bothered by the noise

Discussion of Apps

Each app offers opportunities for children to improve their social-emotional recognition skills through different resources. The following discussion focuses on an overall impression of the app and provides a qualitative description of salient app features, mode of interaction, and overall assessment of each app's ability to effectively teach skills and promote generalization to real life situations.

Autism Emotions & Feeling Cards

The first app, *Autism Emotions & Feeling Cards* uses multiple games and exercises to engage children. The app provides both visual and auditory elements. Each picture is fairly large, utilizing most of the screen, and is easy to select. However, there are multiple grammatical and spelling errors throughout the app. There are also ads at the bottom of the screen and during the transition to another game. After leaving a game to go to the main screen, the ad takes up the whole page and requires the child to wait five seconds before being able to hit a small 'x' in the corner that takes the child to the main screen. The ads may be distracting, or the child may accidentally select the ad, which takes the child out of the app and to the Play Store. Of the ads presented, some contain a video that could upset a child on a sensory level. A parent or guardian could purchase the full version to remove the ads.

All of the activities supported by the app focus on helping the child to improve his or her social-emotional labeling. The app does not teach eye contact skills that are important for socialization. The app also does not promote the generalization of the behaviors learned through the activities, for instance by showing the same emotion on multiple faces at once. Overall, *Autism Emotions & Feeling Cards* may increase social emotional identification skills, but most likely would not increase generalization, appropriate social responses, or eye contact skills within real-life situations.

Mission Rescue Kloog

Mission Rescue Kloog is an interactive app designed to teach children with ASD about healthy communication through nonverbal communication, conversation skills, and thinking before speaking. At the end of a lesson, a quiz presents the animated monster or an animated person making a facial expression. The quizzes use large text for the question; however, some answers are quite long and are harder to read than others. When the correct response is selected, the app will go to the next question and a new response will be selected if the child's finger is still on the selected choice from the original question. The immediate selection may cause the child frustration because s/he may select the wrong choice. If the child does not get the required amount depending on the level's requirement of correct responses, the entire quiz must be taken over again. If a child does not pass the quiz after multiple tries, he or she may become frustrated and lose motivation.

The eye contact lesson explains the importance of eye contact within social contexts and how other people might feel when appropriate eye contact is not reciprocated. This explanation helps children with ASD not only to understand that eye contact is important, but it might help children with developing their ToM. By explaining that other people have feelings and that the child's behaviors, such as not making appropriate eye contact, can affect the emotions of others, children may be able to improve their ToM skill. Overall, *Mission Rescue Kloog* may allow children to increase their facial expression and eye recognition skills, but requires a helper in order to complete the "Let's Discuss" activities, which will maximize learning.

ABA DrOmnibus Pro

In the app *ABA DrOmnibus Pro*, ABA techniques are used to help children learn a variety of skills such as colors, shapes, professions, animals, and emotions. There are two sections for learning emotions: basic learning, for children with significant cognitive deficits, and improvement, which

provides the child with more difficult tasks and quizzes to generalize the basic learning. Children with more significant cognitive deficits may work up to the improvement section if they master the basic section.

While testing the app, the verbal instructions stopped working, and the app had to be downloaded again. Without the verbal prompt, the desired selection was unknown and led to incorrect selections and an inability to proceed to the next level.

Reinforcement is used to motivate the child to continue to the next level by allowing the child to play a mini game after the 10th correct response that is tracked using brightly colored balls in a display at the bottom of the page. Even if it takes two or three lessons to collect 10 brightly colored balls, children are allotted 30 seconds to play a game of their choice. At the end of each lesson, the child is provided with the number of correctly identified emotions; this information is stored in the child's individual profile. Overall, *ABA DrOmnibus* uses well-tested and effective methods to teach children with ASD about emotions that will probably significantly increase their performance over time; however, there might still be difficulties during real life interactions because beyond describing emotions, it does not teach children to connect emotions to appropriate context.

Summary

Apps that offer reinforcement either with verbal or visual praise, such as *ABA DrOmnibus Pro*, are likely to motivate the child to keep playing and learning. Along with reinforcements, having the chance to make corrections allows children to understand their mistakes and learn from them. Apps with both visual and verbal prompts could benefit a variety of children with ASD (i.e., with varying levels of language proficiency or sensory sensitivity). All of the apps taught the basic identification of expressions of emotions, but most did not offer a more difficult task like matching an emotion to a context. At this time, there is not a lot of high quality, free social-emotional apps on the market.

Chapter 6

Creating Outer Space

Research

In order to create a social-emotion recognition app that would benefit children with ASD, a qualitative study was conducted to determine what is needed to make an effective app. The study investigated the design features and effectiveness of apps that teach facial recognition. After obtaining IRB approval, an online survey was conducted among professionals and experts in the field from schools in Berks county. Participants were contacted through a local organization that works with children and young adults with ASD. Students in psychology courses were also encouraged to participant.

The survey took approximately 30 minutes to complete and included 42 questions consisting of both open-ended and close-ended questions. The questions focused on theme, motivation, usability, personalization, and gamification of learning, highlighted by Alves, et al., 2013; Sung, et al., 2015; Gay & Leijdekkers, 2014. Examples of such questions included: ‘If an app included the option to interact with the camera, would a child use this feature?’

Participants recommended several design elements as important for apps to teach children with ASD about facial expressions. Motivation and usability were the two most prominent elements reported. The recommended themes that elicit interest for children were organized into categories including transportation (trucks, trains, busses), action/sports, art/music, and animals. These themes can enhance motivation if incorporated into an app. Some participants saw limitations with theme selection. As one participant said, “It would depend on the individual child as each child with autism is different and has specific interests.”

Regardless of what theme is chosen, an app that is both motivating and easy to use allows children to become more independent and invested in their acquisition of social communication skills (Weiss & Harris, 2001). From the results, it is recommended that the following features be incorporated

into the design of such apps: a systematic theme, instant feedback, meaningful rewards, varying levels of games, personalization options, easy to use navigation, and a simple interface.

Among the usability-related elements reported are the unambiguous and instantaneous feedback. This feedback can help children identify how to correct mistakes. Positive feedback may also help maintain motivation over time, particularly if paired with desirable stimuli. Those with lower levels of functioning may need additional assistance with using the app. By using a simple interface with verbal and visual instructions, the app expands the population who benefits from this type of learning intervention.

Outer Space App

From the results of this study, the app ‘Outer Space’ was created using the recommendations from professionals, parents, and students. The theme, which features planets and outer space, was chosen because it allows the child to fly to each planet using a rocket ship. Transportation is a popular theme with children with ASD because most of the vehicles move in a repetitive and predictable nature, as stated earlier. Motivation is an important factor for apps geared toward teaching children with ASD a new skill.

Within the app, there are multiple planets, each associated with a new game. The mini games were all designed with the different areas of social emotion recognition difficulties in mind. The first game was designed to measure labeling of emotions. Each child must pick the correct description of an emotion from a photo of a person displaying an emotion, such as happiness. It is important that the children can correctly identify and describe the basic emotions, such as happiness, sadness, and anger.

The second game was designed to measure eye contact. As children with ASD typically struggle to identify emotions through the eyes, this mini game was intended to allow children to practice looking only at eyes in order to identify the emotion. The pictures only show the eyes of the people who were also

featured in the first game; the rest of the photo is blacked out. Through the lesson, children may begin to understand eyes are an important part of identifying emotions.

The third game was created to allow children to practice matching the emotion of an individual with another card of the same individual displaying the same emotion. Children must turn over cards and try to find a match. The familiarity of the game should motivate children to play because it is the kind of game generally understood and liked by children. Being able to identify each expression and select the two that are identical promotes generalization by identifying patterns within each emotion.

The fourth and final game is very similar to the third. Instead of matching an individual displaying the same expression to its identical card, the child must match the emotion of one individual to another. This ability is important because generalization can increase as children learn to identify emotions on a variety of individuals. Due to the concern that apps of this nature do not generalize well, this app was created to feature different individuals displaying the same emotion to show some of the variability of individuals.

Each game has a visual representation of the instructions at the top of the screen that stays the entire time the child is playing with the selected game. The instructions are simple commands, such as “Select the emotion.” The app was made to be simple because usability is an important factor in apps for children with ASD. There are one touch selections to play each game, select the response, and to leave the game. There are four different choices for the first two mini games and six possible choices for the last two mini games. With limited choices, children are able to easily see each choice and make an appropriate selection.

Chapter 7

Critical Analysis of Outer Space

The previous research contributes to the creation of the app *Outer Space*. Even with a clear guideline of what makes an effective app, there are limitations to the degree of generalization that can be achieved. A critical analysis of *Outer Space* was conducted to compare its elements against the apps already found on the market. The following elements were used to evaluate the app: stimuli used, response to app, reinforcement and correction, and overall appearance and usability. The evaluation criteria from the analysis of apps on the market (chapter 5) was used to analyze *Outer Space*.

Table 5. Stimuli Used (2)

Name of app, Maker, Year developed	<i>Outer Space</i> ; Grindrod and Smith 2017
Skills taught	1, 4, 5
Emotions/States	Happy, sad, anger, surprise, disgust
Type of stimulus	Real photos of individuals displaying emotions
Level of realism	The pictures show real individuals' expressions, but may not translate to subtle expressions in actual socialization
Auditory verbal material	Sound effects are used in the game, but no instructions or feedback are auditory

Table 6. Response (2)

App	<i>Outer Space</i>
Verbal labeling of pictures	<p>Children select the appropriate verbal description out of four choices</p> <p>In the second activity only the eyes are shown, children select the appropriate verbal description out of four choices</p>
Selection of pictures matching verbal labels	No activities for this category
Matching similar emotions (picture to picture)	<p>Children are shown six cards face down similar to matching games, must select two cards to turn over. If both cards show the same individual making the same expression, the cards remain face up, and the child tries to identify the remaining two pairs</p> <p>The next activity shows six cards face down; the two selected cards turn over and feature two different individuals displaying the same expression. If they match, children continue until all three pairs are identified</p>
Matching emotion to context	No activities for this category

Table 7. Reinforcement/Correction (2)

App	<i>Outer Space</i>
Correct response feedback	A green circle with a check mark appears along with a ding to indicate it is correct, a new question is shown after a few seconds
Incorrect response feedback	A red X appears and a noise occurs to indicate that it is wrong
Correction opportunities feedback	Question remains, and children are given the opportunity to choose again

Table 8. External Validity (2)

App	<i>Outer Space</i>
Generalization	Children may generalize emotions through matching the same expression with multiple individuals, may not generalize to real situations
App Interaction	Children navigate the menu by selecting a planet, which leads to a new activity, each label is large and easy to select, to leave a game the child may select the “New World” tab at the top of the screen
Aesthetics	The theme is outer space and features a rocket and astronaut on the menu, each planet is large and brightly colored, pictures are large and feature black text in yellow boxes, making it easy to read
Sensory qualities	The background music is heard throughout the app and during each activity, small sound effects used when selecting planets

The critical analysis suggests a few changes to *Outer Space* to increase its effectiveness. First, verbal as well as visual instructions implemented for each activity would maximize clarity and accessibility to all children. It would be beneficial to add a training activity to teach children what each emotion looks like and how to identify it. The training may help children learn the basics of emotional recognition needed to move on to more difficult tasks (Hadwin, et al. 1996).

Once children are able to identify emotions in the absence of contextual information, an activity that presents a situation and prompts them to choose the emotion most suited to it could be implemented to promote generalization to real-world interactions with others. The app includes opportunities for generalization of learning to different stimuli, such as matching the same emotion with multiple individuals, but more opportunities to practice with more stimuli, including practice with social situations could lead to an increase of social-emotional recognition skills. Overall, *Outer Space* offers children multiple activities to promote social-emotional recognition, but might not be successful in transferring skills learned to behaviors in real life situations without further improvements.

Chapter 8

Conclusion

The critical analysis of *Outer Space* as well as the other apps currently on the market suggests that there are strengths as well as limitations for each app. One strength of the apps is the thorough explanation of verbal description of pictures with an individual displaying an emotion. All apps assessed had elements describing an emotion displayed on an individual. Children need to master the skill of identifying emotions before they are able to master more difficult tasks.

Every app utilized the teaching methods of DTI. Using this proven method, apps are able to increase the likelihood that children will retain the information learned from the app. Using instant feedback and reinforcement is beneficial, especially when the child is able to make a correction immediately after. When a child does select the correct response, having reinforcement in the form of a reward or game is valuable in maintaining or enhancing motivation. Motivation can also stem from apps that have fun and interactive themes, such as *Mission Rescue Kloog*.

Beyond the initial strengths, each app has limitations. Not every app has visual and auditory elements (such as instructions and prompts) that are inclusive to the varying degree of each child's abilities. Children's behaviors improve with intense and extensive treatments, so if a child is not able to use an app independently that may significantly reduce the time that the child is able to spend using it.

Even if a child uses an app independently, that does not guarantee that the app will teach the skills needed for appropriate socialization. There were four categories of socialization skills analyzed for each app, however not one app had all four. The categories included verbal labeling of pictures, selection of pictures matching a verbal label, matching similar emotions in multiple pictures, and matching emotions to context. Each of these categories contribute to better socialization and if taught simultaneously would increase the likelihood of generalization as children have more opportunities to practice these skills in a variety of situations.

Generalization is one of the major concerns from using technology, specifically apps to teach social-emotional recognition. The apps all taught skills that could be applied to real life situations, for example interpreting someone's expression. These skills, however, may not always be helpful to children because facial expressions tend to vary significantly among individuals, and most of the photos used to show expressions were very expressive. Some expressions are only shown briefly during interactions, so some children may not be able to identify the emotion before it disappears. Context is also an important aspect of socialization. An individual might express audibly that s/he is upset, but that might not correlate to the expression. Many apps on the market do not teach emotion recognition and its relationship to context.

The market currently does not have a significant number of apps available that were developed specifically for social-emotional recognition. Some apps focus on verbally describing emotions, but do not further expand related skills. Two of the apps analyzed were from countries outside of the United States, Ireland and Poland. Even with the slim selection on the market, most of the apps do not have a high rating from the Play Store. *Rescue Mission Kloog* has over 10,000 downloads, but a rating of 2.8 out of 5 stars. *ABA DrOmnibus* has over 500 downloads and a rating of 4.4 out of 5 stars, but has only been rated by seven people. The last app, *Autism Emotions and Feeling Cards* has over 5,000 downloads and is rated at 3.6 out of 5 stars. There is a need for more apps that focus on social-emotional recognition designed using effective elements.

Apps that are developed using ABA principles and provide more practice generalizing emotions to a variety of individuals or contexts should be more effective at teaching socialization skills. Empirical studies need to be completed in order to test this theory. In the future, children's socialization skills, categorized into the various skills explained in the critical analysis, should be measured over the course of using an app for an extended period. See appendix C for a detailed procedure to measure social-emotional recognition apps and the level of generalization to real life situations. Three methods of measuring social-emotional generalization are explained.

The first measurement of social-emotional generalization is the Social-Emotional Questionnaire (Wall, Williams, Morris, and Bramham, 2011). It is an inventory consisting of 30 statements (See appendix D). Each statement is rated using a five-point Likert scale. Three categories are measured, including emotion recognition and empathy, social conformity, and anti-social behavior. The internal consistency of the assessment using Cronbach's alpha for each category are as follows: Emotion Recognition & Empathy (.87), Antisocial Behavior (.72) and Sociability (.68).

The second measure of social-emotional generalization is the Vignettes for Emotion Recognition Research and Affective Therapy With Children (Ribordy, Camras, Stefani, and Spaccarelli, 1988). Five emotions are tested, including happiness, sadness, disgust, fear, and anger (see appendix E). Five vignettes represent each emotion. The vignettes are one sentence and describe a situation that correlates with a specific emotion.

The third measure of social-emotional generalization is the Facial Recognition Assessment (see appendix B). Designed to measure generalization of the app *Outer Space*, it measures facial identity matching, facial expression matching, and facial expression labeling. Five emotions are tested, including happiness, sadness, anger, fear, and disgust.

Generalizing social-emotional skills learned through an app to behaviors in real life is a problem for children with ASD; however, apps are a fairly recent technology and more research should be completed before disregarding their worth.

Appendix A Outer Space

The app *Outer Space* features a space theme with four mini games that each features an aspect of social-emotional recognition. The first game provides a photo of a person displaying a specific emotion, such as happiness, which was indicated by a smile (see figure 1). There are four emotions listed below the photo happiness, sadness, anger, and surprise, and children try to accurately pick the emotion correlated with the photo. If children choose an emotion that does not describe the photo, a red X appears, and they pick again.

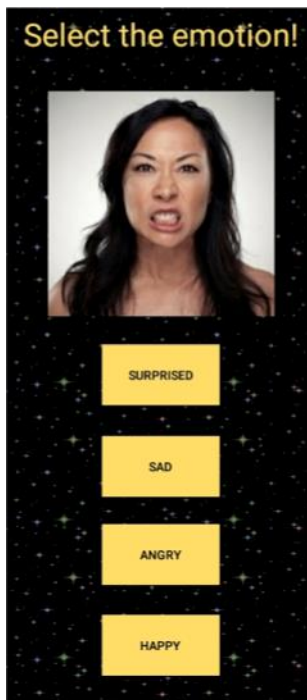


Figure 2. Mini Game 1



Figure 1. Mini Game 2

In the second mini game, children are shown a photo of an individual's eyes displaying an emotion such as surprised (see figure 2). In the third and fourth game, a matching game allows the participant to select two cards to check if it is a match.

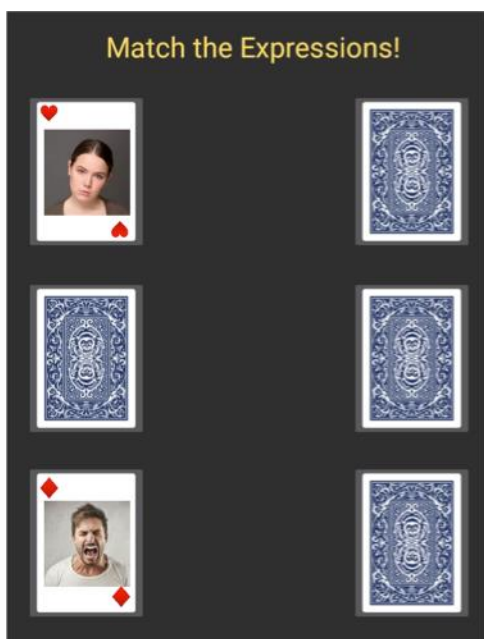


Figure 3. Mini Game 3

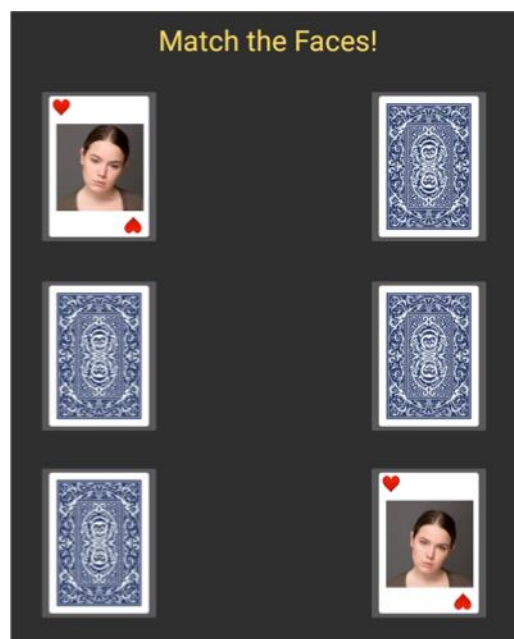


Figure 4. Mini Game 4

In the third game, children are shown six cards face down (see figure 3). The objective is to try to match a picture of an individual displaying an expression such as happiness with a copy of the same picture. Children select a face down card by clicking on the card and it turns over revealing the image. Then another face down card is selected and turns over. If the photos are identical, the pair remains face up. If the two photos are not identical, a red X appears and the cards turn over. Children keep guessing until all identical pairs are face up.

In the fourth game, children are shown six cards face down (see figure 4). The objective is to try to match a photo of an individual displaying an expression, such as happiness, with a photo of another individual making the same expression. Children select a card, and it turns over revealing the image. After the first card is selected, another card is selected and turns over. If the photos show two individuals who express identical emotions, the pair remains face up. If the two photos show two individuals expressing different emotions, a red X appears and the cards turn over. Children keep guessing until all expression pairs are face up.

Appendix B Facial Recognition Assessment

A facial recognition assessment was created for future research. This assessment measures facial identity matching, facial expression matching, and facial expression labeling. The first category is facial expression labeling (see figure 5). Individuals are shown a photo of a person displaying an emotion such as sadness. Listed beside the photo are five emotions, happiness, sadness, anger, afraid, and disgust. The individual picks the emotion that correlates with the expression in the photo.

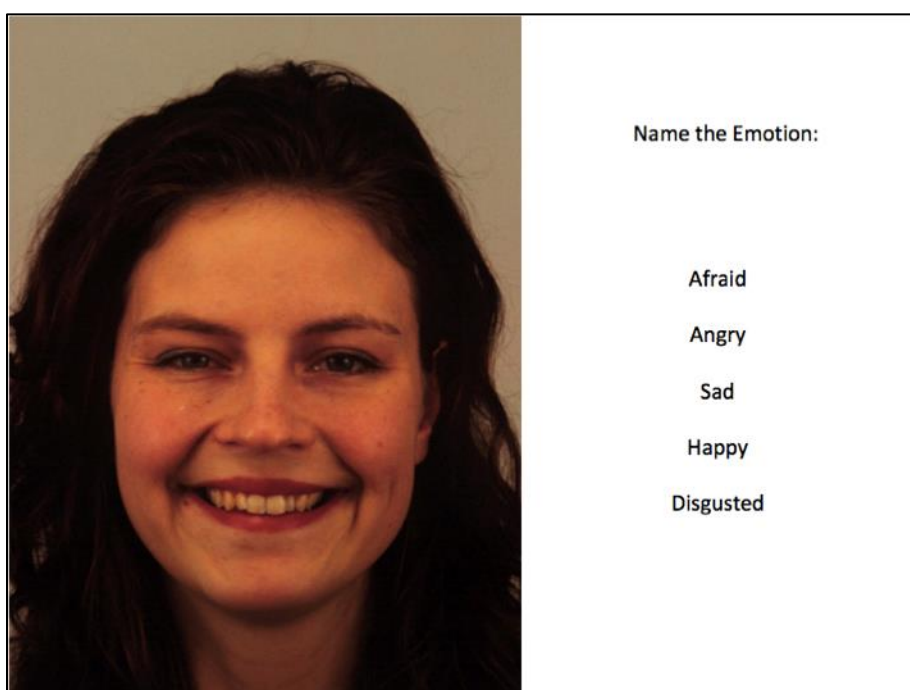


Figure 5. Facial Expression Labeling

The individuals are tested in facial identity matching (see figure 6). A photo of a person displaying an emotion, such as anger, is shown along with four other photos of the same person displaying other expressions such as happiness, sadness, fear, or disgust. Three of the photos show the same person depicting a different emotion, but the fourth photo displays the same emotion as the main photo. Individuals match the facial expression.



Figure 6. Facial Identity Matching

The third category is facial expression matching (see figure 7). A photo of an individual displaying an emotion, such as disgust, is shown along with four other photos of different individuals displaying emotions such as disgust, anger, fear, happiness, or sadness. Three of the photos show individuals depicting different emotions, but the fourth photo shows an individual displaying the same emotion as the main photo. Individuals identify the person who displays the same facial expression as the person in the main photo.



Figure 7. Facial Expression Matching

Appendix C Projected Procedures

Participants will attend four sessions approximately 30 minutes in length on the Penn State Berks campus. About 15 minutes will be devoted to free play using the app and the other will be used to complete assessments. Each participant completes a facial recognition assessment at the beginning and end of each session. This assessment measures face identity matching, facial expression matching, and facial expression labeling. In order to determine if generalization has occurred, the social-emotional questionnaire is given to parents at the first and fourth session. This questionnaire measures social conformity, antisocial behavior, and emotion recognition and empathy. Twice throughout the study participants will be measured for recognition of emotions using vignettes, which depicts typical social situations, such as receiving a new toy at Christmas that a child wished for, and then choosing a photo of an individual displaying an emotion that correlates to the situation.

In the first session, participants complete the facial recognition assessment before and immediately after using the app for 15 minutes. The parent/guardian completes the social-emotional questionnaire, while the child is playing with the app.

In the second session, approximately one week after the first session, participants complete the facial recognition assessment before and immediately after using the app for 15 minutes. Participants are tested on their emotional recognition by responding to vignettes about appropriate emotional responses for a typical social event, such as feeling angry when a sibling breaks a toy. The third session, held approximately one week after the second session, follows the methods of the second session.

In the fourth and final session, approximately one week after the third session, participants complete the facial recognition assessment before and immediately after using the app for 15 minutes. The parent/guardian completes the social-emotional questionnaire while the child plays on the app. At the end of the final session, participants and their parents/guardians are given a debriefing form, which

comprises of the investigators' contact information and explains in depth why the research was conducted. A verbal debriefing explains the assessments and use of the participants' information.

Appendix D

Social Emotional Questionnaire

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Social-Emotional Questionnaire for Children—Parent/Guardian Version

Items

Please say how much you agree or disagree with the following statements. You can strongly agree, slightly agree, be in between, slightly disagree or strongly disagree. Please ring the number to the right of the question.

1 Strongly disagree	2 Slightly disagree	3 In between	4 Slightly agree	5 Strongly agree	
1. He/she expresses their feelings appropriately in public	1	2	3	4	5
2. He/she avoids arguments	1	2	3	4	5
3. When others are afraid, he/she reassures them	1	2	3	4	5
4. He/she speaks their mind	1	2	3	4	5
5. He/she notices when other people are happy	1	2	3	4	5
6. He/she is critical of others	1	2	3	4	5
7. He/she is amusing	1	2	3	4	5
8. He/she notices when other people are frightened	1	2	3	4	5
9. When others are happy, he/she is pleased for them	1	2	3	4	5
10. He/she is not aggressive	1	2	3	4	5
11. He/she co-operates with others	1	2	3	4	5
12. He/she notices when other people are disgusted	1	2	3	4	5
13. He/she is impatient with other people	1	2	3	4	5
14. He/she is apologetic	1	2	3	4	5
15. When others are angry, he/she calms them down	1	2	3	4	5
16. He/she is confident meeting new people	1	2	3	4	5
17. He/she has difficulties making and keeping close relationships	1	2	3	4	5
18. He/she notices when other people are sad	1	2	3	4	5
19. He/she is sociable	1	2	3	4	5
20. When others are disgusted, he/she is appalled for them	1	2	3	4	5
21. He/she takes a long time to make decisions	1	2	3	4	5
22. He/she does what they want to and does not care what others think	1	2	3	4	5
23. He/she notices when other people are angry	1	2	3	4	5
24. He/she does things without thinking	1	2	3	4	5
25. He/she has good manners	1	2	3	4	5
26. He/she is close to their family	1	2	3	4	5
27. He/she lets someone know if he/she finds them attractive	1	2	3	4	5
28. He/she keeps in touch with old friends	1	2	3	4	5
29. He/she prefers being alone than with others	1	2	3	4	5
30. When others are sad, he/she comforts them	1	2	3	4	5

Appendix E

Social Emotional Vignettes

Happy

1. Johnny/Susie wanted his/her friends to come over to play. So he/she asked them, and they came to play with him/her at his/her house.
2. At Christmas, Johnny/Susie got a new toy house that he/she wanted.
3. Johnny/Susie worked hard on a picture and showed it to his/her father. His/her father really liked it and said Johnny/Susie did a good job.
4. Johnny/Susie went to the zoo, and his/her aunt bought him/her a real nice balloon that he/she liked a lot.
5. It is Johnny's/Susie's birthday. He/she is given a party with lots of cake and fun games to play, and presents, too.

Sad

1. Johnny/Susie and his/her little sister have a pet dog. The dog is sick and going to die.
2. Johnny's/Susie's friend, who he/she really liked to play with, moved away. Johnny/Susie couldn't play with his/her friend any more.
3. Johnny/Susie was the only one in class not to get any Valentines on Valentine's Day.
4. Johnny/Susie couldn't play a game, and some of the kids laughed at him/her.
5. Johnny's/Susie's favorite sweater that he/she liked a lot was very old and worn out. He/she had to throw it away and gave it to his/her mom to get rid of it.

Disgusted

1. Someone threw up on Johnny/Susie during lunch at school.
2. A friend gave Johnny/Susie an apple. Johnny/Susie bit into the apple and found a smelly, squashed, dead worm.
3. Johnny's/Susie's friend brought his dog over to Johnny's/Susie's house. The dog made a mess on the carpet and Johnny/Susie stepped in it.
4. Johnny/Susie went to a movie with a friend. In the movie, people were eating bugs and worms.
5. Johnny/Susie saw a friend who had a baloney sandwich with chili on it. He/she thought it was ugly and would taste terrible.

Afraid

1. Johnny/Susie was dreaming about a monster in his/her nightmare.
2. Johnny/Susie and his/her little sister were in their room at night. It was dark, and they saw a tree outside that looked like a person with his hand about to come in the window.
3. When Johnny/Susie went to bed, he/she thought there was something in his/her closet trying to get him/her.
4. Johnny/Susie was walking in the woods and met a hungry bear who liked to eat little children.
5. A bad man was chasing after Johnny/Susie.

Angry

1. Johnny's/Susie's little brother broke his/her favorite toy on purpose.
2. Johnny/Susie was trying to tell his/her mom about something exciting, but his/her little brother kept interrupting.
3. Johnny/Susie let his/her best friend use his/her new ball. His/her friend wasn't careful and lost the ball and wouldn't give Johnny/Susie another one.
4. Johnny's/Susie's friend gave him/her a present because Johnny/Susie helped him with his homework. Later, Johnny's/Susie's friend changed his mind and took the present back.
5. Johnny/Susie made his/her dad an ashtray for his birthday. Johnny/Susie told his/her baby brother not to touch it, but his/her brother did, and the ashtray broke.

Note. Reprinted from "Vignettes for Emotion Recognition Research and Affective Therapy With Children," by S. C. Ribordy, L. A. Camras, R. Stefani, and S. Spaccarelli, 1988, *Journal of Clinical Child Psychology*, 17, 322–325. Copyright 1988 by Lawrence Erlbaum Associates, Inc. Reprinted with permission.

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Academic Vita of Kaylee M. Grindrod
kayleegrindrod@gmail.com

Pennsylvania State University, Berks
Major: Applied Psychology
Graduation: May 2018

Schreyer Thesis Title: Effectiveness of Social-Emotional Recognition Apps for Children with Autism Spectrum Disorder
Thesis Supervisor: Dr. Catherine Mello

Awards:

- Student Marshal, Division of Humanities, Arts and Social Sciences
- Excellence in Sociology Award, Spring 2018
- Dean's List Fall 2014-Present
- Penn State Berks Campus Life Award, Spring 2016
- Michael Kane Award, Spring 2015

Presentations:

- *Design Elements of Facial Recognition Apps for Children with Autism Spectrum Disorder*
Eastern Psychological Association Conference
Presented March 2017 in Boston, MA
- *Play Therapy Lecture*
Presented in Developmental Psychology (PSYCH 212)
October 2017 in Reading, PA

Scholarships and Grants Received:

- Roderick Family Memorial Scholarship, Fall 2016-Present
- Boscov Family Scholarship, Fall 2016-Present
- Class of 1922 Memorial Scholarship, Fall 2017-Present
- Franco Grant, Fall 2016
- Schreyer Ambassador Grant, February 2017
- Schreyer Ambassador Grant, March 2017

Relevant Experience

Aaron's Acres Camp Counselor
June 2016-July 2017

Planned activities to promote communication and socialization skills, monitored goals and behaviors and recorded observational notes twice daily for 8 campers; understood each camper's disability and made necessary modifications for all activities; counselor for two summer programs as well as the school year program Aaron's Acres, *Reading & Lancaster, PA*

Principal Investigator
Jan. 2017-May 2017

Design elements of Facial Recognition App for Children with Autism Spectrum Disorder, Organized qualitative survey and data from 27 experienced and non-experienced participants, presented research at Eastern Psychological Association Conference in Boston, MA in March 2017
Pennsylvania State University, Berks, *Reading PA*

Research Assistant
Aug. 2016-Dec. 2016

Worked with Dr. Eric Lindsey, professor at Penn State Berks who specializes in Human Development and Family Studies, researched and organized scholarly articles, co-wrote and edited literature review on Play Therapy, entered data into statistical software, presented lecture for 40 students in September 2017
Pennsylvania State University, Berks, *Reading PA*

Professional Memberships:

- Phi Kappa Phi, National Honors Society, December 2016-Present
 - Top 7.5% of junior class at Penn State (University Park and Commonwealth campuses included)
- Psi Chi, International Psychology Honors Society, October 2016-Present
- APA, American Psychological Association
- EPA, Eastern Psychological Association

Community Service Involvement:

Penn State Berks Benefitting THON Executive Board

World's largest student-run philanthropy to raise money to fight pediatric cancer

Technology Executive (April 2015- March 2016): Responsible for setting up technical equipment at all campus THON events, oversaw three social media accounts and posted frequently to communicate activities

Family Relations Executive (April 2017- March 2018): Provided emotional support for four 'Four Diamond' families assigned to Berks, planned and arranged

holiday parties for over 50 attendees, wrote detailed bi-weekly reports to THON executive committee at University Park

International Education:

English 297 Honors: Properties of Water (Water Ways)
Copenhagen, Denmark
March 2017