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The Predictive Viability of Executive Function on a Social Skills Intervention in Adolescents with ASD and without Cognitive Impairment

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The Predictive Viability of Executive Function on a Social Skills Intervention in Adolescents with ASD and without Cognitive Impairment

by

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Abstract

The purpose of this study is to examine the relation between executive function (EF) and social skills in adolescents with Autism Spectrum Disorder without accompanying cognitive impairment following completion of the Program for the Education and Enrichment of Relational Skills (PEERS; Laugeson & Frankel, 2010). PEERS was designed for 13- to 18-year-olds with ASD and without cognitive impairment. PEERS is a manualized and evidence-based intervention designed to help adolescents develop the social competencies necessary to make and keep friends. PEERS is administered over the course of 14 weeks, with each week incorporating a 90-minute session. EF and social skills were examined one week prior to beginning the program (pre-test) and one week after completion of the program (post-test). Results indicate significant improvements from pre-test to post-test for both EF and social skills. Additionally, pre-test measures of EF were found to correlate positively with both pre- and post-test measures of social skills. However, post-test measures of EF were only found to correlate with post-test measures of social skills. Finally, a low reliability of difference scores prevented examining the predictive viability of EF on social skill outcomes. The implications of these results are discussed alongside several limitations and suggestions for future research.

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List of Abbreviations

ANOVA	Analysis of Variance
APA	American Psychiatric Association
ASD	Autism Spectrum Disorder
CDC	Centers for Disease Control and Prevention
CEFI	Comprehensive Executive Function Inventory
CF	Cognitive Flexibility
DSM	Diagnostic Statistical Manual of Mental Disorders
EF	Executive Function
FSIQ	Full Scale Intelligence Quotient
ID	Intellectual Disability
IN	Inhibition
PCF	Prefrontal Cortex
PDD	Pervasive Developmental Disorder
PDD-NOS	Pervasive Developmental Disorder – Not Otherwise Specified
PEERS	Program for the Education and Enrichment of Relational Skills
SSIS	Social Sills Improvement System
WASI	Wechsler Adult Intelligence Scale
WCST	Wisconsin Card Sorting Test
WM	Working Memory

Chapter 1: Introduction

Executive function (EF) refers to a set of cognitive-based skills that allow an individual to engage in a multitude of higher order cognitive processes such as impulse control, goal directed behaviour, planning, and mental flexibility (Best & Miller, 2010; Diamond, 2013; Hosenbocus & Chahal, 2012). The functions that compose EF are commonly grouped into three subcategories: inhibition, working memory, and cognitive flexibility (Best & Miller, 2010; Diamond 2013). Not unexpectedly, the functions composing EF (and its accompanying subcategories) impact an individual's ability to successfully perform in a wide range of areas, including completion of academic-based tasks, activities of daily living (e.g., self-care), and social functioning (Best & Miller, 2010; Diamond 2013). Numerous social, emotional, behavioural, and developmental disorders demonstrate impairments in these areas of functioning as well as corresponding deficits in EF. For instance, individuals with Autism Spectrum Disorder (ASD) typically present with impairments in social functioning and accompanying deficits in their EF (Craig et al., 2016).

ASD is classified as a neurodevelopmental disorder with persistent impairments in the realms of social communication accompanied by restricted and/or repetitive patterns of behaviour, interests, and/or activities (American Psychiatric Association [APA], 2013). Significant impairments in EF have been noted in individuals with ASD (Craig et al., 2016; Robinson, Goddard, Dritschel, Wisley, & Howlin, 2009). This is not necessarily surprising given that individuals with ASD tend to demonstrate a number of social, emotional, and behavioural challenges influenced by EF (e.g., activities of daily living, academic-based settings, and social interactions; Pisula et al., 2017). Furthermore, these impairments have been shown to exist regardless of cognitive ability (Craig et al., 2016). It is then prudent to consider that deficits in

EF may be further compounding the impairments in social functioning experienced by those with ASD. Furthermore, it may be worthwhile to consider the reciprocal, in that impairments in social functioning may impact the development of EF.

As discussed, a common construct between both EF and ASD is that of social functioning, which is heavily reliant on social skills. Social skills are typically described as those skills that enable an individual to communicate and interact with others using both verbal and non-verbal behaviours successfully and acceptably (Guivarch et al., 2017). In order to do so it's important for an individual to be able to inhibit socially off-putting behaviours, plan out interactions, and adapt fluidly to changes in conversation (i.e., areas which correspond to EF; Gresham & Elliott, 2008). However, it is also important for individuals to be aware of the rules and explicit behaviours governing social interaction. Because individuals with ASD experience impairment in social functioning and social functioning incorporates abstract or difficult to target constructs (e.g., EF) some interventions have taken the approach of trying to target the learning of specific social skills over functioning in general (i.e., explicit behaviours and social rules that govern typical interactions). Research into the effectiveness of these programs has produced varying results, with some researchers advocating a need for more stringent empirical research methods (Reichow, Steiner, & Volker, 2012). Despite this, some programs have demonstrated promising gains in social skill acquisition (Gates, Kang, & Lerner, 2017; Spain & Blainey, 2015), movement towards more typical profiles of neurological functioning (as measured by EEG patterns; Van Hecke et al., 2015), and improvement in core constructs of EF (Christ et al., 2017). One such program that has received a considerable amount of empirical support is the Program for the Education and Enrichment of Relational Skills (PEERS; Laugeson & Frankel, 2010). PEERS is a social intervention aimed at developing social functioning in adolescents with

ASD without accompanying cognitive impairment. PEERS has been demonstrated to produce a number of positive changes in its participants including improvement in the quality and quantity of social interactions and get-togethers, increased knowledge of social protocol, higher levels of social cognition, and increased communication (Laugeson, Ellingsen, Sanderson, Tucci, & Bates, 2014; Laugeson, Frankel, Gantman, Dillon, & Mogil, 2012; Laugeson, Frankel, Mogil, & Dillon, 2009; Schohl et al., 2014; Van Hecke et al., 2015; Yoo et al., 2014).

Current Study

This study examines several constructs in relation to PEERS. First, it will attempt to replicate previous findings that completion of PEERS improves social skills. Second, it will examine whether completion of PEERS results in significant changes in EF. Third, it will identify whether a correlation exists between EF and social skills both before and following PEERS completion. Finally, if improvement in EF is found, this study will attempt to identify if that improvement acts as a predictor variable for social skill improvement.

The current study is separated into four chapters. Chapter one provides a general overview of the concepts to be addressed within the study. Chapter two offers a more detailed overview of each of these concepts, including EF, ASD, social skills, social interventions, and the PEERS program. Chapter three details the methodology used to address the research questions. Chapter four describes the results. Finally, chapter five discusses the implications of the results alongside limitations of the study, future directions, and concluding comments.

Chapter 2: Literature Review

Social functioning is often seen as divergent from cognition, and social success is more commonly linked to physicality and oratorical skill rather than specific areas of cognitive functioning (Bhide, 2008). However, being able to navigate the complex milieu of social settings requires knowledge of social conventions and the cognitive functions to carry-out multi-sequenced goal-oriented behaviours (Alduncin, Huffman, Feldman, & Loe, 2014; Bierman, 2004; Blain-Briere, Bouchard, & Bigras, 2014; Jacobson, Williford, & Pianta, 2011). The current study investigates a particular set of cognitive processes, executive functions (EFs), that have been linked to social skills and explores the relation between the two as they relate to a social intervention for youth with Autism Spectrum Disorder (ASD). This paper will first outline EFs and their typical developmental trajectory. Next, social skills and their developmental trajectory are described. Third, the relation between these two constructs is explored. Then, ASD is discussed in relation to the preceding topics. A social intervention targeting ASD is then detailed. Finally, the proposed study, including hypotheses, methodology, and results is presented.

Executive Functioning

EFs are cognitive processes pertaining to a multitude of higher-order cognitive functions (Best & Miller, 2010; Diamond, 2013; Hosenbocus & Chahal, 2012). EF refers to skills needed to prepare for and execute complex behaviours such as goal-directed and task-oriented behaviours, self-regulation/behavioural inhibition, planning, working memory, mental flexibility, impulse control, and self-awareness (Best & Miller, 2010; Diamond, 2013; Hosenbocus & Chahal, 2012). These processes are implicated in several domains of functioning, including academic achievement, adaptive ability, and social competence. Given the wide range of behaviours, adaptive domains, and skill areas that EF seems to encompass, a large portion of

literature has been devoted to determining whether EF represents an overarching unitary concept or if there are independent but related constructs that should be seen as governing the various areas (McKenna, Rushe, & Woodcock, 2017). Xu et al. (2013) conducted confirmatory factor analyses on several different age ranges to assess the viability of five alternative models of EF. In their study, they found that a single factor unitary EF model fit best for both the 7- to 9-year-old and 10- to 12-year-old groups but that a three factor model (composed of inhibition, working memory, and cognitive shifting/flexibility) best fit the 13- to 15-year-old group. They postulated that EF may begin as a unitary construct with the three factors examined relying on similar underlying cognitive mechanisms until further dissociating later in adolescence. However, subsequent work has posited that an underlying and unitary EF is present throughout development. For instance, McKenna, Rush, and Woodcock (2017) conducted a meta-analysis of functional neuroimaging data to ascertain the structure of EF. Their findings indicated shared neural functioning across all three of the factors examined by Xu et al. (2013). They further postulated the presence of partially separable constructs of EF that are nevertheless connected by a "common executive" or unitary EF. This unitary component may develop first and consequently explain the differences in age groups seen by Xu et al. (2013). Furthermore, McKenna et al.'s (2017) findings align with current integrative models of EF which suggest that there are separate inhibition, working memory, and cognitive flexibility factors that are underlaid by a common and unitary EF component (Miyake & Friedman, 2012). In light of this information, EF will be first discussed as it relates to the three foundational constructs previously mentioned: inhibition, working memory, and cognitive flexibility (Best & Miller, 2010; Diamond 2013). However, it is important to keep in mind that these constructs are pieces of a larger overarching construct (i.e., a unitary EF).

Inhibition. Inhibition (IN; also known as inhibitory control) is conceptualized as processes allowing an individual to suppress impulsive behaviours to allow an individual to control their attention, behaviour, thoughts, and/or emotional reactions (Diamond, 2013). In doing so, IN facilitates the ability to focus on more relevant/appropriate tasks by resisting external influences and internal desires. To support the notion of IN in attentional control, Diamond (2013) discusses the scenario of a cocktail party in which an individual is engaged in one on one conversation. Success in this scenario requires an individual to screen out all but one voice. Regarding self-control, this can often be seen by an individual's ability to deny acting on impulses (e.g., not blurting out the first thing that comes to mind; Diamond, 2013). Additional research has linked improvements in impulse inhibition with increased attentional control, further demonstrating the validity of an IN construct (Poushaneh, Bonab, & Namin, 2010).

Working Memory. Working Memory (WM) involves storing, manipulating, and reorganizing information held in an individual's mind (Diamond, 2013). Although several theories pertaining to WM exist, the current section will give focus to the current predominant model put forth by Baddeley and Hitch (1994; Davies & Wright, 2009). In this model, verbal WM is composed of the Phonological Loop, which allows for the brief (2 seconds) storage of verbal/auditory information. This brief storage of information can then be maintained and manipulated via an articulatory rehearsal process that refreshes the fleeting memory trace (i.e., repeating the information allows it to stay in the phonological loop; Baddeley & Hitch, 1994). A Visuospatial Sketchpad is thought to perform a similar but distinct function for dealing with material that is represented visually rather than auditorily (Baddeley & Hitch, 1994). Additionally, a Central Executive is posited to be responsible for overseeing the other aspects of EF and integrating/switching between them (Baddeley & Hitch, 1994). Finally, a more recent

addition to the concept of WM is the Episodic Buffer (Baddeley, 2000) in which visual, spatial, and verbal information is linked temporally so that things occur in a continual sequence (e.g., like a story from a book). This time component explains why memories can be experienced as a linear sequence of events rather than individual units/segments (Baddeley, 2000).

Cognitive Flexibility. Cognitive Flexibility (CF), also referred to as set shifting, is the ability to switch between mental states, rule sets, or tasks (Miyake et al., 2000). CF encapsulates the abilities that allow an individual to monitor, regulate, and switch strategies and/or conceptualizations when they are no longer effective. These processes are thought to be heavily dependent on, but distinct from, both IN and WM. For instance, the ability to inhibit a previously active strategy would be necessary for successful task switching. Additionally, CF may tax WM by requiring the maintenance and evaluation of two separate rule sets (Best & Miller, 2010).

Development of EF. EF is thought to reside largely in the frontal lobes and prefrontal cortex (PFC). Frontal lobe activation (beginning in the occipital cortical region) has been found to occur at 6 months of age (Chugani, Phelps, & Mazziota, 1987; Jurado & Rosselli, 2007). It's not surprising then that it is during infancy that the first observable signs of EF are exhibited (i.e., the ability to inhibit certain behaviour and switch to new response sets; Anderson, 2002; Jurado & Rosselli, 2007) between 9 to 12 months of age. Despite the documentation of both frontal lobe activation and EF skills in early childhood, the PFC does not follow a similar path of maturation as other brain regions. Rather, it remains in a state of development until early adulthood (25 years of age; Anderson, 2010; Arain et al., 2013; Fuster, 1993). Thus, many of the skills associated with the PFC and EF also remain in a period of development until maturation (Anderson, 2010). Researchers have posited that many of the typical developments we associate with infant-child-adult transitions (e.g., the ability to think of and plan for the future, and the

development of complex decision-making capabilities) are correlated with the development and maturity of EF (Denckla, 1996). Notable and discrete periods of EF development have been described as occurring from (a) birth to two years (attentional control), (b) seven to nine years (cognitive flexibility, goal setting, and information processing), and (c) 16 to 19 years (development of executive control; Anderson, 2002; Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001). Despite the general trend of EF developing sequentially alongside the PFC, it has been noted that specific components of EF have different developmental trajectories. This means that EF does not develop universally or in a linear manner, but rather as discrete parts, with some aspects of development being necessary precursors for other skills (Best & Miller, 2010; Passler, Issac, & Hynd, 1985). For instance, children can postpone the consumption of a preferred food-item and display near adult-levels of IN by 10-12 years of age (Garon, Bryson, & Smith, 2008; Passler et al., 1985; Welsh, Pennington, & Groissier, 1991). CF is first found to occur around 3 to 4 years of age (Anderson, 2002; Hughes, 1998) and continues to improve until around 15 years of age. WM also develops early in childhood but continues at a linear rate from 4 to 15 years of age (Luciana, Conklin, Hooper, & Yarger, 2005). While these abilities appear to develop as discrete parts of EF, CF development has been suggested to rely on IN to inhibit previous mental sets and WM to hold multiple mental sets in mind.

EF assessment. EF is composed of several areas that coalesce to produce an executive management system for cognitive processes. As such, it influences a wide range of skills. Assessment of EF requires clustering these skills around the different domains and then evaluating an individual's proficiency. Given how far-reaching EF can be, comprehensive assessment requires a number of different tasks that target specific skills. EF can be assessed via either behavioural rating scales or performance-based measures (i.e., tasks that target specific

EFs; Isquith, Crawford, Espy, & Gioia, 2005). Behavioural rating scales require parents, teachers, or an individual themselves to rate the frequency with which behaviours and skills associated with EF are exhibited. These rating scales attempt to quantify behavioural observations and then map those behaviours onto clinical scales that subsequently link more broadly onto the three domains of EF. Behavioural rating scales have been praised for their ability to collect and interpret qualitative information in a standardized manner (Anderson, 2002). Furthermore, behavioural rating scales offer a way to examine real-world everyday use of EFs. This is important as performance-based measures are typically conducted in a one-on-one clinical setting and may not be representative of daily functioning (Isquith, Roth, & Gioia, 2013). However, several limitations to behavioural rating scales exist. First, it is difficult to identify the influence of environmental factors on the ratings (Isquith et al., 2013). Second, it is more difficult to identify a specific deficit in EF than with performance-based measures as EFs are reliant on one another (Isquith et al., 2013). For instance, an individual demonstrating low IN may also receive a low WM rating, when in reality their inability to inhibit distractions may affect their WM as perceived by others. Finally, rating scales are subjective in nature; an individual's emotional state, personality, relationship with the ratee, and points of comparison can all impact their rating (Isquith et al., 2013).

Whereas behavioural rating scales attempt to get both a holistic and criterion-based measure of EF, specific measurement is often conducted using performance-based measures. These measures can include tasks such as the Stroop Test (Stroop, 1935), the Digit Span subtest on the Wechsler Intelligence Scale for Children (i.e., Wechsler, 2017), and the Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Kay, & Curtiss, 1993). The Stroop Test uses a variety of color words written in ink that does not match the word (e.g., the word *red* may be

written in green ink) to assess for IN. Digit Span involves an evaluator verbally presenting a sequence of numbers and having the test recipient recite them back in differing specified orders to measure WM. Finally, the WCST shows an individual five cards, four lined up in a row and one by itself directly below the row, each with a different figure on it. These figures can vary by shape, color, or number from card to card. The individual is then told to match the bottom card with one on the top but is not told the rule for matching. Rules change as the examinee learns them, and so the task evaluates CF. Although performance-based measures have been praised for offering the ability to target and evaluate specific skills associated with EF, they have been conversely criticized for several inherent limitations. The foremost of these is that typical assessment environments reduce the demands on EF as an examiner contributes to the structure, planning, organization, guidance, and attention to the task (Isquith et al., 2013). They also provide additional cueing and monitoring to ensure optimal performance. As such, performance-based measures may not be reflective of actual real-world EF ability.

EF summary. EFs are higher-order cognitive skills that allow people to plan, organize, and complete tasks. These cognitive skills can be assessed either generally, via behavioural rating scales, or specifically, via tasks that measure discrete components of EF. Furthermore, they can impact several areas of functioning, including academics, adaptive functioning, and social skills. Direct application of EF in academics can be observed when a student is required to solve for different problem types and/or operators on a single test (CF) or when a student is required to hold and manipulate information in their mind to solve a problem (WM). Indirectly, IN helps to regulate attention and promote learning as well as task completion. Adaptive functioning (how well a person independently handles tasks of daily living) is influenced by an individual's ability to perform goal directed behaviours (a concept associated with EF), follow

instruction (WM and IN), and transition between novel and potentially unexpected events (CF). Additionally, although EF is commonly discussed in terms of three foundational constructs (i.e., IN, WM, and CF), it is best conceptualized as a unitary construct. Finally, the development of EF is directly related to the development of social functioning.

Social Skills

Social skills are most readily defined as skills that an individual utilizes to communicate and interact with others in an acceptable way using both verbal and non-verbal behaviours (Guivarch et al., 2017). These skills often involve predicting and understanding others' behaviours and involve a complex interaction between cognitive, behavioural, and environmental factors (Soto-Icaza, Aboitiz, & Billeke, 2015). An individual must be competent in self-regulation, communication, empathy, engagement, cooperation, assertion, and responsibility to predict, understand, and respond to others' behaviours (Gresham & Elliott, 2008).

Typical early development of social skills. Social skills are typically cited as learned behaviours and are in development throughout the life-cycle (Hess, Osowski, & Leclerc, 2005). However, discrete and foundational skills often occur during specific developmental periods, referred to as milestones, that occur throughout infancy and into early childhood. For ease of discussion, the milestones will be discussed in three separate sections: 4 to 18 months, 18 to 48 months, and 48 months to 5 years of age. It's important to note that these time periods to not necessarily represent distinct developmental periods.

During the 4- to 18-month period, children develop several skills that underlie future social functioning (Dosman, Andrews, & Goulden, 2012). First, they begin to demonstrate facial expression of emotion. This involves conveying emotions such as joy, anger, sadness, distress, and surprise through facial communication. Second, infants develop the ability to respond to

emotion (i.e., share the enjoyment and displeasure of others). Third, infants begin to develop a permanent sense of attachment to their caregivers. This stems from the development of object permanence and consequently an ability to envision and miss their caregiver. Fourth, infants begin showing interest in other infants by very rudimentary attempts at engagement and basic levels of empathy. Fifth, eye-contact and joint attention allow infants to attend to their caregivers and salient environmental information. Finally, infants also demonstrate imitation of caregivers that allows them to influence their environment through learned behavioural cues.

During the 18- to 48-month period, social functioning builds off the foundational abilities acquired earlier in life and grows in complexity. Children begin to acquire the ability to socially reference (i.e., take cues from other people in the environment as to which emotions and actions are appropriate; Dosman et al., 2012). Comforting of others and parallel play also develop during this time period, building off the basic levels of engagement and empathy acquired previously (Dosman et al., 2012). Finally, initiation of peer interactions, role playing, use of rules, and the establishment of preferred friendships all develop during this period (Dosman et al., 2012). This development helps form the foundation for future friendships and social understanding.

Finally, during the 48-month to 5-year time period, children begin to solidify their independent social skills. Children begin wanting to play with their friends without parental involvement and demonstrate an insistence on group rules (Dosman et al., 2012). Additionally, children begin to have elaborate discussions regarding their thoughts, emotions, and desires (Dosman et al., 2012).

These milestones do not mark the end of social development, but rather serve as the basis for the development of more complex social competencies that further enable the child to navigate their social environment. For instance, children’s earliest peer relationships often begin

in the form of parallel play, before developing into reciprocal interactions (Dosman et al., 2012). Typically, during this period, child interactions are overseen by an adult (Dosman et al., 2012). As children age into adolescence, much of their peer interactions become independent. In addition to reciprocity, peers begin to look for things such as the provision of intimacy, security, trust, and norm teaching from one another (Rubin, Dwyer, Kim, & Burgess, 2004). It is important that adolescents have met basic milestones of social development to be able to provide and receive this level of support. Additionally, it's suggested that successful peer interaction is necessary for individuals to learn socially acceptable behaviours and norms (Bandura & Walters, 1963). When foundational social skills are not developed due either to a socially impoverished environment or a developmental impediment, an individual may be unable to interact with their peers successfully and lose out on future social development. This creates a cycle in which past social deficits reinforce further impairment in social skills. With enough impairment, children can display problem behaviours, exhibit social maladaptation, school maladjustment, poor academic performance, and are at an increased risk for mental illness (Miers, Blote, & Westenberg, 2010; Takahashi, Okada, Hoshino, & Anme, 2015).

EF and Social Skills

Given EF's prominent role in facilitating goal-oriented behaviour, self-regulation, self-awareness, and planning, it's not surprising that it plays a major role in the development of successful social functioning. Social interactions often require a great deal of emotional-regulation, self-awareness, and planning, as well as goal-oriented behaviour (for the interactions to be initiated). As such, EF has been implicated in several social and emotional skills (Alduncin et al., 2014; Blain-Briere et al., 2014; Jacobson et al., 2011). For instance, EF allows for prioritizing of long-term goals over immediate desires via inhibition and planning. Deficits in

these realms may lead to impulsivity and an inability to delay socially off-putting but self-gratifying behaviours. Consequently, these deficits decrease the likelihood of social acceptance and further reduce opportunities for social development. Additionally, EF allows an individual to maintain attention when discussing something that may be uninteresting to the individual but important to their social partner, thus fostering social relationships. Finally, EF can aid in the understanding of consequences via planning and organization, allowing an individual to understand the effects of their behaviour on others and foster positive social interactions while avoiding negative ones. All these behaviours are important when engaging in social interaction with gaps in development becoming more salient as individuals age.

Research into the link between EF and social skills has revealed several interesting associations. First, research discussing EF and communicative behaviours has suggested that inhibitory skills help individuals to avoid saying the first thing that come into their mind when asked a question (Moriguchi, Okanda, & Itakura, 2008). This works in tandem with planning and allows the speaker to consider the effect of saying a thought aloud on the recipient. Second, research into individuals with hearing difficulties has also identified WM as playing a significant role in effective and efficient communication by allowing an individual to store, reference, and respond to someone's statement (Murray & Goldbart, 2011). Third, recent research has revealed that improvements in social competency have led to secondary increases in EF (Christ et al., 2017). Finally, deficits in components of EF have been found to coincide with deficits in functional communication, indicating that aspects of EF are required for succinct and understandable use of language (Freeman, Locke, Rotheram-Fuller, & Mandell, 2017). Succinct and understandable language is a cornerstone of communication which is in turn fundamental to the way individuals commonly interact (i.e., by speaking to one another).

Difficulties with communication, perspective taking, socially off-putting but self-gratifying behaviour, discussing topics of disinterest, and understanding the nuances and consequences of social behaviour are all social impairments associated with deficits in EF. Deficits in these areas are also characteristic features of Autism Spectrum Disorder (ASD). Furthermore, deficits in ASD have been associated with deficits in EF (Craig et al., 2016).

Autism Spectrum Disorder

ASD is classified as a neurodevelopmental disorder in the *Diagnostic Statistical Manual of Mental Disorders, Fifth Edition* (*DSM-5*; APA, 2013). ASD is characterized by persistent impairment in social communication and restricted and/or repetitive patterns of behaviour, interests, and/or activities. These difficulties first present in early childhood and may lessen in adulthood but do not abate. Additionally, symptoms must either limit or impair an individual's daily functioning. Symptoms of ASD are highly variable in that symptom severity can change throughout the lifespan and symptom presentation can vary between individuals (APA, 2013).

Prevalence. Recent data indicates that rates of ASD may affect as many as 1 in 59 U.S. children (Centers for Disease Control and Prevention [CDC], 2018) and 1 in 66 Canadian children (Government of Canada, 2018). This number has been verified in at least one other developed western country (Brugha, McMannis, & Bankart, 2011). Furthermore, these prevalence rates have only grown over time, with prevalence rates more than doubling since 2002 (which saw rates at 0.6%; CDC, 2018).

Etiology and risk factors. Current conceptualization posits that ASD results from a combination of genetic and environmental factors, with genetics taking precedence. The genetic emphasis comes from a multitude of twin studies indicating that heritability rates fall somewhere in the range of 64% to 91% (Tick, Bolton, Happé, Rutter, & Rijsdijk, 2016). While genetic

heritability has been well established in the literature, the genes responsible are still unidentified (Yoo, 2015). This is in large part due to issues of multi- and equi-finality in which a single gene mutation may lead to any number of different phenotypes or conversely a number of different mutations may lead to the same phenotype (Lenroot & Yeung, 2013). Furthermore, the heterogeneity of ASD symptoms may mean that individuals who display different profiles have unique/distinct variations of genetic mutation (Chaste & Leboyer, 2012). Environmental factors offer another key area of research into the etiology of ASD. These factors can include parent age (Hultman, Sandin, Levine, Lichtenstein, & Reichenberg, 2011), stress, and/or drug use in the prenatal period (Dietert, Dietert, & Dewitt, 2010; Gardener, Spiegelman, & Buka, 2011), and heavy metals, environmental chemicals, and pesticides (Dietert et al., 2010).

History of ASD. The term autism was coined by Eugen Bleuler in 1910 to describe individuals with schizophrenia who were displaying flat affect. A few decades later (in 1943), Leo Kanner took up the term infantile autism to describe 11 children who exhibited similar characteristics, the most apparent of which were "autistic loneliness", "impaired communication", and an "insistence on sameness". These behaviours closely parallel what we would today refer to as impairments in social interaction, language use, and restrictive and repetitive interests. One year after this, Hans Asperger used the term autistic psychopathy to identify a group of children exhibiting very similar behaviours to those detailed by Kanner but possessing intact verbal abilities (Hippler & Klicpera, 2003).

Autism symptomology and schizophrenia (mirroring Bleuler's findings) were conflated for the *DSM-I* (APA, 1952) and *DSM-II* (APA, 1968), and were thought to represent a childhood type of schizophrenia. Research into the symptomology of ASD resulted in the notion of autism as a distinct construct as recognized by "infantile autism" in the *DSM-III* (APA, 1980). The

DSM-III characterized infantile autism as (a) occurring before 30 months of age, (b) a pervasive lack of responsiveness to others, (c) gross deficits in language development, (d) peculiar speech patterns such as echolalia, pronoun reversal, or impaired metaphorical language, (e) peculiar interests/attachments and/or resistance to change, and (f) an absence of characteristics that would better indicate schizophrenia (APA, 1980).

In 1987, the *DSM-III-R* (APA, 1987) continued to develop the notion of autism and made several changes to its diagnostic criteria. The name was changed to Autistic Disorder, the age of onset was opened to include infancy or early childhood, and a much more comprehensive list of symptoms was introduced (e.g., impairments in reciprocal social interaction, marked impairment in the ability to initiate or sustain conversation, stereotyped body movements, and an absence of imaginative activity).

Later, the *DSM-IV* (APA, 1994) posited three related but distinct sub-disorders which all fell under the purview of the term Pervasive Developmental Disorder (PDD) in an attempt to enhance classification of the different symptomologies exhibited by individuals with ASD. This included Autistic Disorder, Asperger's Disorder (syndrome), and Pervasive-Developmental Disorder Not Otherwise Specified (PDD-NOS; APA, 1994). Asperger's Disorder incorporated common features of Autistic Disorder such as impairments in social interaction and restricted, repetitive, and/or stereotyped behaviours, interests, and activities, but required the absence of clinically significant impairments in language and intellectual functioning (APA, 1994). PDD-NOS effectively acted as a fall back for when pervasive impairment in the development of social interaction or verbal/non-verbal communication was present but criteria for other disorders (i.e. Autistic Disorder, Asperger's Disorder, or Schizophrenia) could not be met (APA, 1994). However, research indicated that while clinicians were highly accurate in identifying whether a

person met criteria for a PDD, inter-rater reliability was relatively low when identifying which PDD an individual should be diagnosed with (Van Daalen et al., 2009). Additionally, diagnoses were found to lack stability over time, as individuals would often move from Autistic Disorder to PDD-NOS as they aged due to diminished symptom severity (Van Daalen et al., 2009).

Diagnostic classification. Current conceptualization and diagnosis of ASD differs from past iterations. As a direct consequence of issues with reliability and validity, the *DSM-5* (2013) eliminated the specific diagnoses and replaced them with a unified ASD framework. ASD is now conceptualized as a multidimensional disorder that presents as impairment in social communication in conjunction with restricted/repetitive patterns of behaviour, interests, and/or activities. Additionally, ASD may be diagnosed at any point in the life-span, provided evidence of symptoms can be obtained for some point during the early developmental period (first 5 years of life). The following section will describe the current *DSM-5* diagnostic classification.

Deficits in social communication and interaction. A primary feature of ASD involves lifelong impairment in social communication and interaction across multiple contexts (APA, 2013). Specifically, this must present as deficits in: (a) social-emotional reciprocity, (b) non-verbal communication, and (c) developing, maintaining, and understanding relationships (APA, 2013). Communicative deficits are often accompanied by atypical speech including delay in the onset or development of speech, use of idiosyncratic language (odd or strangely clinical), echolalia (repetition of speech or sounds), or unusual prosody (tone or inflection; APA, 2013; Mody & Belliveau, 2013).

Social-emotional reciprocity refers to the back and forth flow of social interactions and the skills necessary to make to this possible. This includes an individual's skills in trading information, finding common interests, or showing interest in others' conversational topics as

well as sharing their feelings and emotions (APA, 2013). Furthermore, social-emotional reciprocity incorporates self-awareness of one's own emotions, thoughts, and behaviours as well as awareness of others' emotions, thoughts, and behaviours (Whitcomb, Rodrigues, & Merrell, 2013). Consequently, deficits in this area can result in difficulties with conversational turn-taking, collaborative behaviour, and acknowledgement of others' emotional states (Ommeren, Begeer, Scheeren, & Koot, 2012).

Non-verbal communication describes the process of conveying information without language. This typically includes an individual's use of gestures, facial expressions, body language, or eye contact (APA, 2013). However, non-verbal communication can be extended to include pitch/tone of voice, distance from a conversational partner, and behaviours undertaken during a conversational exchange. Impairments in this area can result in difficulties initiating/responding to joint attention, a lack of emotional expression, seemingly odd behaviours, and inappropriate conversational distance (APA, 2013; Chiang, Soong, Lin, & Rogers, 2008).

Developing, maintaining, and understanding relationships is a blanket concept that incorporates an individual's ability to adjust their behaviours to fit a social situation (APA, 2013). This concept also includes the general ability to make friends, show interests in others' thoughts/perspectives, and engage in romantic relationships (APA, 2013). Impairments in this area can result in difficulties adapting to changing social contexts, lacking the ability to engage in imaginative play with others, or showing a lack of interests in peers (APA, 2013). Impairments in this area are oftentimes further compounded by impairments in the other areas of communication discussed previously.

Overall, individuals with ASD display impairment in the use and understanding of abstract speech (e.g., metaphors, sarcasm, and humor) as well as non-verbal social interaction (e.g., eye contact, joint attention, and facial expressions; APA, 2013; Mody & Belliveau, 2013). Examples of this can include one-way conversation, disinterest in others' attempts to steer the conversation, and perseverating on topics of interest (APA, 2013). Additionally, individuals often display difficulties differentiating situations in which a behavior may be appropriate or inappropriate. Consequently, correctly attributing intent and implementing socially appropriate responses can prove difficult (APA, 2013). These difficulties all contribute to challenges with reciprocal social interaction, which in turn can diminish the capacity to make and maintain meaningful social relationships (APA, 2013).

Restrictive and/or repetitive patterns of behaviour, interests, or activities. Another core feature of ASD is the presence of restricted, repetitive patterns of behaviour, interests, or activities. The *DSM-5* requires that at least two of the following symptoms have been present at some point in development: (a) stereotyped or repetitive motor movements, use of objects, or speech, (b) insistence on sameness, inflexibility in routine, or ritualized patterns of verbal or nonverbal behaviour, (c) restricted/fixated interests that are aberrant in intensity, or (d) sensory impairment such as hyper- or hypo-reactivity to input or environmental sensations (e.g., indifference to temperature or atypically averse responses to certain fabrics).

Stereotyped or repetitive motor movements, use of objects, or speech refers to three distinct types of repetitive/compulsory behaviours. First, motor movements refer to movements of the body (e.g., hand flapping, rocking, or odd posturing; APA, 2013). These movements often seem meaningless to the observer but may hold significance for the individual (e.g., sensory stimulation). Second, stereotyped use of objects refers to repetitive/compulsory behaviours

associated with particular objects (e.g., driving a toy train back and forth in the exact same spot; APA, 2013). Third, stereotyped use of speech refers to the repetitive use of language, or language components. This is often referred to as echolalia and may include repetition of words, phrases, sounds, or intonations (APA, 2013).

An insistence on sameness, inflexibility in routine, or ritualized patterns of verbal or nonverbal behaviour all reference three ways of externalizing a single internal construct. Generally, these externalizing factors refer to an individual's rigid need to carry out a routine or activity in a specific way (APA, 2013). This can become ritualistic and is often inflexible and non-functional in its implementation. Disruption of these ritualistic behaviours can result in negative reactions. These rituals may represent an underlying desire to predict what will happen and therefore act as a coping mechanism.

Restricted/fixated interests that are atypical in intensity or focus refer to a very strong interest in one or more special topics (APA, 2013). Generally, topics of interest tend to focus on areas of science and technology (Parsons, Bayliss, & Remington, 2017). For instance, foci pertaining to specific historical dates, the periodic table, or an understanding of how mechanisms, machines, vehicles, or physical systems work have all been identified as potential areas of interest (Parsons et al., 2017; Turner-Brown, Lam, Holtzclaw, Dichter, & Bodfish, 2011). These interests are often thought to represent non-social areas and are typically outside the purview of the general populace (Parsons et al., 2017). Individuals with ASD have also been noted as developing an unusual depth of knowledge surrounding these topics, often demonstrating rote memorization of specific and obscure facts (Parsons et al., 2017).

Sensory impairment can manifest itself as either hyper- or hypo-reactivity to sensory input or environmental sensations (APA, 2013). For instance, an indifference to extreme

temperatures or an atypically aversive reaction to particular fabrics may be observed (APA, 2013). Additionally, sensory seeking behaviours may fall under this area (McCormick, Hepburn, Young, & Rogers, 2016). Sensory seeking behaviours are typically premeditated by hyposensitivity, causing an individual to seek out increased levels of sensory stimulation. This may include prolonged visual inspections or repetitive touching of objects (McCormick, et al., 2016). As noted previously, sensory impairment may contribute to certain stereotypies by means of satisfying sensory seeking behaviours.

Diagnostic specifiers. In all cases, symptoms must be present in early in life, significantly impact functioning in multiple environments, and not be better explained by intellectual disability or global developmental delay (APA, 2013). The *DSM-5* guidelines also allow for specifiers to be indicated. These specifiers provide information about the level of support required for an individual with ASD (i.e., level 1 = requiring support, level 2 = requiring substantial support, level 3 = requiring very substantial support). Additionally, the *DSM-5* allows for specifiers which indicate the presence and/or absence of intellectual disability, language disorder, catatonia, and/or any additional *DSM-5* disorders (APA, 2013).

ASD without cognitive impairment. Individuals with ASD display considerable variability in their verbal and cognitive abilities and have a high rate of co-occurrence of Intellectual Disability (ID; characterized by significant impairment in intellectual and adaptive functioning; APA, 2013). In 2008, the Centers for Disease Control and Prevention cited 38% of children with ASD as having comorbid ID, with an additional 24% falling in the borderline range (IQ of 71 – 85). Other epidemiological studies have reported much higher numbers, ranging from 50% to 70% (Fombonne, 2003). Individuals who do not present with this comorbidity (i.e., IQ > 70) are often referred to as having ASD without cognitive impairment. These individuals tend to

experience less severe ASD symptomology but are at greater risk for developing co-occurring psychopathology (Mayes & Calhoun, 2011; Ratcliffe, Wong, Dossetor, & Hayes, 2015). Additionally, individuals with ASD and without cognitive impairment tend to be self-aware of the difficulties they face when attempting to make and maintain social relationships, and frequently cite developing friendships as one of their most important goals (Kasari & Patterson, 2012; Mayes & Calhoun, 2011). Research suggests that the difficulties these individuals face when attempting to develop and maintain relationships may partially result from impairments in their knowledge of typical social procedures and skills (Laugeson & Frankel, 2010).

Social skills in those with ASD and without cognitive impairment. In comparison to individuals with ASD and co-occurring ID, those with ASD and without cognitive impairment have been characterized as having a greater interest in social interaction despite lacking the necessary skills (Ozonoff, Dawson, McPartland, 2002). Given their intact verbal and cognitive functioning, social skills impairments tend to be one of the primary symptoms observed in this population (Kasari & Patterson, 2012). This contrast between desire and ability for social interaction can have a negative effect on mental health. Atypical or absent social skills have been linked to numerous mental health conditions with special consideration given to the development of depression and anxiety (Miers et al., 2010). Not only do mental health challenges negatively impact a person's level of daily functioning, but they can further compound social skills deficits, leading to a cycle that reinforces avoidance of social interaction and furthers social deficits (Rubin, Coplan, & Bowker, 2009). Additionally, individuals with ASD and without cognitive impairment are often expected to operate in environments composed primarily of typically developing individuals. These environments provide a high level of exposure to social contexts that may highlight an individual's social deficits, causing greater levels of distress (De-la-Iglesia

& Olivar, 2015). Further compounding this issue is that interventions for adolescents and young adults typically lack a focus on developing the necessary social skills needed to engage in complex social interaction (Weiss & Harris, 2001). In general, social problems experienced by individuals with ASD and without cognitive impairment include one-way conversations, overly formal speech, topic perseveration, overly detailed responses, inability to notice social cueing, difficulties with sarcasm, and general deficits in pragmatic use of language (Kasari & Patterson, 2013; Laugeson et al., 2012).

EF in ASD without cognitive impairment. Given the link between EF and social skill development, it's not surprising to find that individuals presenting with a disorder characterized primarily by social impairment have been found to demonstrate EF impairments as well (Craig et al., 2016). Several studies have attempted to identify the possible EF impairments in children and adolescents with ASD and without cognitive impairment, and in most cases significant impairment of IN, WM, and CF has been reported (Corbett, Constantine, Hendren, Rocke, & Ozonoff, 2009, Craig et al., 2016; Ozonoff, Pennington, & Rogers, 1991; Robinson et al., 2009). Studies involving individuals from the broader ASD population have also suggested significant impairment in CF, IN, and WM (Brian, Tipper, Weaver, & Bryson, 2003; Courchesne et al., 1994; Hughes, Russel, & Robbins, 1994; Noterdaeme, Mildenberger, Minow, & Amorosa, 2002; O'Hearn, Asato, Ordaz, & Luna, 2008). Additionally, neuroimaging studies offer further validation of these findings by linking ASD to impairments in the PFC (Gilbert, Bird, Brindley, Frith, & Burgess, 2008; Girgis et al., 2007; Schmitz et al., 2006). Some researchers have identified what is thought to be an association between impairments in certain areas of EF and impairments in socialization and adaptive functioning in individuals with ASD (Panerai et al., 2014). Given the link between EF and social skills and the perceived association between EF and

social impairment in ASD (Panerai et al., 2014), it's possible that an individual with ASD's ability to moderate social impairment is influenced by their level of executive dysfunction. This in turn may prove relevant for interventions aimed at remediating social impairment.

Social Skills Interventions

Given that social difficulties form part of the core symptomology of ASD and that these difficulties contribute to risk factors for co-occurring mental illness, interventions to improve social functioning or mitigate the impact of current delays present an important avenue of support. Traditionally, intervention for individuals with ASD has involved behavioral modification paradigms and has not focused on the development of meaningful social interaction (Krasny, Williams, Provencal, & Ozonoff, 2003). This lack of social focus is especially notable for teenagers and young adults who typically engage in more complex social relationships (Weiss & Harris, 2001). Most forms of social intervention rely on didactic teaching, role-playing, behavior modeling, and skill coaching (Williams White, Koenig, & Scahill, 2007). These interventions often rely on a group-based setting to facilitate the practicing of social skills and interactions; such interventions are referred to as Group Social Skills Interventions (GSSIs). This form of intervention is especially relevant for adolescents and young adults with ASD and who demonstrate average or greater cognitive functioning (McMahon, Lerner, & Britton, 2013).

GSSIs typically attempt to increase social knowledge and social performance and have seen a substantial increase in use in the past 15 years (Wolstencroft et al., 2018). Numerous studies have indicated a range of effect sizes depending on the measurement method being used (i.e., self-report, parent-report, performance based, etc.; Gates et al., 2017; Spain & Blainey, 2015; Wolstencroft et al., 2018). These studies tentatively indicate that GSSIs may be effective for children (Wolstencroft et al., 2018), school-age and teenage youth (Gates et al., 2017), and

young adults (Spain & Blainey, 2015). However, consensus on the effectiveness of GSSIs has been inconsistent in large part due to differences in outcome measurement (i.e., questionnaire vs observation) and weaknesses with methodology (Wolstencroft et al., 2018).

Several reviews pertaining to social interventions for people with ASD have identified limitations in the literature (Krasny et al., 2003; Reichow, Steiner, & Volkmar, 2012; White et al., 2007; Wolstencroft et al., 2018). These issues include a lack of establishing empirical research practices and methods such as use of control groups and random assignment (Randomized Control Trials [RCT]), multi-site replication, collection of follow-up data, confirmation of diagnoses, and using varying outcome measures within a single construct. An additional area of concern is the potential for publication bias (Reichow et al., 2012). In each of their respective reviews, the above authors cited future research in GSSIs as needing to address these limitations, specifically in regard to applying more stringent empirical methods. For instance, Reichow et al. (2012) conducted a Cochrane review analyzing all social interventions for ASD and were only able to identify five interventions that had RCT evidence to support their use. RCTs are considered the gold standard in research and are commonly considered the most rigorous way of determining whether a cause-effect relation exists (Sibbald, 1998). RCTs allow for randomization which minimizes selection bias as well as comparisons between treatment and non-treatment groups to determine effects. Consequently, large scale replication of RCT studies is often required to validate the effectiveness of an intervention. Of the five interventions examined, only one was validated for use in an adolescent population: the Program for the Education and Enrichment of Relational Skills (PEERS).

PEERS

Noticing the large gap present in current empirically validated social interventions, Laugeson and Frankel (2010) developed PEERS to serve the largely neglected demographic of 13- to 18-year-olds with ASD and without cognitive impairment. PEERS is a manualized intervention that has its roots in cognitive behavioural therapy and is based on the evidence-based Children's Friendship Training program (a manualized parent-assisted intervention for children with ASD; Frankel & Myatt, 2003). The intervention is administered over the course of 14 weeks, with each week incorporating a 90-minute session. PEERS utilizes didactic instruction, coaching, modeling, role-play, take-home social interaction assignments, and parent/caregiver training to help teens with ASD and without cognitive impairment develop the social competencies necessary to navigate the complexities of adolescent social interactions. Developing these competencies is accomplished by teaching concrete rules and steps that are involved in common social interactions, with the primary goal focusing on initiating and maintaining peer relationships. One of the tenets of PEERS is to teach ecologically valid social skills; PEERS takes a descriptive rather than prescriptive approach when assessing what skills to teach (i.e., it looks at how socially-successful individuals actually interact with others, rather than how we think they ought to interact with others). Specific topics include conversational skills (i.e., having a two-way conversation, finding common interests, appropriate use of humor, and entering/exiting group-based conversations), finding potential sources of friends, making phone calls (texting, instant messaging, and social media), being a good sport, hosting, organizing, and attending get-togethers, handling conflict (e.g., teasing, bullying, rumors, gossip, and/or disagreements), and changing a bad reputation. Each session ends with the assignment of homework (i.e., real-world practice with either parents or peers) that is reviewed and discussed

in the following session. Parents also receive concurrent training in a separate room that reviews the teen lessons, homework assignments, and offers support in guiding their teens towards positive peer interactions and relations so that parents can become competent social coaches who can continue to develop and maintain the skills taught in PEERS after the program has ended.

PEERS research findings. Research into the effectiveness of PEERS has generated evidence supporting both the efficacy and durability of the program to improve constructs associated with social skills (e.g., increased knowledge of social protocol, higher levels of social cognition, and increased communication, motivation, and awareness; Laugeson et al., 2014; Laugeson et al., 2012; Laugeson et al., 2009; Schohl et al., 2014; Van Hecke et al., 2015; Yoo et al., 2014). These studies have also demonstrated improvement in the quality and quantity of peer interactions, including increased numbers of get-togethers. Additionally, longitudinal benefits have been observed in studies examining follow-up data from one to five years (Laugeson et al., 2012; Mandelberg, Frankel, Cunningham, Gorospe, & Laugeson, 2014; Van Hecke et al., 2015). Further research has found improvements in neural functioning by demonstrating a significant shift from right-hemispheric lateralization to left hemispheric dominance as observed in EEG activity, resulting in patterns of EEG activity more similar to a typically developing control group (Van Hecke et al., 2015). Additionally, other researchers have demonstrated significant reduction in social anxiety (Schohl et al., 2014) and effectiveness of the program cross-culturally (Yoo et al., 2014). Above and beyond social skills improvement, researchers have noted a reduction in both aggressive and impulsive behaviours as well as certain ASD mannerisms (Schohl et al., 2014; Van Hecke et al., 2015). Finally, Chang et al. (2014) examined possible predictors for success in PEERS. Their findings indicated that the level of social skill impairment upon entering PEERS was significantly correlated with the level of social skill improvement

seen upon ending PEERS. Given the number of studies that have indicated improvement in social domains following completion of PEERS, the intervention appears to represent an empirically validated and effective option for building social competencies in teens with ASD.

Limitations of PEERS. Despite the growing body of evidence demonstrating the effectiveness of PEERS, several limitations exist. First, nearly all outcome measures consist of parent or adolescent report. Given that both parents and adolescents take part in the intervention, it becomes difficult to disentangle participant effects and expectations from actual behavioral change. Consequently, there is very little unbiased evidence to support the positive changes described in the literature. Third, none of the studies attempted to use performance-based measures, making it difficult to ascertain if participants are able to apply their knowledge in a task specific way. Fourth, neither symptomology, knowledge, nor performance were compared at pre- and post-test by a blinded and impartial clinician. Fifth, participants have demonstrated varying ranges of success in the program. However, there has been very little examination as to the variables which may be contributing to this variation. Finally, there has been little examination pertaining to the effect that the program has on other constructs related to social functioning (e.g., depression, anxiety, EF).

Summary

EF refers to higher-order cognitive processes that allow individuals to engage in complex daily tasks and is described as consisting of three inter-related yet distinct constructs: IN, WM, and CF. These constructs contribute to our ability to engage in goal directed behaviour, concentrate, attend, analyze, plan, prioritize, schedule, initiate, and complete activities in a timely manner (Best & Miller, 2010; Diamond, 2013; Hosenbocus & Chahal, 2012). Furthermore, EF has been implicated in academic achievement, adaptive ability, and social

competency. EF's role in social functioning is primarily to aid in emotional-regulation, self-awareness, planning, and social initiation. Furthermore, EF allows an individual to delay socially off-putting but self-gratifying behaviours, maintain attention during uninteresting but important interactions, and understand social consequences (Alduncin et al., 2014; Best & Miller, 2010; Blain-Briere et al., 2014; Diamond, 2013; Hosenbocus & Chahal, 2012; Jacobson et al., 2011).

A large component of social functioning is based on social knowledge and its application in the form of social skills. Application often involves communicating and interacting with others in an acceptable way via predicting and understanding social behaviours. Impairment in social functioning is a hallmark characteristic of ASD, a neurodevelopmental disorder characterized by persistent impairment in social communication and restricted/repetitive patterns of behaviour, interests, or activities (APA, 2013). ASD co-occurs with cognitive impairment in approximately 50% of cases (Fombonne, 2003). Individuals with ASD and without cognitive impairment are often more aware of their impairments while simultaneously having an increased desire for social interaction (Kasari & Patterson, 2012; Mayes & Calhoun, 2011). Consequently, they may be at greater risk for the development of co-occurring mental health conditions such as anxiety and depression (Miers et al., 2010). These disorders can further impair social functioning and create a cycle that worsens symptoms of ASD (Rubin, Coplan, & Bowker, 2009).

Impairment of EF in those with ASD and without cognitive impairment has been demonstrated in several studies (Corbett et al., 2009, Craig et al., 2016; Ozonoff et al., 1991; Robinson et al., 2009). In the vast majority of these studies, impairment has been noted in IN, WM, and CF, and has been linked to impaired socialization. While no "cure" exists for ASD, several interventions have been developed that attempt to target social skill development. Of

these interventions, only PEERS offers an empirically validated and manualized approach to the development of social skills in adolescents with ASD and without cognitive impairment.

Research findings from PEERS have demonstrated consistently successful outcome measures; however, individual variation has been observed. Given that PEERS seems to provide high levels of success for some individuals, but only marginal improvements for others, it is prudent to examine potential factors which may be affecting/predicting success.

Current Study

The present study explored the predictive ability of changes in EF on the outcome measures being used in a cross-cultural iteration of PEERS. Additionally, this study aimed to address two of the previously cited limitations inherent in the current PEERS literature: exploration of variables contributing to success in the program and examination of the effect of the program on separate constructs that are related to social functioning. The study examined both executive and social functioning at pre- and post-intervention. The study also incorporated standardized measures of cognitive functioning to ensure participant parameters were consistent. The results of this study examined the predictive value of improvements in EF on successful social intervention in adolescents with ASD without cognitive impairment.

Research Questions and Hypotheses

The proposed study aimed to address the following research questions (hypotheses in italics):

1) Will completion of PEERS improve social skills? *Participants will have greater self- and parent-reported social skills at post-intervention.*

2) Will completion of PEERS improve EF? *Participants will demonstrate improved ratings on self- and parent-reported constructs of EF at post-intervention.*

3) Is there a correlation between EF and social skills before and after completion of PEERS? *Participant's EF and social skills will be positively correlated at pre- and post-intervention.*

4) Will improvement on a construct of EF act as a predictor variable for social skill improvement upon completion of PEERS? *Participants showing improvement in EF will demonstrate increased social skills from pre- to post-intervention.*

Chapter 3: Methodology

Participants

Participants included 32 adolescents between the ages of 13 and 18 years (M = 15.39, SD = 1.46, 29 males and 4 females) and a parent/caregiver for each youth. Participants were recruited through media and social media advertising, community-based agencies that provide support to those with ASD and their families, and word of mouth. Parents initially completed an online questionnaire to gather background information and an intake interview to determine their youth's eligibility for the intervention. Inclusionary criteria included adolescents with ASD and without cognitive impairment (FSIQ >70) as determined by the Wechsler Abbreviated Scale of Intelligence – Second Edition (WASI-II; Wechsler, 2012). Data from an additional 45 adolescents was not included due to low cognitive abilities (n = 3) or research dropout/incomplete forms (n = 42). Relevant demographic information is shown in Table 1.

Table 1.
Demographic Information.

	Mean (SD)	Minimum	Maximum
Age (years)	15.39 (1.46)	13.00	18.00
Gender (% male)	87.9		
FSIQ-4	106.94	79.00	130.00

Note: age is presented in decimal form (i.e., 15 years, 6 months = 15.5). FSIQ is presented in standard score format (M = 100, SD = 15).

Measures

Wechsler Abbreviated Scale of Intelligence, Second Edition. The WASI-II (Wechsler, 2012) is a brief standardized measure of cognitive functioning comprised of four subtests (Block Design, Vocabulary, Matrix Reasoning, and Similarities) taken from the more comprehensive Wechsler Adult Intelligence Scale, Fourth Edition (WAIS-IV; Wechsler, 2008). Raw scores for the subtests are converted into norm-based standard scores (M = 100, SD = 15) that are combined

to form composites that represent verbal (Verbal Comprehension Index [VCI] comprised of Vocabulary and Similarities) and non-verbal (Perceptual Reasoning Index [PRI] comprised of Block Design and Matrix Reasoning) ability. All four subtests also comprise the Full-Scale Intelligence Quotient (FSIQ-4). Administration was conducted according to the instructions presented in the examiner's manual.

The WASI-II was normed on a sample of 2,300 individuals representative of the general United States population. Participants were matched based on the U.S. Census Bureau's Current Population Survey (2008). In regard to consistency and reliability, Wechsler (2012) reports interrater reliability coefficients from .94 to .99 across all four subtests. Additionally, internal consistency was reported with Cronbach's alpha ranging from .87 to .97 for the VCI, PRI, and FSIQ-4. Wechsler (2012) has also demonstrated concurrent validity between the WASI-II and both the WAIS-IV and Wechsler Intelligence Scale for Children, Fourth Edition (Wechsler 2003). Specifically, correlation coefficients for the WAIS-IV ranged from .70 to .86 for subtests and .86 to .92 for FSIQ-4 scores. Correlation coefficients for the WASI-II and WISC-IV ranged from .73 to .83 for subtests and .85 to .91 for FSIQ-4 scores. Additionally, correlations with the Wechsler Intelligence Scale for Children, Fifth Edition (Wechsler 2017) have been examined by third party researchers. Their findings indicate corrected correlation coefficients ranging from .53 to .80 for subtests and an overall FSIQ-4 corrected correlation coefficient of .87 (Raiford, Zhou, & Drozdick, 2016).

Comprehensive Executive Function Inventory. EF was assessed by the Comprehensive Executive Function Inventory (CEFI; Naglieri & Goldstein, 2013). The CEFI was chosen as its theoretical underpinning is in alignment with the concepts of a unitary EF as discussed earlier in the literature (CEFI; Naglieri & Goldstein, 2013). The CEFI measures several behaviours

associated with EF and its underlying constructs (Attention, Emotion Regulation, Flexibility, Inhibitory Control, Initiation, Organization, Planning, Self-Monitoring, and Working Memory; Naglieri & Goldstein, 2013). These factors include common constructs associated with EF such as IN, WM, and CF. The nine-factors of the CEFI are also combined to form an overall measure of full-scale EF. Scores from the nine-factors and the overall composite are presented as standard scores. Three forms (Parent, Teacher, and Self-Report) are offered, each composed of 100 questions (Naglieri & Goldstein, 2013). The CEFI requires respondents to answer questions using a six-point Likert-type scale with N ("Never"), R ("Rarely"), S ("Sometimes"), O ("Often"), V ("Very Often), or A ("Always"), reflecting the frequency with which the individual being evaluated performs an indicated behaviour (Naglieri & Goldstein, 2013). Respondents are instructed to base their answers on behaviours observed/conducted during the past 4-weeks. Administration typically takes 10 to 15 minutes (Naglieri & Goldstein, 2013).

The CEFI standardization sample consisted of over 5,000 participants residing in the United States. Samples included parents, teachers, and self-reporting adolescents (12 to 18 years old; Climie, Cadogan, & Goukon, 2014). The standardization sample was gathered from all 50-states and based upon demographic data from 2009 U.S. census (Climie et al, 2014). Internal consistency for full-scale scores were calculated using Cronbach's α and ranged from .97 to .99 for all forms (Climie et al, 2014). Individual subscales ranged from .70 to .86 for all forms (Climie et al, 2014). Test-retest reliability was found to be excellent with corrected *r* values ranging from .77 to .91 for the full-scale ($p < .001$) and .74 to .91 for the subscales ($p < .001$; Climie et al, 2014). Content validity was assessed by a thorough review of current research and theoretical literature (Climie et al, 2014). Construct validity was examined via an exploratory factor analysis which revealed that the items and scales were best represented by one factor (EF;

Climie et al, 2014). Criterion validity was explored by analyzing the CEFI's ability to detect difference between typically developing and clinical samples. For instance, results indicated that individuals with Attention-Deficit/Hyperactivity Disorder (ADHD), ASD, learning disorders, or mood disorders scored significantly lower across all raters than members of the general population without a diagnosis (Climie, Cadogan, & Goukon, 2014). Finally, correlations with the Behaviour Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) ranged from 0.85 (parent) to 0.64 (teacher; Primus, Warnick, Svenkerud, & Greene, 2014).

Social Skills Improvement System. The Social Skills Improvement System (SSIS; Gresham & Elliot, 2008) was completed by both adolescents and parents to examine changes in adolescent social functioning. The SSIS is a 46-item standardized questionnaire that provides information related to an individual's social functioning via self-, parent-, and teacher-report forms (Gresham & Elliot, 2008). The SSIS asks questions pertaining to social functioning in a multitude of environments including home, school, and peer-based settings. The SSIS assesses domains pertaining to Social Skills as well as Problem Behaviours by providing standard scores (mean of 100 and a standard deviation of 15) and percentile ranks for the corresponding domains (Gresham & Elliot, 2008).

For the purposes of this study, only the Social Skills domain was examined. This domain provides subscale information on communication, cooperation, assertion, responsibility, self-control, engagement, and empathy (Gresham & Elliot, 2008). On the self-report form, individuals are required to indicate their level of agreement with statements reflecting real-world social skill use (i.e., not true, a little true, a lot true, or very true; Gresham & Elliot, 2008). Parents complete a similarly structured 46 question form indicating the frequency with which

their child engages in the social behaviours described (i.e., never, seldom, often, or almost always; Gresham & Elliot, 2008). Additionally, parents and adolescents are required to rank the importance of the behaviours they're rating (i.e., not important, important, or critical; Gresham & Elliot, 2008).

The SSIS was normed on a general United States population composed of 4,700 children between the ages of 3 and 18 (Gresham & Elliot, 2008). Participants were matched in regard to geographic region, race/ethnicity, and socioeconomic status (Gresham & Elliot, 2008). These matches were made using the U.S. Census Bureau's Current Population Survey (2006). In regard to consistency and reliability, Gresham and Elliot (2008) report test-retest correlations as .84 for the parent-form and .80 for the self-report form. Additionally, internal consistency was reported with a Cronbach's alpha of .95 for the parent-form and .94 for the self-report form. Content validity for the SSIS was assessed using external content guidelines/key social skills terms, the DSM-IV-TR (APA, 2000), and the expertise of individual professionals (Gresham & Elliot, 2008). Additionally, further assessment of content validity (as well as construct validity) was conducted using differential item functioning, factor analysis, and examination of item-total correlations. Criterion validity was assessed by examining differences between special populations (e.g., individuals with social, emotional, or behavioural impairments) and typically developing populations (Gresham & Elliot, 2008). Finally, validity was also assessed by ensuring high levels of correlation between several relevant scales/measures (e.g., the Social Skills Rating System; Gresham & Elliot, 2008).

Procedure

Data Collection. Data for this study was collected as part of a larger project examining PEERS in adolescents with ASD and without cognitive impairment. Data for this study was

conducted at four time points: 16 weeks prior to intervention (T1: Baseline); one week before intervention (T2: Pre-intervention); one week after the intervention (T3: Post-intervention); and 16 weeks following intervention (T4: Follow-up). The current study will use data collected from T2 and T3 as these times offer the most data due to attrition at T4 and challenges with completion of measures at T1.

The intervention and research projects were related yet distinct activities. Eligible youth were able to complete PEERS and not engage in the research project. Youth and their parents were provided the opportunity to participate in the study after eligibility for the intervention was established. Those who consented were requested to complete a series of measures at each of the time points. First, adolescents completed the WASI-II to ensure that they met cognitive inclusion criterion. If they did not, the youth was able to complete the intervention but did not continue in the research project. Second, parents and adolescents completed questionnaires including the SSIS and CEFI. Adolescents were offered a $25 gift card and parents a $10 gift card after each research session as compensation for their time. Youth who were deemed ineligible for the research project were provided this compensation in consideration of their time during the inclusionary testing session.

Intervention. Parents and adolescents participated in the 14-week PEERS intervention. Lessons adhered to the process outlined in the manual and were led by a certified PEERS facilitator once a week for 14 weeks, with each session lasting approximately 90 minutes. Two-behavioural coaches were also present to assist in lesson demonstrations and managing group behaviour. Adolescents participated in didactic lessons that involved instruction in skills such as how to have a two-way conversation, identify common interests, be a good sport, as well as appropriate strategies for dealing with bullying. Each adolescent session entailed first reviewing

homework (i.e., practice) assignments given out the previous week and discussing any potential difficulties. Following this, the instructor reviewed the current week's lesson, provided behavioural demonstrations of the skills being taught (with the accompaniment of behavioural coaches), allowed time for adolescents to practice the current skills in small groups, and then assigned homework for the following week.

During this time, parents were engaged in separate but related sessions. These sessions focused on providing parents with the necessary skill set to offer social coaching around PEERS concepts both during the program and after its conclusion. This involved providing information about the didactic lessons being provided to the adolescents, troubleshooting difficulties with homework assignments, and providing suggestions for how to implement PEERS concepts in real-world situations.

CHAPTER 4: RESULTS

Analysis of Outcomes

Data was examined prior to analysis to determine the presence of outliers as well as to ensure that the relevant statistical assumptions were met. In doing so, visual inspection of boxplots revealed 3 outlying data points (2 on the SSIS and 1 on the CEFI) with a value greater than allowed (i.e., a value greater than the IQR multiplied by 1.5 and added to the third quartile). These data points were removed and resulted in a working sample size of 29. Examination of the data-set revealed that both the SSIS and CEFI met the assumption of normality as tested by Shapiro-Wilks as well as the assumption of homogeneity of variance as examined by Levene's test. Data was re-examined prior to individual analyses.

Social Skills. Pre- (T2) and post- (T3) SSIS test data was examined to identify changes in social skills as rated by adolescents and their parents. Analysis was carried out using a two-way mixed model ANOVA with Time as the within-subject factor (i.e., T2 and T3) and Report-Version as the between-subjects factor (i.e., Parent- and Self-Report). Visual inspection of boxplots revealed no remaining outliers with a value greater than allowed (i.e., a value greater than the IQR multiplied by 1.5 and added to the third quartile). Data was again found to meet the assumption of normality as tested by Shapiro-Wilks as well as the assumption of homogeneity of variance as examined by Levene's test.

Results of the ANOVA indicated a significant main effect of time on SSIS ratings, $F(1,56) = 13.739$, $p < 0.001$, $\eta^2 = 0.197$ (see Table 2). Additionally, a significant main effect of Report-Version was also found, $F(1,56) = 26.398$, $p < 0.001$, $\eta^2 = 0.320$, with parent-report ratings being lower than self-report ratings at both time-points (see Table 2). Finally, no significant interaction was found between Time and Report-Version, $F(1,56) = 0.300$, $p = 0.586$,

$\eta^2 = 0.005$ indicating that level of improvement from T2 to T3 was not significantly impacted by group membership (i.e., the level of improvement reported from T2 to T3 by both parents and adolescents was similar).

Table 2.
Means and Standard Deviations for all Primary Analyses

	T2 M (SD)	T3 M (SD)
SSIS		
Parent-Report	76.79 (10.28)	80.28 (11.94)
Self-Report	90.52 (11.00)	95.21 (12.34)
Total	83.66 (12.62)	87.74 (14.20)
CEFI		
Parent-Report	85.69 (10.38)	90.38 (9.39)
Self-Report	90.52 (11.44)	92.66 (11.24)
Total	88.10 (11.10)	91.52 (10.33)

Note: SSIS denotes the Social Skills Improvement System, CEFI denotes the Comprehensive Executive Function Inventory, "M" is the mean, and "SD" is the standard deviation of the mean. T2 and T3 indicate pre- and post-test time-points (directly before and directly after PEERS). Values are reported as Standard Scores.

Executive Functioning. Pre- (T2) and post- (T3) CEFI data was again examined, this time to identify changes in EF as rated by adolescents and their parents. Analysis was again carried out using a two-way mixed model ANOVA with Time as the within-subject factor (i.e., T2 and T3) and Report-Version as the between-subjects factor (i.e., Parent- and Self-Report). Analysis was conducted using full-scale EF, however, both pre- and post- CEFI index scores can be seen in Table 3. Visual inspection of boxplots revealed no additional outliers. The data was again found to meet the assumption of normality as tested by Shapiro-Wilks as well as the assumption of homogeneity of variance as measured by Levene's test.

Results of the ANOVA revealed a significant main effect of Time, $F(1,56) = 12.220$, $p = 0.001$, $\eta^2 = 0.179$, with improvements being seen from T2 to T3 (see Table 2). No significant main effect of Report-Version was found, $F(1,56) = 1.838$, $p = 0.181$, $\eta^2 = 0.032$. Additionally, no significant interaction was found between Time and Report-Version, $F(1,56)$

= 1.707, $p = 0.197$, $\eta^2 = 0.030$, indicating that level of improvement from T2 to T3 was not significantly impacted by group membership (i.e., the level of improvement reported from T2 to T3 by both parents and adolescents was similar).

Table 3.
Means and Standard Deviations for CEFI Subscale Scores

	T2 M (SD)	T3 M (SD)
Parent-Report		
Attention	89.41 (9.95)	92.97 (9.60)
Emotional Regulation	87.59 (13.56)	92.28 (11.43)
Flexibility	81.48 (10.87)	87.24 (8.89)
Inhibitory Control	89.90 (12.01)	94.31 (11.07)
Initiation	81.31 (10.61)	86.55 (10.65)
Organization	88.01 (10.18)	92.28 (10.37)
Planning	87.14 (10.44)	90.03 (9.57)
Self-Monitoring	88.66 (11.18)	92.66 (9.80)
Working Memory	86.28 (11.46)	88.76 (11.12)
Self-Report		
Attention	91.83 (14.44)	94.03 (12.45)
Emotional Regulation	97.41 (14.24)	95.79 (12.90)
Flexibility	91.66 (13.34)	94.17 (13.13)
Inhibitory Control	94.17 (12.56)	95.90 (11.30)
Initiation	86.38 (11.62)	92.24 (14.78)
Organization	90.07 (11.14)	92.79 (13.28)
Planning	90.31 (11.56)	93.03 (12.40)
Self-Monitoring	92.72 (13.14)	94.10 (13.01)
Working Memory	92.62 (12.60)	90.97 (14.75)

Note: CEFI denotes the Comprehensive Executive Function Inventory, "M" is the mean, and "SD" is the standard deviation of the mean. T2 and T3 indicate pre- and post-test time-points (directly before and directly after PEERS). Values are reported as Standard Scores.

Correlation Between Social Skills and Executive Function. A Pearson correlation was performed to examine the relation between the SSIS and CEFI at T2 and T3. No outliers were found to remain in the data-set (having been pruned from the previous two analyses) and all variables met the assumption of normality as examined by the Shapiro-Wilk's test. Additionally, the variables were found to meet the assumption for homogeneity of variances as measured by Levene's test. Pearson correlations between EF and social skills on the

parent-report indicated significant positive correlations between pre-test CEFI scores and both pre-test (r = .389, p < .05) and post-test (r = .386, p < .05) SSIS scores. Similarly, post-test CEFI scores showed a significant positive correlation with post-test SSIS scores (r = .388, p < .05), However, they did not show a significant correlation with pre-test SSIS scores (r = .209, p > .05). See Table 4 for a summary of parent-report correlations. Pearson correlations between EF and social skills on the self-report showed no significant correlations. See Table 5 for a summary of self-report correlations.

Table 4.
Pearson Correlations Parent-Report

	Pre-Test CEFI	Post-Test CEFI
Pre-Test SSIS	.389*	.209
Post-Test SSIS	.386*	.388*

Note: * indicates significant correlation $p < 0.05$.

Table 5.
Pearson Correlations Self-Report

	Pre-Test CEFI	Post-Test CEFI
Pre-Test SSIS	.268	.193
Post-Test SSIS	.043	.060

Note: * indicates significant correlation $p < 0.05$.

Predicting Improvements in Social Skills with Executive Functioning. A primary purpose of this study was to evaluate the predictive ability of EF on social skills. This analysis requires the development of a difference score, or a value representing the change in scores from T2 to T3 on each variable, with a positive value indicating an increase in scores from T2 to T3 and a negative value indicating a decrease. As this value represents a departure from the original values provided by the SSIS and CEFI at either specific time points, an inherent issue with reliability of the scores arises. Specifically, Lord (1956, 1963) found that

the unreliability of difference scores often exceeded that of the scores from which they were derived. Consequently, it is important for researchers working with difference scores to ensure that the observed differences between scores are a reliable indicator of the construct they purport to measure. Furr and Bacharach (2014) developed a formula that uses the reliability (R_x, R_y) variance ($S_{x_0}^2$, $S_{y_0}^2$) and standard deviation (S_{x_0}, S_{y_0}) for both the pre- and post-test as well as the correlation between the two tests ($r_{x_0y_0}$) to ensure the reliability of difference scores:

$$\boldsymbol{R_d = \frac{S_{x_0}^2 R_x + S_{y_0}^2 R_y - 2r_{x_0y_0} S_{x_0} S_{y_0}}{S_{x_0}^2 + S_{y_0}^2 - 2r_{x_0y_0} S_{x_0} S_{y_0}}}$$

The values for the above formula are presented in Table 6.

Table 6.

Reliability of Difference Scores

	Pre-Test			Post-Test				
	α	S^2	S	α	S^2	S	r	Rel. α
SISS Self-Report	0.96	121.04	11.00	0.96	152.24	12.34	0.71	0.86
SSIS Parent-Report	0.90	105.60	10.28	0.91	142.64	11.94	0.76	0.62
CEFI Self-Report	0.87	130.97	11.44	0.97	126.45	11.24	0.82	0.55
CEFI Parent-Report	0.89	107.79	10.38	0.83	88.24	9.39	0.67	0.59

Note: α represents Cronbach's alpha for each individual measure. S^2 and S denote variance and standard deviation. *r* is the correlation between the pre-test and post-test and 'Rel. α' denotes the calculated reliability alpha of the difference score.

Cronbach's alpha on the self-report version of the SSIS were excellent, with both pre- and post-test having values of 0.96. This helped to mediate the large amount of variance and moderate correlation between pre-and post-test and resulted in a difference score with a reliability of 0.86. Reliability of the difference score was also calculated for the parent-report version of the SSIS. Here, Cronbach's alpha was 0.90 and 0.91 for T2 and T3, respectively, with a similar level of variance to the self-report and a Pearson correlation of 0.76. Despite

these values, the SSIS parent-report difference score was found to have questionable reliability with a value of 0.62. Similarly, both self-report and parent-report versions of the CEFI were analyzed to find out the reliability of their difference scores. Self-report forms were found to have a Cronbach's alpha of 0.87 and 0.97 for pre- and post-test, respectively, as well as a Pearson correlation of 0.82. This resulted in a reliability of the difference score of 0.55. Likewise, the parent-report version had a Cronbach's alpha of 0.89 at pre-test and 0.83 at post-test, with a Pearson correlation of 0.67. These scores resulted in a reliability of the difference score of 0.59.

Different reports regarding the acceptable values of Cronbach's alpha exist with typical values ranging from 0.70 to 0.95 (Bland & Altman, 1997; Tavakol & Dennick, 2011). Recommended values are typically differentiated based upon the information being gathered, with 0.7 to 0.8 being acceptable for identifying between group differences and higher values (i.e., > 0.9) when dealing with medical trials (Bland & Altman, 1997). Considering the previously quoted values, it is apparent that only the SSIS Self-Report offers a reliable difference score for use in statistical analysis (in this case regression). Furthermore, the moderate to high level of correlation between all pre- and post-test measures indicates that the observed change score may not be reflective of a true change in performance. As only one difference score was usable (i.e., SSIS Self-Report), a regression analysis examining the predictive ability of EF changes on SSIS improvement was not conducted.

CHAPTER 5: DISCUSSION

This study examined EF and social skills in the context of four research questions. The first question asked if completion of PEERS would improve social skills. In answer to this question it was hypothesized that participants would have greater self- and parent-reported social skills post-intervention. Analysis of SSIS scores revealed a significant improvement in social skills from pre- to post-intervention for both groups (i.e., parent and self-report forms). This finding was expected as it aligns with previous research indicating social skills improvement following completion of PEERS (Laugeson et al., 2014). Additionally, parent-reported social functioning was found to be significantly lower than self-reported social functioning at each time-point measured. This finding was not unexpected and has been reproduced in previous studies (Lerner, Calhoun, Mikami, & De Los Reyes, 2012; McMahon & Solomon, 2015). However, in both cases noted effect sizes were small and call into question the clinical significance (i.e., real world utility) of such findings. Regardless of these findings, no significant interaction was found for group membership, indicating that the actual change/degree of improvement from T2 to T3 was similar for both adolescents and parents despite starting and ending at different levels.

The second question asked if completion of PEERS would improve EF. It was hypothesized that participants would demonstrate improved ratings on self- and parent-reported constructs of EF. In order to assess this, the CEFI's overall full-scale EF score was used to represent unitary EF. The hypothesis itself was derived from previous research examining the link between social skills and EF as well as literature positing a common element underlying EF. Analysis of CEFI scores revealed a similar trend to social skills and indicated a significant improvement in EF from T2 to T3 for both groups. Additionally, no significant interaction was

found for group membership, again indicating that the degree of improvement from T2 to T3 was similar for both parents and adolescents. These findings align well with new research findings that demonstrate a link between improved social functioning and improvements in areas of EF through the use of a social competency intervention (Christ et al., 2017). Given that the development of EF has been linked to social functioning at various ages (Blain-Brière et al., 2014; Moriguchi, 2014) and has been hypothesized as being a precursor for the acquisition of certain social skills (Moriguchi, 2014), it's possible that a social intervention will influence associated EF domains. However, as with social skills, the observed effect size for this change was small and may again call into the question the clinical significance of this finding.

The third question asked if a correlation between social skills and EF would be found at T2 and T3. It was hypothesized that participants' CEFI and SSIS scores would be positively correlated at both time-points. This hypothesis was based on well-established literature discussing the interplay between the two constructs (Alduncin et al., 2014; Blain-Briere et al., 2014; Jacobson et al., 2011). As noted earlier, IN allows an individual to inhibit self-gratifying but socially off-putting behavior, WM facilitates communication by allowing messages to be stored, referenced, and responded to, and CF offers the ability to switch between mental states that can help in understanding others' viewpoints. Furthermore, a common EF component likely underlies all of these constructs and allows the interplay of the three to meaningfully contribute to social functioning. Correlation analysis of CEFI and SSIS scores revealed weak positive associations between both T2 and T3 parent-reported SSIS and CEFI scores. While the strength of the correlation was lower than might be expected given the literature supporting the relation between the two variables, the presence of a correlation was expected and aligned with previous findings. However, self-reported CEFI and SSIS scores revealed no significant correlation at

either T2 or T3. This outcome was unexpected but may have resulted from a difference in reporting trends between parents and adolescents regarding their social skills. As noted previously, adolescents with ASD have been found to overestimate their social abilities in relation to their parents/caregivers (Lerner et al., 2012; McMahon & Solomon, 2015). Given that self-reported SSIS scores were significantly higher than parent-report whereas CEFI scores were not, it's possible that adolescents overestimated both their pre- and post-test social skills while providing an accurate (or less inflated) assessment of their EF. This overestimation of one measure but not another would likely reduce the likelihood of finding a significant correlation.

The final research question examined whether improvement in EF would act as a predictor variable for social skill improvement upon completion of PEERS. It was hypothesized that participants showing improvement in EF would also demonstrate increased social skills from pre- to post-test examination. As discussed earlier, it is necessary to calculate the reliability of the change scores being used prior to examining the predictive viability of change scores. When the reliability coefficient is low, the ability to generate meaningful results from the accompanying analysis becomes increasingly reduced. Of the scores calculated, only the self-report version of the SSIS was found to have a reliable change score; consequently, a regression analysis was not run.

Clinical Significance

Prior to discussing the implications of this study, it is important to discuss several factors that strongly limit the studies clinical significance. First, this study utilized a limited sample size (N = 32) which likely impacted its ability to make generalizable and clinically relevant claims above and beyond the participants examined. Additionally, the presence of outliers in the data further reduced the sample size down to 29, further reducing the possibility of generalization.

Second, the effect size of each measure examined was small (in the case of the correlational analysis the strength of the relation was characterized as weak). Although small effect sizes (and weak relations) don't preclude the possibility of clinical significance, they may relate to limited observable differences before and after an intervention (Sullivan & Feinn, 2012). If observable differences are too small, then they may not have practical utility. A decision regarding practical utility needs to be contextualized by considering several factors. For instance, interventions effect sizes may be considered in relation to other interventions attempting to achieve the same outcome. Additionally, it may be important to consider the cost, resource requirement, stress, and time commitment that an intervention requires and weight that against the effect size. For instance, if an intervention is relatively non-intrusive and reliably provides a change the fact that the effect size is small may not be particularly relevant to its implementation. In either case, the implications discussed below should be considered in conjunction with the small effect size reported.

Third, and most importantly, the analysis of this studies results incorporated the use of several outcome measures. This required deliberation regarding the use of statistical procedures to account for the possibility of error introduced by conducting multiple analyses. When conducting studies with multiple hypotheses it is important to consider the possibility of an increase in Type I errors (the chance of finding a significant result when none exists). This can occur because with each subsequent test that is run you provide an additional opportunity for random variances to produce a seemingly "significant" result. In other words, some researchers have (correctly) endorsed the notion that "if you test long enough, you will inevitably find something statistically significant" (Feise, 2002). In order to correct for this there are many statisticians and researchers who promote the use of statistical procedures to correct the alpha

value (i.e., the significance value) and thus restrict the possibility of Type I errors occurring (Chen, Feng, & Yi, 2017; Feise, 2002; Ranganathan, Pramesh, & Buyse, 2016). For instance, one of the most commonly used methods of correcting for the increased possibilities of Type I errors is the Bonferroni correction (Cheng et al., 2017). The Bonferroni correction consists of simply dividing the overall alpha level by the proposed number of comparisons being done (Ranganathan et al., 2016). However, a number of researchers have cited reasoning against the use of the Bonferroni correction specifically as well as alpha correction in general (Armstrong, 2014; Feise, 2002; Perneger, 1998; Ranganathan et al., 2016). Perneger (1998) indicates that use of the Bonferroni correction causes more problems than it solves. He cites that the method itself is over-focused on the general null hypothesis (i.e., that all the null hypotheses being examined are true at the same time) while researchers are generally concerned with the individual hypotheses themselves. Additionally, Perneger (1998) cites the Bonferroni correction as requiring that the interpretation of a finding be dependent on the number of other tests being performed. This is likely to occur in lieu of a reliance on the context and previous literature in which they were found. Finally, Perneger (1998) indicates that although the Bonferroni correction reduces the likelihood of Type I errors, it simultaneously increases the likelihood of Type II errors (i.e., the chance of saying that no significant result exists when one does). This consequently fails to correctly identify meaningful and important differences that can be just as problematic as incorrectly identifying them. Many of the criticisms put forth by Perneger (1998) are not specific to the Bonferroni correction. For instance, researchers have noted that alpha adjustment in general may create significance values that are too stringent (Ranganathan et al., 2016). Other researchers have taken a practical approach by stating that p-values may be better served as a pragmatic guide to the interpretation of results but not as a binary boundary in

reference to real world effects (Buyse et al., 2016). In order to illustrate this point they discussed the use of a chemo-therapy drug (Everolimus) that appears to have real-world utility but when subjected to strict alpha-splitting rules fails to demonstrate statistical significance. Other researchers have suggested that alpha corrections should only be performed within a "family of tests", with a "family" being described as a set of tests examining the same hypothesis (Drachman, 2012). Generally, it seems that researchers are divided on the issue of how to handle the use of multiple outcome measures. Overall guidelines indicate that statistically significant findings should be considered within the context of previous literature and findings on the subject (Feise, 2002). In situations where this is not possible (i.e., novel findings), consumers of research should wait for further corroboration of findings (Feise, 2002). Based on the novelty of the examination (i.e., changes in EF, social skills, and their relation within the PEERS program), the extensive literature discussing the relation between EF and social skills, as well as previous research validating the presence of social skill improvement in PEERS, this study chose to focus on the identification of possibly statistically significant results. The following implications are considered with the understanding that further research is necessary to corroborate statistically and/or clinically significant findings.

Implications

Results of this study suggest several important implications for ASD, ASD interventions, and specifically PEERS. Additionally, the results of this study also reveal potential implications relating to the effect of social interventions on EF, and EF itself. First, this study indicates that PEERS may improve social skills in adolescents with ASD. This finding implies that social skills training, practice, parental involvement, and didactic instruction might be beneficial to adolescents with ASD and without cognitive impairment by alleviating some of the social

difficulties they face. These findings align with previous research conducted on the PEERS program specifically and social skills interventions in general (Gates et al., 2017; Laugeson et al., 2014; Laugeson et al., 2012; Laugeson et al., 2009; Mandelberg et al., 2014; Schohl et al., 2014; Spain & Blainey, 2015; Van Hecke et al., 2015; Wolstencroft et al., 2018; Yoo et al., 2014). This implication is important as a defining characteristic of ASD is impairment in social communication and interaction (APA, 2013). A secondary but related implication is that individuals with ASD and without cognitive impairment appear to exhibit difficulties with social functioning that are caused in part by a lack of knowledge of social expectations (or a lack of knowledge regarding how to enact those social expectations). This implication is reached by acknowledging that teaching social expectations/rules resulted in seeming improvements in social skills, a concept reinforced by earlier research in the PEERS program (Laugeson & Frankel, 2010). Given the improvements observed, future research may wish to explore the potential of incorporating aspects of social skills training into other interventions targeting adolescents with ASD.

Research into the effects of social interventions on EF is a relatively new avenue of study with a small body of literature. Consequently, results from this study are important as they contribute to this literature base by demonstrating gains in EF alongside social skills. Specifically, this study suggests that completion of PEERS may result in improvement of EF, a novel finding not yet reported in previous studies. Additionally, this study demonstrated a correlation between parent-reported social skills and EF, in alignment with previously cited literature discussing the link between social skills and EF (Alduncin et al., 2014; Blain-Briere et al., 2014; Jacobson et al., 2011). In fact, it may be important for both PEERS and social interventions in general to consider additional means of fostering EF alongside treatment to

enhance the likelihood of improving social skills. Furthering this line of thought, results from this study suggest that there may be associated variables which are important to social development. EF appears to be one such possible factor; however, there are likely others that have not yet been considered. Consequently, it will be important for future research to consider identification and examination of these variables and for social interventions to consider the variables that have been identified as integral to their effectiveness. Finally, while previous research into interventions targeting specific areas of cognitive functioning have suggested that improvements are both isolated and short-lasting (Rossignoli-Palomeque, Perez-Hernandez & González-Marqués, 2018), results from this study suggest that targeting social skills may have implications for improvement in broader areas of cognitive functioning (i.e., unitary EF).

Overall the results of this study suggest further support for the link between social skills and EF. Additionally, the results suggest that it may be beneficial to explore the merits of targeting EF when attempting to effect changes in social functioning and/or when teaching social behaviours to adolescents with ASD and without cognitive impairment. However, further research is needed to ascertain the predictive viability of changes in EF and the extent to which targeting EF could enhance gains in social skill acquisition.

Limitations

Despite the important implications of this study there are several limitations that must be considered in tandem with its findings. First, this study utilized a relatively small sample (N = 32) that was composed exclusively of adolescents with ASD and without cognitive impairment. Because of this, generalization of the findings beyond the immediate ASD population worked with should be made with caution. Additionally, a formal control group was not used for comparison. This may affect internal validity by making it difficult to detect improvements as a

result of intervention as opposed to confounding variables such as maturation over time. An initial attempt to control for this limitation was conceptualized by incorporating the collection of baseline data approximately 14 weeks prior to administration of the intervention. It was hoped that this would act as a waitlisted control group and help to illuminate potential changes in the variables being measured in the absence of intervention. However, due to several difficulties outlined later in this section, neither baseline nor follow-up data was used in the analysis.

Second, adolescent participants acted as their own evaluators by means of the self-report questionnaires, resulting in several sub-limitations. These sub-limitations can also be seen as applying to parent-report questionnaires due to the necessity of parental involvement within the program. For example, there is the possibility of a self-reported observer bias (i.e., the tendency to see/feel what a participant or observer expects to see/feel). In other words, adolescent participants may have been more likely to report improvement from the intervention because they had invested time and energy into something that they expected to work. A similar challenge arising from the use of self-report questionnaires was that reporters were not blinded. A lack of blinding in research studies can further contribute to outcomes being influenced by both the placebo effect and observer bias. A third and final sub-limitation stemming from the use of self-report questionnaires was that knowledge of how to act as opposed to actual action was not measured/differentiated. Because a third-party observer did not engage in performance-based measures of real-world social skills, it is difficult to ascertain the extent to which knowledge gained and improvements made translate into actual social functioning in an adolescent's native environment. Furthering this line of thought, even if improvements are made in their immediate family environment (where their parents are present and capable of acting as social coaches), there are no guarantees that these improvements are being maintained outside of the home.

Disentangling these effects is further confounded by the inflated self-report social skills scores often seen in adolescents with ASD and without cognitive impairment (Lerner et al., 2012; McMahon & Solomon, 2015).

Third, neither baseline nor follow-up data was incorporated into the analysis. This was a conscious decision made so as to maximize the sample size and thus increase the study's ability to detect meaningful differences at pre- and post-intervention. Collection of baseline data requires that interested participants are accepted into the intervention and agree to participate in research well in advance of the actual program being run. This can be problematic as it requires a substantial degree of future planning and commitment from participants. If a participant later decides they don't wish to participate in either the program or the research, then their baseline data is no longer useable. Additionally, participants who initially indicate interest in the program but later change their mind about participation are typically replaced much closer to the program's start time. This doesn't leave enough time for collection of baseline data with these participants but does leave time for collection of pre-, post-, and follow-up. Because of these reasons, the number of participants who have completed baseline measurements is significantly less than those who completed pre-test measurements. Had baseline data been collected it would have allowed for the comparison of baseline and pre-test data and in turn would have helped to identify changes occurring as a result of the program as opposed to other extraneous factors. Similar to baseline data collection, the number of participants completing follow-up measures is significantly less than those completing post-test measures. This has been attributed to a high level of attrition following completion of the program. Reasons for this may vary but it seems that interest in completing research wanes as active time within the program fades from memory. Furthermore, the primary benefactor of the intervention is the participants, but the primary

benefactor of research participation is the researchers. Therefore, research participants may feel less committed to continuing the research after they achieved their primary purpose. Because of these difficulties with participant inclusion and retention at baseline and follow-up, it was not possible to have both a large sample size and baseline/follow-up data. For the purposes of accurately detecting significant changes in a relatively new study, the decision was made to utilize a larger sample size. However, it will be important for future research to try and expand the number of participants completing both baseline and follow-up data points.

Fourth, ASD was not independently confirmed in participants. The current study attempted to confirm ASD through use of the ADOS but was unable to secure a trained professional for one of the intervention cohorts. This results in several participants not receiving ADOS scores. Given the already limited sample size ADOS confirmation was forgone as an inclusionary method. However, future research should strive to independently confirm diagnoses when possible.

Finally, comorbidity was neither assessed for nor used as an inclusionary/rule-out measure for participants joining the research. This means that a number of confounding disorders influencing an adolescent's social skills may have been present in the research population. However, because individuals with ASD are prone to such comorbidities it is hoped that the aggregate results of this study remain generalizable to other adolescents with ASD and without cognitive impairments. Furthermore, because of the high frequency of comorbidities associated with ASD (Fuld, 2018) as well as the confidential nature of these diagnoses, it would not have been feasible to exclude participants with any co-occurring diagnoses.

Future Directions

Considering both the implications and limitations of this study, several areas for future research are discussed. First, future studies examining EF and PEERS should expand the sample size and utilize randomized assignment into control and experimental groups. Second, the inclusion of a wider array of measurement tools and reporting methods may help to disentangle observer bias from actual improvement. Third, collecting a list of co-occurring conditions for each participant and then analyzing data based on these may prove time-consuming but beneficial if attempting to account for differences in individual response to treatment. Fourth, pending alterations to the reliability of the difference score, it may be useful to look at whether baseline levels of EF (as opposed to changes in EF) predict changes in adolescent's social skills. Fifth, it may be prudent to explore whether participation in an intervention targeting EF would yield similar improvements in social skills. If so, it may be useful to examine whether these effects could be additive in nature. Sixth, consideration should be given to the identification and examination of extraneous variables that are important to social skills. This could also involve reconceptualizing current social interventions and ensuring that these variables are being targeted to maximize the effectiveness of the intervention. Finally, future research may examine individual areas of EF (e.g., IN, WM, or CF) and their relation to social improvement in PEERS.

Conclusions

ASD effects approximately 1 in every 66 Canadian children (Government of Canada, 2018). Prevalence has been increasing at a dramatic rate with studies showing that rates of ASD have more than doubled in the past 16 years (CDC, 2018). Approximately 69% of individuals diagnosed with ASD do not have accompanying intellectual disability (CDC, 2018). For these individuals, developing and maintaining relationships throughout the lifespan represents an area

of interest and difficulty (Ozonoff, Dawson & McPartland, 2002). Given increasing rates of individuals with ASD without cognitive impairment there is a heightened need for interventions that target the characteristic social impairments experienced by this population.

Successful social skill development and use is inextricably linked to certain EF abilities. For instance, inhibiting socially off-putting but self-gratifying behaviours relies on an individual's successful development and ability to invoke IN (Alduncin et al., 2014; Blain-Briere et al., 2014; Jacobson et al., 2011). Previous studies have demonstrated that social interventions may be an effective method of addressing social impairments in individuals with ASD (Gates et al., 2017; Spain & Blainey, 2015; Wolstencroft et al., 2018). Furthermore, relatively new studies have begun to examine the possibilities of improving EF through social competency interventions (Christ et al., 2017). Consequently, the link between social skills and EF is important to examine within the context of an evidence-based social intervention.

Aligning with previous research findings, this study demonstrated that participation in PEERS does result in an improvement in social skills in individuals with ASD and without cognitive impairment. Additionally, this study demonstrated that completion of PEERS also resulted in secondary gains in EF. This indicates that as a result of participation in PEERS EF may be indirectly targeted and improved. Taken together, this further indicates that EF and social skills represent related constructs and that one may depend on the other. Furthermore, these findings imply that interventions looking to increase an individual's social competency may benefit from also targeting constructs of EF as the two seem to increase together. Nevertheless, several limitations need to be addressed before the results of this study can be considered generalizable, including an expansion of measurement tools outside of self-report questionnaires.

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