# The Social and Attentional Benefits of Structured Exercise For Students with Neurodevelopmental Conditions

Kian A. Habib

Department of Educational and Counselling Psychology

McGill University, Montreal, QC

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**Abstract**

Most students with neurodevelopmental conditions (NDC) have an impaired ability to communicate, attend to tasks, and appropriately control their body movements (Richler et al., 2010). Repetitive and off task behaviors significantly affect functioning for students with NDC and impede development by interfering with academic activities and limiting social opportunities. Increasing physical activity (PA) in the classroom has recently been explored as a novel teaching method which may address these challenges (Lord, 2010). PA's such as jogging in place, weight-training, and bike riding have been found to increase social skills as well as improve self-regulation for students with NDC (Lang, 2010; Nicholson, 2011; Todd et al., 2010). Research findings incorporating PA have consistently found strong evidence supporting the positive developmental benefits of exercise for students with NDC. However, these studies have provided little insight into theories about why PA has benefits for students with NDC. For example, while studies by Todd et al. (2010) and Nicholson (2011) both found that exercise increased self-regulation, they lacked a cohesive theoretical framework for this social skill development. This doctoral dissertation seeks to apply social learning theory (SLT) to examine the possible social and cognitive benefits from exercise for students with and without NDC. Social learning theory emphasizes the role of observational learning and modeling for the development of behavior (Bandura, 1977). Examining how exercise may influence behavior, motivation, and attention will help expand research beyond physiological findings. This dissertation consists of two manuscripts, one critical review paper and one empirical study, which are both orignial contributions to the field. The manuscripts examine the impact of physical activity (PA) and structured exercise (SE) on social skills and attention for students with neurodevelopmental conditions (NDC). Chapter 3 of this dissertation, manuscript 1, is a published critical review of findings related to PA which describes the often-overlooked social

impact on behavior for students with autism spectrum disorders (ASD), as well as typically functioning students. Chapter 5 will describe empirical manuscript 2, an intervention which examined the impact of a brief 5-minute classroom SE intervention before academic work for students with NDC. 40 students with NDC, aged 14-17 participated in this intervention study. Four classrooms participated in a 5-minute SE routine and four classrooms were control groups. Pre-vs post-test attentional levels were measured with the d2 Test of Attention, and socialization changes by the Physical Activity Leisure Motivation scale (PALMS). Results indicated a significant decrease in for the total number score for d2 attention testing [$t(38) = 2.11$, $p = .044$] as well as a decrease of omissions for d2 testing [$t(38) = -2.30$, $p = .031$] for the intervention group directly following SE. Social results indicated significantly higher levels of the PALMS subscales Affiliation [$t(38) = 2.17$, $p = .036$] and Other's Expectations [$t(38) = 2.35$, $p = .024$] for the intervention group when compared to the control group. These findings should encourage further testing of the immediate effects of in classroom SE which may lead to higher levels of attention. Also, the potential positive impact on social skill development indicates the importance of incorporating SE within classrooms of students with NDC.

*Keywords:* autism spectrum disorders (ASD), physical activity (PA), structured exercise (SE), social development (SD), neurodevelopmental conditions (NDC)

**Résumé**

La plupart des élèves atteints de troubles neurodéveloppementaux (NDC) ont une capacité réduite à communiquer, à accomplir des tâches et à contrôler de manière appropriée leurs mouvements corporels (Richler et al., 2010). Les comportements répétitifs et hors tâche affectent considérablement le fonctionnement des élèves atteints de NDC et entravent le développement en interférant avec les activités académiques et en limitant les opportunités sociales. L'augmentation de l'activité physique (AP) en classe a récemment été explorée comme une nouvelle méthode d'enseignement qui pourrait relever ces défis (Lord, 2010). Il a été démontré que les AP tels que le jogging sur place, la musculation et le vélo augmentent les compétences sociales et améliorent l'autorégulation des élèves atteints de NDC (Lang, 2010 ; Nicholson, 2011 ; Todd et al., 2010). Les résultats de la recherche incorporant l'AP ont toujours trouvé des preuves solides soutenant les avantages positifs de l'exercice pour le développement des élèves atteints de NDC. Cependant, ces études ont fourni peu d'informations sur les théories sur les raisons pour lesquelles l'AP présente des avantages pour les étudiants atteints de NDC. Par exemple, alors que les études de Todd et al. (2010) et Nicholson (2011) ont tous deux constaté que l'exercice augmentait l'autorégulation, il leur manquait un cadre théorique cohérent pour ce développement des compétences sociales. Cette thèse de doctorat vise à appliquer la théorie de l'apprentissage social (SLT) pour examiner les avantages sociaux et cognitifs possibles de l'exercice pour les étudiants avec et sans NDC. La théorie de l'apprentissage social met l'accent sur le rôle de l'apprentissage par observation et de la modélisation pour le développement du comportement (Bandura, 1977). Examiner comment l'exercice peut influencer le comportement, la motivation et l'attention aidera à étendre la recherche au-delà des découvertes physiologiques. Cette thèse se compose de deux manuscrits, un article de revue critique et une étude empirique,

qui sont tous deux des contributions originales au domaine. Les manuscrits examinent l'impact de l'activité physique (AP) et de l'exercice structuré (SE) sur les compétences sociales et l'attention des étudiants atteints de troubles neurodéveloppementaux (NDC). Le chapitre 3 de cette thèse, manuscrit 1, est une revue critique publiée des résultats liés à l'AP qui décrit les problèmes sociaux souvent négligés impact sur le comportement des élèves atteints de troubles du spectre autistique (TSA), ainsi que des élèves au fonctionnement normal. Le chapitre 5 décrira le manuscrit empirique 2, une intervention qui a examiné l'impact d'une brève intervention d'ES en classe de 5 minutes avant le travail académique pour les étudiants atteints de NDC. 40 étudiants atteints de NDC, âgés de 14 à 17 ans ont participé à cette étude d'intervention. Quatre salles de classe ont participé à une routine SE de 5 minutes et quatre salles de classe étaient des groupes témoins. Les niveaux d'attention avant et après le test ont été mesurés avec le test d2 d'attention et les changements de socialisation par l'échelle de motivation pour les loisirs et l'activité physique (PALMS). Les résultats ont indiqué une diminution significative du score numérique total pour les tests d'attention d2 [t(38) = 2,11, p = 0,044] ainsi qu'une diminution des omissions pour les tests d2 [t(38) = -2,30, p = . 031] pour le groupe d'intervention suivant directement SE. Les résultats sociaux ont indiqué des niveaux significativement plus élevés des sous-échelles PALMS Affiliation [t (38) = 2,17, p = 0,036] et Attentes des autres [t (38) = 2,35, p = 0,024] pour le groupe d'intervention par rapport au groupe témoin . Ces résultats devraient encourager d'autres tests des effets immédiats de l'ES en classe, ce qui peut conduire à des niveaux d'attention plus élevés. De plus, l'impact positif potentiel sur le développement des compétences sociales indique l'importance d'intégrer l'ES dans les salles de classe des élèves atteints de NDC.

*Mots-clés*: troubles du spectre autistique (TSA), activité physique (AP), exercice structuré (ES), développement social (DS), troubles neurologiques du développement (CND)

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## Preface and Contribution of Authors

Each manuscript presented herein were written and edited by me. I collected all my participant data and analyzed all data presented. My supervisor Dr. Armando Bertone provided editorial support as well as feedback for the first manuscript of this dissertation. Co-author Dr. Tina Montreuil helped with feedback and editorial support as well as help with the design of the first manuscript.

# Chapter 1 : Introduction

## Thesis Overview

This dissertation consists of two manuscripts, one critical review paper and one empirical study, which are both orignial contributions to the field. The manuscripts examine the impact of physical activity (PA) and structured exercise (SE) on social skills and attention for students with neurodevelopmental conditions (NDC). Chapter 3 of this dissertation, manuscript 1, is a published critical review of findings related to PA which describes the often-overlooked social impact on behavior for students with autism spectrum disorders (ASD), as well as typically functioning students. Chapter 5 will describe empirical manuscript 2, an intervention which examined the impact of a brief 5-minute classroom SE intervention before academic work for students with NDC ($n$ =20) compared with a control group ($n$ = 20), which may increase attention for students with NDC.

The results from the proposed doctoral project would be of great interest to both scientific and non-scientific communities. The critical review paper has been published in the Review Journal of Autism and Developmental Disorders (Habib, K., Montreuil, T. & Bertone, A. Rev J Autism Dev Disord (2018) 5: 285. https://doi.org/10.1007/s40489-018-0139-3). The manuscript based on the results of Study 1, which comprises Chapter 5, will be submitted to the American Journal on Intellectual and Developmental Disabilities. Educators, parents, and researchers for the NDC and ASD populations will also have great interest in this topic. Findings could lead to changes in teaching methods and curriculum and the use of fitness trackers in classrooms.

Chapter 6 is a discussion of the results from both studies and how these findings are related to social and cognitive development. Findings will contribute toward a deeper understanding of how SE benefits extend beyond physiological and physical health

improvements. This dissertation will also help increase awareness for clinicians, teachers, and researchers regarding the impact of SE for enhancing development for students with NDC.

## Chapter 2. Literature Review and Objectives

Most students with neurodevelopmental conditions (NDC) have an impaired ability to communicate, attend to tasks, and appropriately control their body movements (Richler et al., 2010). Repetitive and off task behaviors significantly affect functioning for students with NDC and impede development by interfering with academic activities and limiting social opportunities.

Increasing physical activity (PA) in the classroom has recently been explored as a novel teaching method which may address these challenges (Lord, 2010). Physical activity is defined as movement which takes place requiring energy from a human being (Pan et al., 2011). These movements take place naturally for humans each day and can levels vary based on individual characteristics, environmental influences, and opportunity. Different levels of physical activity have been found to influence both mental health as well as physical health outcomes (Lang, 2010; Nicholson, 2011; Todd et al., 2010).

PA's such as jogging in place, weight-training, and bike riding have been found to increase social skills as well as improve self-regulation for students with NDC (Lang, 2010; Nicholson, 2011; Todd et al., 2010). Nicholson (2011) found jogging for short periods of time yielded positive gains in attention, as well as behavior, for students with NDC.

Research findings incorporating PA have consistently found strong evidence supporting the positive developmental benefits of exercise for students with NDC. However, these studies have provided little insight into theories about why PA has benefits for students with NDC. For example, while studies by Todd et al. (2010) and Nicholson (2011) both found that exercise increased self-regulation, they often have small sample sizes to measure social skill development and are limited in their measures for cognitive developments such as attention.

This proposed doctoral research project seeks to apply social learning theory (SLT) to structured exercise (SE) examine the possible social and cognitive benefits from acute exercise in the classroom for students.).

SE is defined as a specific form of PA which involves structure, guidelines, and a basic set of rules during participation. Participants are allocated into teams, groups, and exercise together concurrently. Students with NDC have also been found to benefit from the additional social opportunities which SE participation provides (Abadie & Brown, 2010; Lopez et al., 2017; Zach et al., 2012). Examining how short increases in daily SE may influence behavior, motivation, and attention will help expand research beyond its predominantly physiological findings.

While SLT has been utilized for teaching in classroom settings, there has been little application and study about use during SE interventions for students with NDC. SLT emphasizes the role of observational learning and modeling for the development of behavior (Bandura, 1977). Examining components of SLT theory offers insight into why increased SE promotes social and self-regulation skills for students with NDC. For example, in SLT, conditioning and imitation are major factors which influence development. Social development is viewed as continuous cognitive process and not only limited to early stages of life.

Utilizing SLT has been particularly effective for teaching students with NDC (Bandura, 1977; Lang, 2010; Lord, 2010; Rutherford & Rogers, 2003) who have been found to benefit from one-on-one social interaction as well as group interaction (Lord, 2010). Modeling of appropriate behavior and inclusion in classrooms with typically functioning peers has also helped students with NDC develop social skills (Bandura, 1977; Lang, 2010).

Concepts in social learning theory may provide novel insight about the impact of SE on social and self-regulation skills. Modeling, imitation, prompting, and social interaction are prevalent in SE studies yet are not often closely examined. Therefore, applying SLT to examine how SE benefits students with NDC will provide a unique lens to understand current research findings, the factors involved and the implications for future research in the field, which will serve to increase our understanding regarding under what conditions SE has the greatest benefits. This dissertation will make significant contribution to the fields of both education and psychology.

Most SE findings have focused on positive results from exercising without exploring underlying theories which are vital to understanding why there are effects on student behavior. For example, Mahar et al. (2003) observed an increase of on task behavior for elementary students directly following a daily exercise routine. However, these findings focused solely on the duration, intensity, and type of SE activity without examining underlying social and environmental influences. Although these findings supported the use of SE to increase skills for students with NDC, they are limited by a singular focus on the form, length, and intensity level of SE. Findings are therefore weakened because they simply support the use of exercise itself, without a thorough analysis of students' social and academic abilities.

Methods used to incorporate SE in intervention studies often involve aspects of SLT including prompting, modeling, and interacting, all of which affect results from current and past research findings. Peer interaction and motivation for students must be more closely examined to truly understand the social impact of SE. This proposed doctoral project seeks to analyze how an acute increase of SE may influence student social learning and attention.

This dissertation provides background information on the use of SE as a catalyst for student social and attentional benefits and critically review current related literature. The specific social and behavioral benefits for students with NDC are discussed and analyzed. Data was collected directly from classrooms of students who attend a school for special needs in Montreal. The empirical study implemented a short SE routine that measured student attention following participation. Students also answered a questionnaire regarding their primary motivations for exercise. Findings were examined by applying social learning theory and increase our understanding of how participation in SE may influence social skill development as well as increase attention in the classroom. In conclusion, the results of the impact of SE on social skills and attention will be presented. Aims of the following critical review are to examine how current literature often has a focus on physiological effects of SE, while there are likely many social and cognitive benefits for students with ASD, a common NDC for students with special needs.

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# CHAPTER 3

## Manuscript 1

This chapter is an exact reproduction of the following article, published in the Review Journal of Autism and Developmental Disorders, 5(3), 285-293. doi.org/10.1016/j.intell.2018.06.001

## Social Learning Through Structured Exercise for Students with Autism Spectrum Disorders

Kian Habib[1,2] Tina Montreuil[1,3], Armando Bertone[1,2]

(1) Department of Educational and Counselling Psychology, McGill University
(2) Perceptual Neuroscience Lab (PNLab) for Autism and Development, McGill University
(3) Faculty of Medicine, Department of Psychiatry, McGill University, Montreal, Canada

Address correspondence to:

Kian Habib
Department of Educational and Counselling Psychology
McGill University
3700 McTavish Street
Montreal, QC H3A 1Y2, CANADA
Office: (514) 398-3448
Email address: kian.habib@mail.mcgill.ca

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**Abstract**

Increased participation in structured exercise (SE) routines has positive effects on physiological, cognitive, and social development (SD) for students of all ages and abilities. SE offers unique opportunities for social learning in a non-academic context. SE allows students to practice vital social skills such as observation, imitation, and self-regulation. Unfortunately, SD during SE is often overshadowed by more commonly known physiological benefits. Researchers of autism spectrum disorders (ASD) are encouraged by SE findings which offer alternative methods for learning social skills the students struggle to develop. Examining the social impact of increased SE for these students bolsters the value of SE findings beyond physiological effects, illuminating the complex, often overlooked positive relationship between SD and exercise for students with ASD.

Autism spectrum disorders (ASD) significantly affect an individual's development of social interaction and communication skills (American Psychiatric Association, 2013). Individuals may display narrow interests, resistance to change and difficulty following rules. ASD research over the past 20 years has predominantly focused on how to change these restrictive and repetitive behaviors without a clear consensus (Lord, 2010). Social development (SD) has become a priority as such symptoms negatively impact learning, interfering with communication and attention during academic activities (Foti et al., 2014; Lord, 2010). Students with ASD have an impaired ability to attend to tasks and control movement in academic settings. Current research findings support exercise and physical education (PE) programs as socially beneficial for all types of students.

While the physiological benefits of exercise for all individuals have been well established for many years, recently there has been evidence of the potential for significant SD benefits for students with ASD and other neurodevelopmental conditions. Researchers, teachers, and caretakers have observed increased behavior regulation, attention, and communication skills when students with ASD exercise and participate in inclusive PE classes (Richler et al., 2010; Srinivasan et al., 2014). Increased physical activity (PA) levels, especially during a structured exercise (SE) routine, have been found to improve social interaction and increase self-regulation (Foti et al., 2014). Findings have indicated that students with ASD improve their ability to control their off- task behaviors in the classroom directly following participation in SE. (Lang et al., 2010). Additionally, attending inclusive PE classes has been found to enhance SD for students with ASD (Pan et al., 2011). However, the question remains, why do students with ASD gain social and communication skills through participation in SE's when they often struggle to develop these skills in traditional classroom settings? Are exercises and physical movement

alone involved in the stimulation of SD or are there perhaps other influences at play? Participation in both UE (unstructured exercise) like recess and SE such as PE class involve physiological exertion as well as social interaction which make both activities beneficial. Yet students with ASD often have fewer opportunities to participate in SE when compared to typically developing students, further limiting their SD (Hilton et al., 2008; Pan & Frey, 2006).

Components of social learning are utilized throughout most PA studies yet their potential influence on findings is often inadequately addressed (Hilton et al., 2008; Hsu et al., 2004). For example, studies will examine academic scores following exercises or may focus on how to address the low fitness levels of students. Also, studies rarely use social scales to measure the impact of SE, opting to record physiological data such as heartrates. However, examining the influence of social learning in a context of SE, greatly enhances our understanding of how and why students at vastly different ends of the ASD spectrum improve social skills, providing valuable insight beyond physiological findings.

**Defining Social Learning Components**

Reliance on social learning theory has been particularly effective for teaching students with ASD (Bushwick, 2001; Lang et al., 2010; Lord, 2010; Rutherford & Rogers, 2003). Social learning theory emphasizes the roles of observation, modeling, retention, and motivation for the development of behavior throughout an individual's lifespan (Bandura, 1977; Bushwick 2001; Foti et al., 2014). Each of these four components has been found to have a positive influence on the SD of students with ASD at different ages and ability levels (Foti et al., 2014; Ingersoll, 2008; Pan et al., 2011). Direct observation of human behavior often helps students understand social norms and appropriate behavior. Essential social skills, such as understanding facial

expressions, eye contact and implicit communication are said to be learned through direct observation (Bushwick, 2001; Lord, 2010; Foti et al., 2014).

Modeling of appropriate behavior and inclusion in classrooms with typically functioning (TF) peers helps students with ASD develop social skills (Downey & Rapport, 2012; Pan et al., 2011). Physically imitating actions of other individuals, as opposed to listening or reading instructions, often simplifies communication and minimizes confusion (Hamilton et al., 2007). This can be especially important for students with severe forms of ASD (Gallese et al., 2012). For example, the simple act of throwing a ball would be more easily described by physically performing the action as opposed to describing it using words. Students with severe ASD may be non-verbal, yet modeling offers an alternative form of communication that relies on body language and physical expression.

Retention of social skills is often increased by consistently reinforcing the modeling of appropriate behaviors (Bushwick, 2001; Ingersoll, 2008). Reinforcement involves use of praise and rewards to increase motivation. Motivation to behave appropriately, complete tasks correctly, and participate in classroom activities is vital to prevent the rigid routines and limited interests, characteristic of ASD, which interfere with learning in classrooms (Pan et al., 2011). Motivation can also be affected by levels within the spectrum of ASD (Hilton et al., 2008). For example, students with higher levels of social skills may be motivated by praise and encouragement whereas students who have more difficulty socializing may need more salient rewards such as toys or food (Srinivasan et al, 2014).

These components of social learning theory are often utilized directly and indirectly in SE studies for students with ASD, yet research literature often inadequately addresses these influences. While exercise research findings support increased SE and extended PE classes may

help increase SD for students with ASD, often they are limited by a focus on form, length, and intensity level of activity (Hsu et al., 2004; Pan et al., 2011). This often overshadows the positive impact on SD (observation, modeling, retention, and motivation) during exercise routines (Todd & Reid, 2006; Spitzer & Hollman, 2013).

### *Utilization of Social Learning During Structured Physical Activities*

Many SE studies incorporate components of social learning for students with ASD even if they are not the focus of the study. A review of SE by Lang et al. (2010) is an excellent example of how each of the four components of social learning are often incorporated in a SE context. Lang et al. (2010) found that exercise had an overall positive effect on behavior for students regardless of age or place on the ASD spectrum. Specifically, exercise was found to lower the incidence of aggression and off-task behaviors. SE activities were implemented for 64 individuals with ASD with an average age of 12.5 years (M= 12.5 years, SD =3.27). Lang et al.'s (2010) intervention allowed for many opportunities for positive reinforcement and modeling, vital social learning cues for students with ASD (Bushwick, 2001; Ingersoll, 2008). Participants were verbally given instructions, feedback, and praise throughout the activity.

PA was defined as jogging, weight training and bike riding. Non-verbal communication was also consistently utilized through eye-contact and observation of correct jogging form by the instructor before and during the activity. Exercises were modeled, and physical guidance was used to teach activities. Most participants had limited experiences with any type of SE, so an instructor would jog alongside students to help guide them through implicit and explicit communication. Lang et al. (2010) described the instructors' interactions with students as being necessary to ensure participants exercised for a defined length of time and correctly performed the activity. Therefore, while exercising, participants were concurrently socially interacting with

others by observing appropriate behavior with their instructor prompting and providing praise as well as technical instruction for each student when necessary. Despite a range within the spectrum of ASD for the various participants, exposure to a variety of communication methods likely increased their ability to correctly participate. Immediately following these exercises, participants experienced decreases in aggression and off-task behaviors in the classroom (Lang et al., 2010).

While Lang et al.'s (2010) findings indicate that negative behaviors were decreased immediately following exercises, the long-term effects on behavior were not addressed. While findings were positive, the retention of exercise skills learned may have differed for students with different severities of ASD. For example, lower functioning students may rely more heavily on modeling movements and may lose jogging skills over time if not continuously practiced and reinforced. However, students deemed as high functioning on the ASD spectrum may have an easier time retaining their jogging skills which may decrease social learning opportunities. The use of observation, praise and modeling was likely to decrease if these students already had learned how to jog.

In contrast to Lang et al. (2010), Movahedi et al. (2013) examined that social behavior improvements for students with ASD were retained for a longer period of 30 days following participation in a Kata (karate) program lasting 3 months. A total of 30 students with an ASD diagnosis from ages 5 to 16 years (M= 9.13 years, SD =3.27) participated. Movahedi et al. (2013) employed several strategies to reduce group differences and confounding variables in their study. They were selected from the same educational institution to ensure they had experienced the similar treatment strategies. They were matched into pairs based on severity of autism, chronological age, and gender pre-intervention. These pairs were then randomly assigned

into an exercise (n=15) or control (n=15) group. Participants in an exercise intervention group learned karate techniques by viewing a video before each class. They worked with trainers learning techniques 30 to 90 minutes a day, 4 days per week, for 3 months. Various components of social learning took place throughout these sessions. A karate video was used which allowed students to observe and imitate techniques. Students also practiced skills as a group where they could observe peers and model appropriate movement. Additionally, exercise took place in what is described as a highly motivational climate. Verbal praise, prompting and encouragement were used as often as possible during each exercise session. The use of these social components during the karate activities likely contributed to behavior improvements.

Social dysfunction was measured using the Gilliam Autism Rating Scale- Second Edition (GARS-2). This social interaction subscale has been widely used in both educational settings and research studies. The GARS-2 consists of a 14-item questionnaire for caretakers and teachers that describe specific observable as well as measurable social behaviors. Students are then rated on the frequency of the occurrence of each of the 14 social behaviors under typical circumstances over a 6-hour period. This subscale has excellent psychometric properties and is both valid and reliable (Worley & Matson, 2011). Differences in social dysfunction severity baselines (pre-intervention) were examined by performing an independent t test for the GARS-2 and indicated no significant differences $t(24) = -.31$, $p = .76$.

Findings for the Kata intervention group revealed significant improvement in social interactions post intervention. Dysfunction baseline levels were decreased by 40.32% across participants. Movahedi et al. (2013) findings indicate that social improvements were retained for at least 30 days following the program for the participants in the exercise group, with no change in the control group. These findings indicate the possibility that social gains are not always

ephemeral and may have a positive impact on SD over longer periods of time. Further examination of how long SD skills are sustained for students with ASD may aide in the development of targeted intervention programs which address social deficits while maximizing retention of skills over longer periods of time beyond 30 days.

These findings are promising however, Movahedi et al. (2013) may have overestimated the impact of this specific karate activity. While the form of karate is discussed as an important component which influenced findings, the social components utilized could be incorporated into a wide variety of SE types such as team sports like basketball and soccer. Videos providing observation opportunities and practicing with a teacher led group of peers also occurs in many other sports contexts to help improve skill through visual observation (Vazou et al., 2005). Increased social interaction would appear more likely a result of implementation of social learning components (integration with peers, teacher modeling) as opposed to the specific type of exercise.

### *Physical Exertion and Fatigue*

The influence of physical exertion and fatigue on behavior is often overstated or at times misunderstood, in SE studies. For instance, Lang et al.'s (2010) findings support the use of increased exercise, yet exertion during exercise was unlikely the sole factor that improved behavior for students. Despite varied types of exercises, components of social learning were consistently present throughout the activities. Participants did not exercise alone; an instructor accompanied them, consistently modeling socially appropriate behavior. If exercises had taken place in an isolated setting with no prompting or social interaction, social behavior changes may have differed significantly. Despite variations in the physical intensity of exercise, all participants displayed improvements in behavior regardless of baseline fitness levels.

This suggests that social interaction, praise, and modeling appropriate behavior during a SE activity may be an effective tool for development of social skills. Positive changes in behavior were unlikely attributed to simply increasing SE intensity levels to make participants too tired to be aggressive or engage in off task behavior. Lang et al. (2010) discussed how it is unlikely that student fatigue from SE's influenced behavior changes because students increased their attentiveness in the classroom and performed better on their academic tasks immediately following their participation. These findings support that tools integrated from social learning theory during SE routines likely influenced behavior changes, not solely the increase of energy expenditure. However, the effects of physical exertion cannot be discounted completely. Participants had different functioning and fitness levels. Often students with severe ASD struggle with inappropriate movement and have numerous sensory problems which may have been alleviated through exertion during SE (Morrison et al., 2011). Behaviors may have improved for these students on the surface, but it would be beneficial to examine if there are different social outcomes related to the different levels on the spectrum of ASD.

A study by Petrus et al. (2008) provides an example of how increased exertion in SE's may lead to increased self-regulation of stereotypic behaviors for students on the low end of the spectrum of ASD. The effect of increased SE exertion on decreasing harmful stereotypic behaviors during school was examined for students ages 4 through 15 years. This systemic review of previous research of SE concluded more rigorous levels of exercise correlated with short term reductions of stereotypic behavior. Like Lang et al.'s (2011) research, regardless of variances in intensity levels and type of exercises, stereotypic behavior (abnormal, repetitive movement) was decreased immediately following SE (Petrus et al., 2008).

However, Petrus et al. (2008) found that although reductions in behaviors were greater following increased levels of SE, reductions in movement were likely a result of exhaustion or fatigue rather than skill development. Exercise interventions in this review included intense aerobic exercise and jogging for intervals lasting 20 minutes. The exercise interventions focused solely on the reduction of stereotypic behavior through energy expenditure. Opportunity for social learning was reduced as exercises were performed solo and often at a vigorous pace. Interaction or inclusion with TF students was non-existent.

These findings exemplify that only increasing exertion during SE is not an effective way to maximize benefits for students academically or socially. Additionally, while decreasing stereotypic behavior for students with ASD is a concern, it has become less of a priority compared to developing social and communication skills (Richler et al., 2010). Findings by Nicholson et al. (2011) suggested that intensity level of SE's was far less important than routine, modeling, and consistent incorporation within classrooms. It was concluded that concise low-intensity SE's were found to be easier to incorporate into daily school activities and allow students of all fitness levels to participate, providing much needed opportunities to bolster SD through practice and observation (Mahar et al., 2006; Nicholson et al., 2011; Pan et al., 2011).

***Fitness Level***

Students with ASD often have lower levels of fitness and fewer opportunities to participate in SE's, such as PE classes and sports teams, than TF peers (Memari et al., 2012; Pan, 2008). These deficits in SE participation may further compound the social and cognitive development issues for students with ASD; a result of the failure to provide the same experiences as TF students. Pan and Frey (2006) examined how these differences in activity may affect behavior.

Pan and Frey (2006) compared activity levels of students with ASD with TF students. Activity levels of thirty students with ASD aged 10-19 years were measured. To ensure precise measurement, students were required to wear an accelerometer (an electronic device which records activity level) for one week. SE levels for students with ASD were found to be lower than standards for TF students. Pan and Frey's (2006) findings indicated that participation in extracurricular activities was also significantly limited for students with ASD. However, the lower levels of exercise were unlikely to be a physiological explanation for behavior problems. Opportunity for social interaction was theorized to be more influential on development than a low fitness level from a lack of exercise (Pan & Frey, 2006).

Furthermore, there is evidence that fitness level and physical ability may contribute to a lack of social interaction, especially for students with ASD who have higher levels of social skills, by preventing them from developing skills and joining teams. This is especially damaging for this population of students because they have increased ability to interact appropriately in inclusive settings with TF peers (Hilton et al., 2008). Participation in all types of social activities outside of school was found to be much lower for students with ASD compared with TF students. While motor impairments are more common for students with ASD, Hilton et al.'s (2008) findings indicated that social factors may also limit participation.

The influence of these social factors for participation was examined by Frey and Sandt (2005). Participants in the study were 15 students with ASD and 13 TF students ages 5 to 12 years ($M$ = 9.2 years, $SD$ = 1.96). Both groups of students wore an accelerometer (a device that keeps track of PA level) for a total of 5 days for the entire day. While Frey and Sandt (2005) hypothesized that PA levels would differ significantly between the two groups their data did not reveal any differences in activity level between the two groups.

Despite both groups having similar activity levels, the two groups had significant differences in the structure of exercise activities during both SE and UE. Students with ASD were observed having less recess time (UE) than TF students because of their need for extra academic tutoring and behavioral support. PA levels remained similar because of negative repetitive behaviors rather than participation in an appropriate exercise activity. Students in the ASD group had very little social interaction during UE in contrast to TF students who were far more likely to participate in organized group orientated PA. SE differences were found to be even more significant for students with ASD (Frey & Sandt, 2005).

Outside of school, the study found that students with ASD were not on sports teams and often were physically active because of negative behaviors not because of a constructive activity. Additionally, during PE classes students required extra verbal instructions, and physical prompts to complete activities. This reduced the actual time that was spent exercising properly, limiting the opportunity for SD during SE in PE classes. Researchers concluded that similar PA levels do not necessarily indicate equal opportunity for SD. The need for proper supervision, staff support, and additional time was recommended to allow for additional social opportunities for students with ASD which are extremely scarce outside of school.

Findings by Hilton et al. (2008) provide further evidence about how differing levels of support impact SD for students with ASD across the spectrum. Out-of-school activity participation levels between a control group of TF students ($N$ =53) and students with ASD ($N$ = 52) were assessed with the use of the Children's Assessment of Participation and Enjoyment (CAPE) and the Social Responsiveness Scale (SRS). Significant differences were found in PA participation patterns between the two groups of students. Students with ASD had significantly

lower number of activities in which they participated in, less individuals with whom they spend time with, and significant lack of exposure to different types of exercise environments.

Socially, students with ASD were found to be less likely to choose activities in which they have less competence. CAPE testing indicated that enjoyment during exercise was increased in direct relation to ability to correctly perform an activity. In contrast, no significant differences were found between student participation in skill-based activities, such as swimming, horseback riding, and singing. Skill based activities are planned, have specific rules, and have adult supervision (Hilton et al., 2008). When performing activities in which they are competent, students with ASD participated no differently than TF students (Hilton et al., 2008). These findings indicate that social impairment may result from a lack of opportunity for participation in SE.

***Limited Social Development Opportunities***

Students with ASD already have deficits in social skills which would likely be exacerbated by isolation from physical activities with TF peers (Hilton et al., 2008; Pan & Frey, 2006; Pan et al., 2011). Often low fitness levels and poorly developed motor skills also limit the amount of activities in which students with ASD can participate. Students are often placed in separate classrooms where their classmates struggle with similar social and behavioral problems. In contrast, TF students have a vast array of activities available for socializing, observing appropriate behavior, and developing communication skills in non-academic settings. Sports teams for example follow rules, communicate during the activity, and practice as a group. Communication may involve praise for correctly performing an activity as well as reinforcement of skills through consistent practice. Behavior problems for students with ASD, therefore, cannot

only be attributed to a lack of activity, but fewer opportunities for the social interactions which take place in SE context (Hsu et al., 2004; Todd & Reid, 2006).

Findings support that children who are exposed to more social interaction are more likely to improve and develop social skills (Nieman, 2002). Nieman (2002) found that when five to six-year-old school aged children participated in aerobic exercise activity for 5-8 minutes daily they reduced their self-stimulatory behavior immediately following the activity. Opportunities to interact socially through SE are far greater for TF children from the beginning of their schooling. In contrast, students with ASD are far less likely to be on sports teams and participate in exercise activities with peers (Sandt & Frey, 2005; Smith, 2003; Srinivasan et al., 2014).

Hillman et al. (2013) findings also support how SD may be improved in a SE context through participation. The effect of exercise on attention and social behavior was assessed following a moderate 20-minute jogging routine for twenty TF children ($N = 20$) with an average age of 9.5 years. The study had half the participants rest and half jog on different days and would then test both groups using the Wide Range Achievement Test (a validated cognition test). Findings indicated that cognitive test scores were higher for participants following the 20-minute aerobic exercise than scores following a 20-minute resting session. (Hillman et al., 2013). These findings suggest that SE may positively impact SD immediately following PA.

Srinivasan et al. (2014) findings also have indicated social-cognitive benefits of inclusive participation for students during exercise. Deficits in social skills for students with ASD would likely be further exacerbated by isolation from physical activities with TF peers (Pan et al., 2011; Todd & Reid, 2006). SD problems, therefore, may possibly be attributed to limited opportunities for participation, rather than the physiological effect of SE. This is important because lack of exercise programs for students with ASD limits opportunities to observe appropriate behavior

and practice communication skills. These findings are similar to Lang et al. (2010) which indicated that physical exertion itself was unlikely to influence social behavior for students with ASD. For example, students with ASD were found to be typically placed in special education programs separate from other students.

Parents and teachers reported there were few, if any, inclusive or even segregated SE programs for students with ASD (Srinivasan et al., 2014). This severely limits opportunities for social interaction and observation of appropriate behavior of TF peers. Srinivasan et al. (2014) also found students with ASD attended schools significantly farther from their residences than peers without special needs and typically have unique transportation requirements (often traveling to school in a separate bus) which may interfere with joining sports teams and other social activities after school. Sedentary time was also found to be greater for students with ASD and again was exacerbated by longer commutes to school. To address these deficits, Srinivasan et al. (2014) suggested efforts be made by teachers and administrators to discover ways to increase appropriate in-school and leisure time SE. Increased participation in these activities would provide students with ASD more opportunities to develop socially through observation, imitation, and reinforcement.

A study by Pan (2008) also provides evidence that social skills may develop in part from participation in SE. The fitness levels of students with and without ASD from 14 elementary schools were compared during inclusive PE classes and recess. This study compared the percent children with and without ASD spent in moderate-to-vigorous PA (MVPA) during inclusive recess settings. Forty-eight children, matched by age and gender (ASD, 23 boys and 1 girl; Non-ASD, 23 boys and 1 girl) aged 7-12 years from 14 schools had their PA during recess recorded using an accelerometer device for 5 days during school time. Findings indicated that children

with ASD were less active overall throughout the day, during recess, PE classes, and academic classes when compared to the control group without any disabilities ($p < .01$).

Students with ASD performed SE's at the same intensity level during PE classes as students without ASD. These students were therefore participating in exercise activities no differently than TF students. The SE context offered social learning opportunities such as observation of appropriate behavior and imitation. However, during recess times with less structure, students with ASD were found to have significantly lower levels of participation in all forms of PA (Pan, 2008). These low levels of participation during UE further supports the importance of incorporating SE's for students with ASD to provide the same opportunities for social growth during SE as TF students. The unstructured nature of recess may not provide the same social stimulation for students with ASD as when students participate with instructors guiding, modeling, and encouraging.

***Structured Vs Unstructured Exercise***

Students with ASD have limited opportunities for both SE as well as UE. Each exercise context often has different implications for social learning for students. Mastrangelo (2008) examined the potential for developing social and cognitive skills through UE which is described as "play". The standard structured, behavioral based unstructured activities were theorized to be too goal-oriented, adult controlled and involuntary to be truly beneficial (Mastrangelo, 2008). This contrasts with findings which support the use of structure, guidance, modeling of appropriate behavior and social interaction to improve development for students with ASD (Richler et al., 2010). Having a student with ASD voluntarily play in an appropriate manner appears quite challenging. While Mastrangelo (2008) is in favor of increasing unstructured activities, this might be especially challenging for individuals with ASD.

UE is theorized as a method to address social and cognitive issues for students with ASD, yet there is a lack of empirical data to definitively determine if it is more effective than SE. This makes it difficult to determine the significance of its influence on SD, and identify which methods are most effective to increase low levels of UE for students with different severities of ASD.

These possible deficits in UE for pre-school age students with ASD were examined by Rutherford and Rogers (2003). Participants included 28 children with ASD and a control group of 27 children without ASD. Frequency and length of play with novel objects was measured during a structured interview for 30 to 45 minutes. An interviewer would present a student with a set of toys on a table. The interviewer then instructed the students to play with the toys. If the child did not play spontaneously, a prompt was given. This prompt was in the form of either modeling the play behavior or giving instructions. When data from children with ASD was compared to the control group, significant deficits in attention, imitation, and communication were revealed. Even when prompted, they often did not play appropriately or play at all. They also had less eye contact and were less likely to model appropriate play compared with the control group.

Findings by Rutherford and Rogers (2003) provide evidence that social learning skills are not properly developed in very young children regardless of the level of ASD. These findings suggested that an increase in physical play at a young age may address deficits in expressive and receptive communication which involves important aspects of social learning such as imitation, observation, and emotion (Bushwick, 2001). Rutherford and Roger's (2003) findings also address developmental concerns by utilizing components of social learning during activity, unlike the more UE's described by Mastrangelo (2008). However, findings may have been

strengthened if more frequent observations of the participants had been conducted. Data measured indicated deficits in play but was collected from only two observations with each participant. While the data samples were small they indicated that incorporation of social learning through structured physical play may provide SD benefits for children with ASD.

SE programs have often been found to decrease negative social behaviors for students with ASD (Pan et al., 2011; Srinivasan et al., 2014; Todd & Reid, 2006). Pan et al. (2011) examined increased self-regulation for students with ASD who were included in PE classes with TF students. Researchers believed that the inclusion would allow the opportunity for students with ASD observe and mirror appropriate in class behavior. The study concluded that students significantly increased their attendance to task, motivation, and appropriate participation in PE classes.

PE class settings provide many opportunities for peer to peer interaction, instruction, praise, and modeling. However, the opportunity for students with ASD to interact and observe TF students would likely be diminished during UE activities such as recess. The social deficits for students with ASD would make it particularly challenging to interact and participate with TF peers during UE. Pan et al. (2011) found a positive effect on regulation of behavior when including students with ASD in PA classes with TF students. Pan et al. (2011) observed increased appropriate behavior during SE in PE classes. Students with ASD increased their ability to concentrate and follow directions through physical participation in activities with TF peers.

Participants in Pan et al.'s (2011) study were 25 students with ASD and 75 TF peers. Level of activity was measured by an accelerometer worn by the students and assessed during one-week of PE classes. Students with ASD participated in these classes concurrently with TF

students and were treated no differently by the instructor. Data was then recorded and used to examine differences in activity levels between the two groups. Findings from this study indicated increased external regulation of behaviors in students with ASD correlated positively with higher levels of active participation. SE during these classes, therefore, increased the ability for students with ASD to regulate their behaviors. Students without ASD did not show any correlation (Pan et al., 2011).

Pan et al. (2011) also concluded that motivation for students with ASD to regulate behavior during physical activities increased through observation and imitation of TF students. The findings related to motivation levels revealed the potential use of SE not only to regulate behavior but to increase social skills. Behavior regulation allowed students with ASD to increase their ability to follow directions and concentrate on their activity. These SE were not academic, yet self-regulation and social skills are consistently a focus for teachers of students with ASD, even in non-academic settings (Lord, 2010).

**Future Directions**

Overall, a range of SE such as basketball, soccer, biking, jogging, and weight-training have been shown to increase positive social behaviors, attendance to task, and communication skills for students with ASD (Todd & Reid, 2006; Srinivasan et al., 2014). The type of exercise, intensity and duration does not appear to affect student behavior as much as opportunities for SD. Examination of the influence of SD during exercise is imperative because of its enormous impact on findings which typically focus on physiological benefits (Srinivasan et al., 2014). Developing communication skills and increasing appropriate classroom behavior are extremely challenging, yet exercise provides an alternative learning tool for students with ASD.

Social benefits also appear to be enhanced when PA programs incorporate social learning theory. Structured physical activities improve behavior for students with ASD through observation, imitation, and inclusion with TF students. Exercise affords students with ASD a unique opportunity to increase vital social skills outside of traditional classroom settings. However, SE programs need to be developed carefully and utilize exercise not simply as a novel classroom activity, but as an effective social learning tool (Todd & Reid, 2006).

Research regarding the impact of all types of exercise on attention and self-regulation is often limited by small sample sizes, limited empirical attention measures and variable types of PA. There is a general lack of literature about how students with ASD gain social and academic benefits from exercise. Studies involving SE for students with ASD are scarce as often this population does not participate together, rather they are often integrated with TF students or work separately with an instructor to exercise. ASD is also a spectrum disorder making it challenging to find a large group with matching IQ levels and social abilities. Students with ASD also often need more guidance and supervision than TF participants because of social, behavioral, and communication difficulties.

However, the possible gains in social and cognitive skills for students with ASD are too valuable to be ignored despite challenges faced by researchers. Further examination of how social learning can be utilized to provide physiological benefits as well as targeted social skill improvements using exercise can lead to more effective PE programs for students with ASD in schools.

In the future, teachers may incorporate physical activities in the classroom to develop social skills and increase self-regulation as part of their curriculum. While utilizing social learning theory has been particularly effective for teaching students with ASD, there has been

limited direct application related to SE to specifically increase SD. However, findings in current exercise literature have consistently found that increased exercise has enormous potential as a positive influence on SD. These findings should encourage researchers in the fields of both education, as well as psychology to continue to identify the most effective methods to utilize exercise to increase positive SD for students with ASD.

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## CHAPTER 4. Bridging Between Manuscript 1 & 2.

The previous critical review, Manuscript 1, focused on general findings which support social and cognitive benefits from SE for students with ASD. A need was indicated for further investigation and increased data collection to gain a greater understanding of how much exercise is needed to make an impact on student behavior. The following, Manuscript 2, is an empirical study which seeks to examine the social and cognitive effects of a brief SE routine for a similar population of students with NDC. The intervention examines the effect of exercise on students with not only (ASD), but also attention deficit hyperactivity disorder (ADHD) and Intellectual Development Disorder (IDD). This allowed for a greater sample size which was able to be tested in the same classrooms at the same time without having to test students individually. The intervention also seeks to address the shortcomings of previous research by examining social effects from exercise in addition to impact on attention.

NDC students have wide ranging difficulties with cognition, social development, and self-regulation (Ma et al., 2014). These disorders cause restrictions on personal autonomy and socialization abilities, with an increasing prevalence of students diagnosed with NDC in recent years (López et al., 2017). Socialization skills, verbal and non-verbal communication, and repetitive, stereotypic self-stimulatory behavior are identified as the three most important areas which interfere with development by negatively affecting students both inside and outside of school (Ahn & Fedewa, 2011; Bahrami et al., 2016).

The following empirical study, Manuscript 2, is an acute exercise intervention which examined social and cognitive impact in the classroom environment rather than in a gym or using specialized equipment. Additionally, our study had a larger sample size of students with NDC than most previous research for exercise interventions for special needs populations. The SE routines incorporated were designed to be simple and to encourage students to be physically

active for several minutes. The intervention provides empirical data which enhances and seeks to address limitations of the findings in Manuscript 1. The following, Manuscript 2, details an empirical study which involved collecting attention data following exercise, as well as examining underlying pre and post social score results from a questionnaire for students with NDC.

**CHAPTER 5 – Manuscript 2**

# The Social and Attentional Effects of Integrating Structured Exercise in Classrooms for Students with Neurodevelopmental Disorders.

Kian Habib[1,2]

(1) Department of Educational and Counselling Psychology, McGill University
(2) Perceptual Neuroscience Lab (PNLab) for Autism and Development, McGill University

Address correspondence to:

Kian Habib
Department of Educational and Counselling Psychology
McGill University
3700 McTavish Street
Montreal, QC H3A 1Y2, CANADA
Office: (514) 398-3448
Email address: kian.habib@mail.mcgill.ca

**Abstract**

Structured exercise (SE) may improve self-regulation and attention to task for students with neurodevelopmental conditions (NDC). Regular exercise has been proven to have physiological and cognitive benefits for all individuals. However, students with NDC have social deficits which may be affected by low exercise levels. These low exercise levels may be addressed by utilizing structured exercise (SE) and incorporating aspects of social learning theory (SLT). 40 students with NDC, aged 14-17 participated in this intervention study. Four classrooms participated in a 5-minute SE routine and four classrooms were control groups. Pre-vs post-test attentional levels were measured with the d2 Test of Attention, and socialization changes by the Physical Activity Leisure Motivation scale (PALMS). Results indicated a significant decrease in for the total number score for d2 attention testing [$t(38) = 2.11$, $p = .044$] as well as a decrease of omissions for d2 testing [$t(38) = -2.30$, $p = .031$] for the intervention group directly following SE. Social results indicated significantly higher levels of the PALMS subscales Affiliation [$t(38) = 2.17$, $p = .036$] and Other's Expectations [$t(38) = 2.35$, $p = .024$] for the intervention group when compared to the control group. These findings should encourage further testing of the immediate effects of in classroom SE which may lead to higher levels of attention. Also, the potential positive impact on social skill development indicates the importance of incorporating SE within classrooms of students with NDC.

*Keywords:* structured exercise (SE), neurodevelopmental conditions (NDC), social learning theory (SLT), physical activity leisure motivation scale (PALMS)

Students with neurodevelopmental conditions (NDC) have an impaired ability to communicate, attend to tasks, and appropriately control their body movements (Richler et al., 2010). Repetitive and off task behaviors significantly affect functioning for students with NDC and impede development by interfering with academic activities and limiting social opportunities. Most students with NDC display sensory and motor impairments very early in their life, which are often not addressed, leading to impairments in social development compared to typically functioning students (Houwen et al., 2014). This identifies the need for exploring interventions which can possibly address these deficits. Increased physical activity (PA) during structured exercise (SE), have been found by researchers as extremely beneficial for both typically functioning and NDC populations (Ardoy et al., 2014; Block, 1996; Butt et al., 2011; DePauw, 1986; Warburton et al., 2006; Weinberg et al., 2011).

PA is defined as movement which takes place requiring energy from a human being (Pan et al., 2011). These movements take place naturally for humans each day and can levels vary based on individual characteristics, environmental influences, and opportunity. Different levels of physical activity have been found to influence both mental health as well as physical health outcomes (Lang, 2010; Nicholson, 2011; Todd et al., 2010). SE differs than PA because it is a specific form of physical activity which involves structure, guidelines and a basic set of rules during participation. Participants are allocated into teams, groups, and exercise together concurrently. When comparing NDC students with typically developing students, PA levels and SE are often far lower due to fewer opportunities and adaptations, which severely limit both participation rates and impair motor skill development (Beets et al., 2006; Erwin et al., 2011).

Increased opportunities for SE would allow for the improvement of vital basic motor skill development. Without proper development of basic motor skills there may be a lasting negative

social impact on students with NDC (MacDonald et al., 2013). For example, higher levels of motor skills for children with NDC have been found to directly correlate with increased communicative skills. Findings have indicated that children with excellent motor skill competence have less chance of social impairment. A study reported that children who had more difficulties with their motor skill activities also presented more deficits in social interaction (López et al., 2017).

Motor skill deficits are present and persist in school-aged children with ASD, identifying a need for increased focus on SE for students at an early age, which may benefit development. A study which examined the gross movement abilities of 25 children with ASD, ages 9–12 using the *Test of Gross Motor Development* (*TGMD-2*) revealed that when compared to typically functioning students, motor skill development was lower. However, more importantly it was found that motor skill was underdeveloped in relation to the cognitive abilities of the students with ASD. These findings suggest that delays in development are increased due to extrinsic factors (Staples & Reid, 2010).

Another study of 35 children between the ages 6-15 also sought to determine if there was a significant impact of motor skill level on social communication. Findings indicated that object-control motor skills significantly predicted ASD severity. Poor motor skills, therefore, correlated with greater social communicative skill deficits (MacDonald et al., 2013). By focusing on improving functional motor skills as soon as students are diagnosed with NDC opportunities for social development are increased. Students who do not fall as far behind their typically functioning peers may be able to participate with less support and have a wider range of activities and programs for which they could participate.

Additionally, a study which examined the use of aquatic therapy also indicated the importance of the relationship between motor skills for social development. A survey taken by eighteen aquatic occupational therapists who had been working with children with NDC evaluated changes which were a result of structured aquatic activities. The majority consensus was that aquatic activities resulted in increased attention, better swimming skills, eye-contact, balance and following water safety instructions. Participants were found to have high social participation rates that correlated with increased motor skill ability (Vonder Hulls et al., 2006). The scarcity of available programs and participation restrictions for students with NDC are likely to be harmful for development because they reduce the opportunities for skill building during SE activities such as sports.

The importance of SE for social growth is also supported by research comparing activity levels among children with NDC and typically developing children study breaks. Findings reported that group activities during study breaks had lower participation rates for children with NDC. It was concluded that when this population of children choose a type of activity, they prefer types of leisure activities which involve as little social interaction as possible (Pan, 2006).

**Social Development**

Social learning theory (SLT) emphasizes the role of observational learning and modeling for the development of behavior (Bandura, 1977). While SLT has been utilized for teaching in classroom settings, there has been little application and study about use during SE interventions for students with NDC. Modeling, imitation, prompting, and social interaction are prevalent during SE and more research is needed to determine the impact on classroom behavior for students with NDC. Development of social skills is often one of the most challenging issues for children with NDC. The ability to socialize and communicate with others can affect academics,

mental health, as well as future career opportunities. Social interaction between children with NDC and other individuals is often avoided as much as possible, inducing anxiety and leading to off task behaviors which interfere with learning (Ma et al., 2014;). Social norms such as eye contact and initiating conversation with other individuals are greatly reduced often preventing relationships with peers. Individuals with NDC are also less likely to identify other individuals as friends or respond to verbal praise compared with typically functioning individuals (Chevallier et al., 2012).

Addressing the deficits in social ability for NDC students as they begin school has become a major goal for special education teachers. The use of SE has increasingly been found to help develop social skills during school. Literature supports guidance and structure during PE as a method to motivate NDC students to participate in inclusive SE activities, increasing opportunities for social interaction (Richard et al., 1997). Students of all ages who participate in SE programs can lead to increased group social participation with peers, leading to vital improvements in motor, socialization, and self-regulation skills (Mahar et al., 2006).

NDC students have also been found to benefit from the additional social opportunities which SE participation provides (Abadie & Brown, 2010; Lopez et al., 2017; Zach et al., 2012). Verbal communication such as asking to pass a ball or expressions of praise for participating in an activity correctly can help foster social growth for NDC students. Students, therefore, are encouraged to participate appropriately and both implicitly by observation of behavior as well as explicitly with direct instruction and modeling by the instructor. Unfortunately, the opportunities for SE are often far less than typically functioning students, compounding the social developmental deficits.

For example, a study by Frey (2006) observed differences in overall PA activity levels of students with ASD. Findings indicated how low activity levels exacerbated symptoms such as off task behavior and low attention levels for students with ASD. PA was measured for thirty students with ASD ages 10-19 with students divided into three groups, high school, middle school, and elementary school. Students were required to wear an accelerometer for one week to accurately measure activity. Students with ASD were found to have significantly lower PA levels when compared with typically functioning students (Frey, 2006).

**Participation**

Efforts should be made by teachers and administrators to discover ways to increase appropriate in-school and leisure time SE for students with NDC. Inclusion of students with NDC in PE with typically functioning students or sports programs increases the opportunity for socially appropriate interactions, observations and verbal communication.

However, access to extracurricular exercise activities has been found to be significantly limited for students with NDC compared with typically functioning peers (Bandini et al., 2013; Frey, 2006). Parents and teachers have reported that there are few, if any, inclusive/segregated SE programs for students with NDC (Frey, 2006). In addition, findings indicated students often attended schools that were farther from their residences than peers without special needs (Frey, 2006; Pan et al., 2011). These findings reveal that students with NDC may be especially vulnerable to the effects of inactivity in direct contrast with typically functioning students. Students with NDC have deficits in social skills and fewer opportunities to interact with typically functioning students limiting important opportunities for behavior observation, modeling, and communication (Hilton et al., 2008; Pan & Frey, 2006; Pan et al., 2011). Studies have also found that as students age, they

often have a greater reduction in SE levels during adolescence which may be linked to lowered self-esteem (Crocker et al., 2000).

Literature supports increased SE participation as a method to increase social abilities, yet there are few specific interventions which are easily implemented efficiently and effectively within classrooms (Lang et al., 2010; Petrus et al., 2008; Zach et al., 2017). It is challenging to create SE programs with sufficient structure and guidance and adaptations for students with NDC which is why they are scarce (Richler et al., 2010). However, the impact of social development through SE should not be overlooked. Students with NDC attending inclusive PE classes have been found to increase their use of appropriate social skills (Allender et al., 2006).

**Self-Regulation**

Findings by researchers in the field have also demonstrated that increased SE may improve self-regulation and attention to task for students with NDC (Abadie & Brown, 2010; Ahn & Fedewa, 2011; Bremer et al., 2016). Simple methods such as using squeeze toys or performing jumping jacks have been used to incorporate SE for short periods in the classroom to increase attention (Todd & Reid, 2006). While regular exercise has been proven to have physiological and cognitive benefits for all individuals, students with NDC have unique social deficits which may be affected opening the possibility for novel discoveries. Previous studies have often focused solely on the duration, intensity, and type of exercise without examining the underlying social and motivational influence of exercise within the context of an NDC population.

Most research examining the relationship between SE and academic achievement for both very young students and adolescent students has increasingly found numerous social benefits (Allender et al., 2006; Bremer et al., 2016). As result of increased self-regulation,

students have generally been found to have improvements in scores for math and reading comprehension following SE interventions. Students have also been found to benefit socially as a member of sports teams and through group participation in a variety of exercises such as running, swimming and weight training. Self-regulation improvements are often a result of opportunities to participate in SE activities which are often scarce for students with NDC (Abadie & Brown, 2010; Ahn & Fedewa, 2011; Petrus et al., 2008).

Pan, (2011) examined the positive effect on regulation of behavior when including students with ASD in SE classes with typically functioning students. The study hypothesized students with ASD gain self-regulation skills through observation of appropriate behavior during PE classes. Participants were nineteen students with ASD and seventy-six typically functioning peers. Students were between the ages of 12-16 from nineteen inclusive PE classes. Levels of SE were measured by an accelerometer, an electronic device which records activity level, worn by the students during one-week of PE classes. Data recorded the correlation of SE levels between the two groups.

Findings indicated increased external regulation of behaviors in students with ASD which correlated positively with higher SE levels. Participation in SE increased the ability for students with ASD to regulate their behaviors. Students without ASD did not show any correlation. The study concluded that motivation for students with ASD to regulate behavior during physical activities increased because of feelings of attachment and modeling appropriate behaviors of typically functioning students. These motivation levels were examined using a questionnaire which was filled out by students with ASD directly following their classes. The findings related to motivation levels revealed the potential use of SE not only to regulate behavior but also to

increase social skills. Behavior regulation allowed students with ASD to increase their ability to follow directions and concentrate on their activity.

In contrast to the pervious study, Lang (2010) measured the regulation of behavior following SE. Exercise activities were implemented for sixty-four individuals with ASD over a range of ages from 3-41 years old, with an average age of 12.5. Results from eighteen case studies were then analyzed. Exercise activities were defined as weight training, jogging and bike riding. Routines were modeled by a teacher who would participate in activities alongside them. This was included to ensure that students were physically active using encouragement as well as explicit and implicit instruction. Each of the researchers in the 18 case studies reported improvements in fitness level, academics, behaviors, as well as a short-term decrease in negative off-task behaviors (Lang, 2010). Directly following exercises, individuals presented with decreases in aggression, off-task behavior, and stereotyping etc. In addition, academic responses, on-task behavior and appropriate motor behavior were significantly improved. Lang (2010) also discussed that it is unlikely that fatigue was a factor because of this increase in academic responses and attentiveness. These findings provide possible insight into how the benefits of SE may transfer to an academic or classroom setting.

While a wide variety of physical activities have been found to increase self-regulation and attention, examining the effect of a specific activity allows for greater control. Simply studying SE level itself ignores the differences in intensity of SE, which may affect self-regulation improvements for students. A systematic review of seven different interventions of short intervals of SE found that students benefited from more vigorous activity such as jogging compared with a low intensity activity, walking (Petrus et al., 2008). For example, a study observed the effects of 6 minutes of jogging with 6 minutes of walking on self-regulatory

behavior outcomes (Celiberti et al., 1997). Jogging was found to improve behavior in the classroom immediately following the activity. Walking, however, did not have a significant effect on behavior.

Another study found that 8-10 minutes of jogging improved self-regulation immediately following activity compared to 10-15 minutes of sedentary classroom activities or watching TV (Watters & Watters, 1980). These studies support that the use of brief SE interventions in classrooms may improve self-regulatory behavior for students. Low self-regulation often interferes with attention and academic work especially for students with NDC. Jogging is a simple activity which does not require additional equipment or complex routines, which can make implementation of SE programs more challenging for students with NDC. Increasing self-regulation skills and reducing stereotypic behaviors may therefore lead to improved attention and academic performance if SE is consistently implemented in classrooms (Allender et al., 2016; Celiberti et al., 1997; Hilton et al., 2008; Pan & Frey, 2006; Watters & Watters, 1980).

**Attention**

Improving self-regulation and attention for students with NDC would increase the ability for teachers to focus on building academic skills, rather than constantly correcting behavior. Teachers who seek to incorporate SE may not have access to inclusive SE programs or equipment. Results from a wide range of exercise interventions have been found to have numerous benefits on behavior for students with NDC. Swimming, dancing, and jogging for example, have each been found to improve social functioning, attention as well as reduce stereotypic behaviors (Bremer et al., 2016).

The challenge of implementing an effective SE program for students often is difficult because of limited time constraints and resources in the classroom. However, the possible gains

in developmental skills and decrease in negative behaviors for students cannot be ignored and educators should be aware of the numerous benefits. Literature in the field supports further investigation of how to increase opportunities for exercise in an efficient and effective manner to maximize student development. This intervention seeks to further examine measurable outcomes related to attention and social development for students within a classroom context.

Research findings support that SE may increase attention and self-regulation for students with NDC. SE such as biking, jogging and weight-training have been shown to decrease negative behaviors and increase attendance to task. There is also solid evidence that increased SE for very brief amounts of time may improve social skills using guidance, modeling and communication. Literature also supports how SE intervention often decrease off task behaviors, as well as increase attention levels for students with NDC. With increased awareness of the importance of SE through quantitative research, teachers may eventually modify teaching methods to help students with ASD increase self-regulation and attention (Frey, 2006).

Literature in the field has also consistently demonstrated that increased SE can improve cognitive behaviors such as attention and memory (Tan et al., 2016). While unstructured PA has also been found to have cognitive and social benefits, for the NDC population, structure and guidance are key factors which have been utilized as effective teaching methods. Students can mirror their instructor's movements and follow visual physical cues for correct participation in SE. In addition, students who participate in SE are exposed to a greater social environment with a group of peers participating in the same activity at the same time.

Studies have also supported increasing the time students are physically active during the school day while decreasing traditional academic learning and increasing SE during the school day did not negatively impact academic progress, development or success. (Allender et al., 2016;

Celiberti et al., 1997; Hilton et al., 2008; Watters & Watters, 1980). However, this does not mean that it is necessary to dedicate large amounts of time to achieve positive cognitive and social developmental results. Short but vigorous exercise has been found to have a positive impact on cognition.

A study of very brief 10-minute bouts of vigorous SE was found to have a significant impact on increasing attention for students with NDC. SE spurs activation of the cerebellum influencing behaviors such as verbal communication, working memory and sustained attention (Budde et al., 2008).

**Aims of Study**

While there are different types of programs studied and backed by the evidence in current literature, the implementation of SE interventions can be quite complex and challenging for students with NDC compared with typically functioning students. Studies typically investigated interventions for young children with far less research on the effects on adolescent students with NDC, identifying a gap in current literature (Sorensen, & Zarrett, 2014).

This study aims to examine both the social and attentional effects of an acute, 5-minute, SE routine daily for a period of one month for adolescent students with NDC within classrooms. The foundation for this study is based on previous findings that support the use of group-based SE as a tool to increase cognitive skills (i.e., attention) for students of all ages with NDCs (Bahrami et al., 2012)

The attention and social motivation levels of students were examined before and after a 5-minute SE routine once a day in the classroom for the intervention group. Results were compared to a control group of students who did not complete an SE routine. Student's attention levels were

measured pre/post and during the intervention, and their social motivations measured through a pre- and post-interview and questionnaire.

With regards to cognitive ability, our expected results were that the intervention group would increase their accuracy and reduce their errors significantly following SE, which was measured at the midpoint of the intervention. Specifically, it is expected that at least one of the main measures of attentional ability, as measured by the D2, will increase in the intervention group only. These findings may be used in the future to support implementing specific SE programs in classrooms that effectively provide social and academic benefits. Demonstrating that brief bouts of SE in the classroom have positive effects on social development, attention and self-regulation may lead to interventions on a far greater scale, such as entire schools or school districts in communities around the world.

***Hypotheses***

1. D2 attention scores following SE at mid-point would have a significant impact on one or more of the 3 main measures of attention for d2 scores compared to the control group.
2. PALMS scores would indicate a significant increase in at least one motivation for exercise score for the intervention group when compared to the control group pre vs. post-test.

## Methods

### Participants

Forty adolescent students (n = 40) diagnosed with NDC participated in the study after informed consent and assent was obtained. Participants were recruited from eight separate classrooms at Summit School in Montreal, which provides specialized services for students diagnosed with NDCs. Classrooms at Summit School typically include students with similar social

and cognitive abilities. All students were verbal and could understand the questions that will be asked during their pre- and post-interviews.

The 40 participants in this study were a rather large group compared with most studies involving smaller classroom-based SE interventions for students with NDCs. Classrooms were randomly assigned to the intervention or control groups.

Four classrooms were selected for the intervention group, comprised of between 3-8 students participating in a 5-minute exercise routine (see below). The other four classrooms of between 4-7 students served as a control group and did not participate in the exercise intervention portion of the study. The control group instead did a sedentary activity, watching an academic video for 5 minutes. Participants in both groups were matched across age and cognitive ability, as defined by the Full-Scale Intelligence Score measured using the (Wechsler Abbreviated Scale of Intelligence (WASI-II) (Wechsler, 2003) (see table 1 below).

The research Ethics Board of McGill University approved the study, with all participating parents and students providing their consent and assent, respectively, before the study was initiated. Students were compensated for their participation with a modest monetary gift.

***Assent and Consent***

A parent consent form (Appendix B) was distributed and collected by teachers while an assent form (Appendix C) was explained to each student by the primary researcher and collected by the primary researcher. After these forms were signed, students in four classrooms served as the intervention exercise group, and four classrooms served as a control group (no exercise program implemented). Each classroom consisted of students with similar IQ scores with an average WASI –II score of approximately 70.

***Recruitment***

Students were recruited by the primary researcher via a presentation about this project in the classroom and a personal meeting with each student. During this meeting the researcher(s) read an assent letter with the student one on one and had them sign an assent form if they agree to participate. A letter of consent was also sent to the parents of each student through Summit. Summit suggested appropriate classrooms for the study, which have previously participated successfully in similar activities within their classrooms.

An information package containing both an invitation letter and consent to participate (Appendix B) was sent to the parents of children in the participating classes during the month of September 2016. Students were also offered $10 dollars as an incentive for their participation in the study. The information letters and consent forms were distributed to the parents of the participating classes after ethics approval.

***Location of Research***

Research for this study was collected while participants were in their usual classroom environment at the Summit school. Summit School is a private school recognized and subsidized in the public interest by the Ministère de l´Éducation du Loisir et du Sport. Language of instruction is offered in English as well as French. Founded in 1963, it is located in the Ville St Laurent borough of Montreal. It currently services over 520 special needs students by creating an individualized and enriching environment. The students range in age from 4 to 21, with intellectual disabilities including behavioral and emotional disturbances, autism, Down syndrome and severe learning disabilities. They are referred by parents, school boards, hospitals, and social services agencies. The student body comes from every socio-economic, religious, and cultural background.

**Procedure**

Four classrooms formed the intervention group, where 3-8 students participated in a 5-minute exercise routine with all students participating. The other four classrooms of 4-7 students served as a control group and did not participate in any exercise intervention portion of the study. The control group instead did a sedentary activity, watching an academic video for 5 minutes. Participants in both groups did not significantly differ in age or cognitive ability, as defined by the Full-Scale Intelligence Score measured using the Wechsler Abbreviated Scale of Intelligence (WASI-II) (Wechsler, 2003) (see table 1 below). The research Ethics Board of McGill University approved the study, with all participating parents and students providing their consent and assent, respectively, before the study was initiated. Students were compensated for their participation with a modest monetary gift.

**Table 1**

*Demographic and Clinical Characteristics of Participating Students*

| Variables | Intervention Group [a b] | | | Control Group [a c] | | | *p* |
|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *R* | *M* | *SD* | *R* | |
| Age | 14.74 | .89 | 12.8-16 | 14.52 | 1.7 | 12-17 | .62 |
| WSI-II | 70.30 | 10.65 | 47-86 | 70.35 | 11.3 | 54-97 | .99 |

[a] n = 20. [b] Intervention group: 16 males, 4 females. [c] Control group: 13 males, 7 females.

***Pre-test Intervention Measures***

Pre-test measures for all participating students were obtained during the first two weeks of spring school semester. All participants completed the items described below, which were obtained either during school hours by the primary researcher/assistants, or after-school hours by collaborating school psychologist and/or participating teachers who consented to participating in the study.

### *D2 Attention Performance*

All participants had their baseline attention levels measured using the D2 test of attention, a pencil and paper task assessment tool which measures different aspects of attention on concentration. The D2 is a simple yet accurate measure of mental concentration as well as selective attention for individuals. Testing requires only 6 minutes for a student to complete yet provides an accurate measure of attentional levels (Bates & Lemay, 2004; Brickenkamp & Zillmer, 1998). The D2 has been used to effectively assess attention levels for individuals with high internal levels of consistency (Brickenkamp & Zillmer, 1998).

Validity and reliability of this attentional measure have consistently been found to correlate with other methods used to examine attention (Bates & Lemay, 2004). Scores from D2 testing examine several layers of attention: including processing speed and commissions and omissions (Brickenkamp & Zillmer, 1998). This allowed each student to have their selective and sustained attention measured using one test.

The test is brief, approximately 6 minutes, and was administered immediately following SE within the classroom for all students at the same time. This also strengthened results by eliminating external influences which may distract students, for example if they needed to use a computer or had to be tested individually outside of their classroom. Also, the test is very straight forward and students with NDC were able to understand and follow directions. These factors all support the use of the D2 as an effective dependent variable for examining the impact of SE on attention.

### *The Physical Activity and Leisure Motivation Scale (PALMS)*

The Physical Activity and Leisure Motivation Scale is a comprehensive self-report which measures motives for individuals participating in SE. This 40-item scale related to participation in

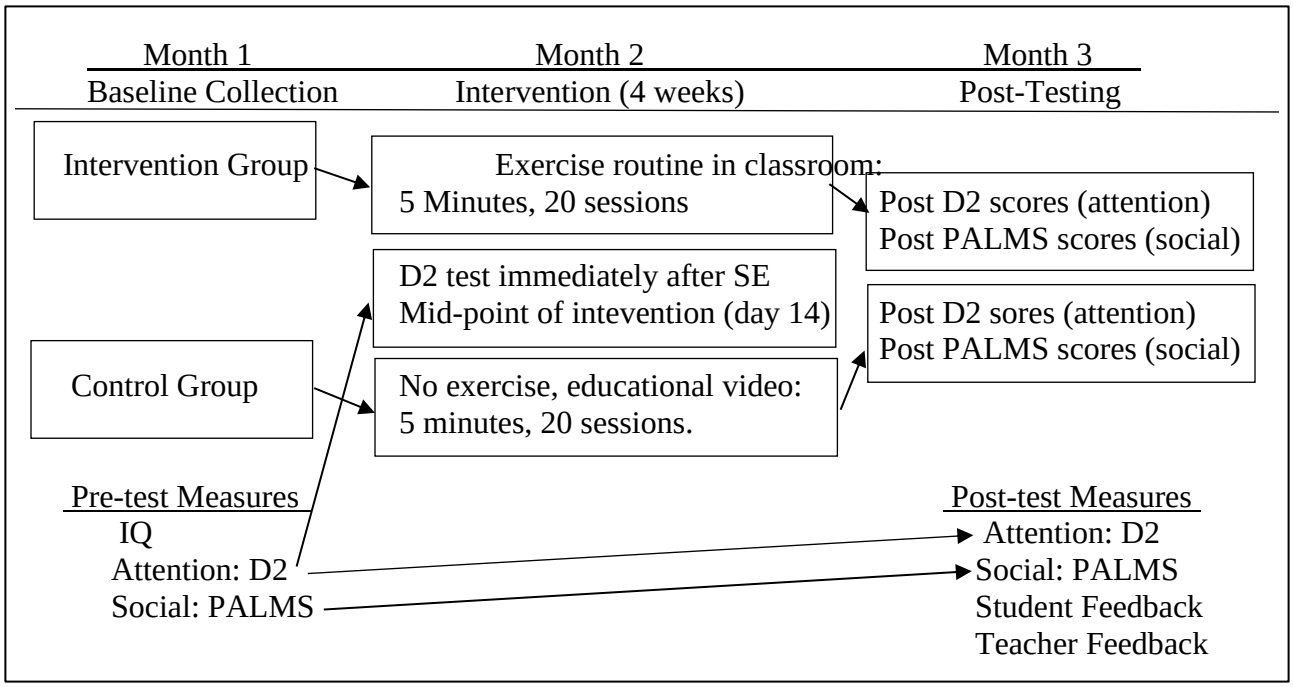
sport and SE is designed for adolescents and adults and has been validated as an effective method to measure motivation related to SE with high internal consistency, validity and reliability **(**Molanorouzi et al., 2014). Five items constitute each of the eight sub-scales, mastery, enjoyment, psychological condition, physical condition, appearance, affiliation, competition/ego, other's expectations, reflecting a variety of social motives for participation in SE.

Correlations between each PALMS sub-scale and the corresponding sub-scale on the validated REMM, another longer more complicated questionnaire from which the PALMS was developed, were high and varied from 0.79 to 0.95. Also, test-retest reliability for the questionnaire sub-scales was between 0.78 and 0.94 over a 4-week period for the PALMS **(**Molanorouzi et al., 2014). The PALMS therefore allowed students with NDC to have their motivations for participation in SE measured effectively with a questionnaire that is simpler to understand yet just as accurate as longer more complex questionnaires.

Features of intrinsic and extrinsic motivation are also measured, and Spearman's rho indicated that the PALMS subscales showed high correlation to corresponding REMM subscales (r, = 0.79 to 0.95) indicating PALMS is an equivalent of the REMM despite being simpler and shorter **(**Molanorouzi et al., 2014). Filling out the PALMS took students around 10-15 minutes. The PALMS was administered to participating students through direct questioning from the principal investigator. Students answered PALMS questions before the first exercise session and then once more after the exercise intervention was completed. The data collected was used as a dependent variable which examined the social impact of exercise and how student feelings towards exercise evolved over the four-week period intervention by comparing pre- and post PALMS scores.

**Figure 1**

*Exercise Intervention Research Measures Timeline*




*Note.* Timeline identifying measures and data collection points for both intervention and control group.

**Structured Exercise Intervention**

Over a period of four weeks, students from the intervention classrooms participated each day in a SE intervention. The SE was designed to last approximately five minutes. Several specific exercises were outlined in a simple guide developed for teachers which provided exercises which can easily be incorporated in a classroom. The specific routine consisted of, while standing, 1-2 minutes of arm circles, 1-2 minutes jumping jacks and 1-2-minute stretching for intervals. The order for these exercises would vary day to day. Students were encouraged to be active by their teachers but were not required to attain a specific intensity level or number of jumping jacks, etc.

The most important goal was simply to have the students be as physically active as best as they can for the duration of the 5 minutes. Teachers modeled the steps of the routine for students

and offered verbal encouragement. There were no exercise or fitness goals that students were asked to attain, so students could participate at their own pace during the routine.

The students who participated in this study have already participated in movement breaks where music was played, and they were encouraged to dance and move. Every student also had the opportunity to choose a song each exercise session that would be played. This served as a motivating tool for both movement as well as a social opportunity for students to share with each other something they personally enjoy. Teachers in the intervention classrooms encouraged student movement through praise and modeling appropriate behavior during the exercise routine by actively participating with their class.

**Table 2**

*Structured Exercise Intervention*

| Procedure | Minutes | Description | Purpose |
|---|---|---|---|
| Music Selection/ Set up | 1 | A different student selects a song they will play during the exercise routine each session. | Motivate students utilizing music. Selecting songs is motivating and rewarding for students socially. |
| Warm up Routine | 1 | Teacher led stretching, arm circles, touching toes. | Preparing mentally and physically for exercise. |
| Movements Guided by Teacher | 5 | Teacher encourages students through verbal praises as well as participation in excercises. | Following instructions, mirroring movements, Implicit communication of movements through exercise. |
| Cooldown / Breathing | 1 | Music ends. Teacher leads a cooldown consisting of light stretching and breathing deeply. | Reducing the energy level physically. Mentally preparing students to cease movement and return to regular classroom activity. |

Control Group: The control classrooms did not participate in the routine and instead viewed a 5-minute video related to their current academic subject on their smartboard. The control group also had a brief 1 minute set up for the video as well as a brief discussion for approximately 1 minute before and after viewing the video. These are typical routines already implemented daily in the classrooms so they were still effective as a control.

### Post-test Measures

Post-test measures for the 40 participants following 4 weeks of the SE intervention included performance on all the testing data that were collected during the pre-test assessment: the D2 performance, and the PALMS questionnaire. These post-test measures were completed following the four-week exercise program. At the 2-week mid point of the intervention concentration scores were recorded from D2 testing immediately following the SE intervention with, the control scores recorded during the same time. This allowed for examination on the impact of the immediate aftereffects of the exercise intervention for the students in the intervention group.

Results, therefore, from testing following exercise, provided evidence of the immediate impact of acute SE in the classroom on attention levels. This differs from many studies which typically do not have the opportunity to test concentration for the same group immediately following exercise. This provided an opportunity to also examine if the intervention was more effective over the duration of the study, or if the effect on attention is more immediate.

## Results

### PALMS Social Testing Results

All data collected was examined initially for any unusual patterns or distributions. Outliers, skews, and unequal variances were examined utilizing SPSS. To test the social hypothesis, an independent T-test was used to compare the group means for the subscales of

PALMS for both the exercise and control groups. Significance between group differences were found at the $p<.05$ level for 1 of the PALMS subscales.

PALMS post testing after the exercise intervention indicated a significant effect at the $p<.05$ level for affiliation from SE [$t(38) = 2.17$, $p = .036$]. This subscale is directly to group and social interaction. High affiliation scores indicate the primary motivations for exercise as being related to a feeling of attachment as a team. Affiliation is identified as a social factor on the PALMS scales. There was also a significant effect at the $p<.05$ level for Other's Expectations [$t(38) = 2.35$, $p = .024$]. This subscale indicates motivation to exercise because by expectations and demands from external sources such as a teacher, instructor, or coach.

**Table 3**

*PALMS Post Social Subscales Intervention Group vs Control Group*

| Participant Group | Intervention Group [a] | | | Control Group [a] | | | *t* | *p* |
|---|---|---|---|---|---|---|---|---|
| PALMS Subscale | *M* | *SD* | *SE* | *M* | *SD* | *SE* | | |
| Enjoyment | 20.9 | 4.21 | .94 | 21.35 | 4.49 | 1 | -.326 | .746 |
| Affilation* | 22.65 | 3.36 | .75 | 18.6 | 7.63 | 1.7 | 2.17 | .036 |
| Physical Condition | 18.75 | 5.12 | 1.14 | 18.7 | 8.02 | 1.79 | .023 | .981 |
| Psychological Condition | 21.25 | 5.02 | 1.12 | 19.55 | 6.52 | 1.45 | .923 | .362 |
| Mastery | 18.75 | 4.63 | 1.03 | 17.35 | 4.68 | 1.04 | .951 | .348 |
| Competition | 12.1 | 6.37 | 1.42 | 11.65 | 6.89 | 1.54 | .214 | .831 |
| Appearance | 13.05 | 5.32 | 1.19 | 14.95 | 7.87 | 1.76 | -.894 | .377 |
| Other's Expectations* | 8.4 | 3.01 | .67 | 6.4 | 2.30 | .51 | 2.35 | .024 |

[a] $n = 20$. [b] 2-Tailed.

*$p < .05$. **$p < .01$.

***D2 Attention Results Immediately Following SE***

Intervention Vs Control Group Independent Samples T-tests following exercise scores confirmed our hypothesis that immediately following SE would have a significant effect on students for at least one of the main attention scores, in this case TN scores for the intervention group (Table 4). TN refers to the "Total Number of Items Processed". TN is a quantitative

measure of performance of all items that were processed, both relevant and irrelevant. TN is a highly reliable and normally distributed measure of selective and sustained attentional allocation, processing speed, amount of work completed, and motivation.

**Table 4**

*Intervention Results: D2 Test for Attention Post Exercise*

| Measures | Intervention Group [a] | | | Control Group [a] | | | *t* | *p* |
|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *SE* | *M* | *SD* | *SE* | | |
| Total Number | 323.65 | 72.733 | 16.264 | 401.25 | 147.489 | 32.979 | 2.11** | .044 |
| Omissions | 8.95 | 12.42 | 2.777 | 36.3 | 51.589 | 11.536 | -2.305** | .031 |
| Comissions | 8.35 | 11.25 | 2.516 | 20.05 | 36.123 | 8.077 | -1.383 | .18 |
| Concentration | 119.8 | 41.316 | 9.239 | 117.6 | 53.710 | 12.010 | .145 | .885 |

[a] $n = 20$. [b] 2-Tailed.

*$p < .05$. **$p < .01$.

Results from D2 concentration testing directly following SE for the intervention group vs the control group scores found significance between group differences at the $p<.05$ level for post-SE-intervention total processed [$t(38) = 2.11$, $p = .044$]. Total processed refers to the total number (TN) of attempts to cross out a D2 during testing. This is an indication of speed of processing time, recording the total amount of opportunities students were able to score during the entire test. Reading and writing answers quickly may indicate increased student motivation to finish the task yet does not necessarily ensure that answers are being marked correctly.

Results from the D2 omissions and commissions scores further support increased levels of attention for the intervention group when tested following exercise. Results from D2 omissions errors scores directly following SE for the intervention group vs the control group scores indicated significant between group differences at the $p<.05$ level for post-intervention omission errors [$t(38) = -2.30$, $p = .031$] . Omission errors refers to the total number of times a student missed marking an answer during their testing. For example, if a student was working

very fast and skipped over a letter which they were told to cross out. A decrease in omission errors increases accuracy in scores.

The intervention group significantly lowered their omission errors when compared to the control group when testing was done directly following their SE. This finding confirmed the hypothesis that omission errors would be significantly reduced for the intervention group only when D2 testing was done following SE. The lower omission errors combine with the lower TN which provide further evidence that students may have increased their sustained attention during the D2 testing following SE.

Commission errors are when a student marks an answer incorrectly. This differs from omission errors in that there is an action taken where the student marks an answer incorrectly, not just misses or "skips" an answer. Commission errors between the groups at mid-point were extremely close to being statistically significant and would likely have been significant if the sample size were larger.

These results further support the possible attention improvements immediately following SE in the classroom. Students in the intervention group decreased their commission errors and were much lower than the control group. A larger sample size would likely make this result significant and should encourage researchers to conduct further SE testing for larger groups of students. Pre-Test and Post-Test did not reveal any significant results with scores provided below.

**Table 5**

*Pre-Test Group D2 Statistics*

| Measures | Intervention Group [a] | | | Control Group [a] | | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *SE* | *M* | *SD* | *SE* |
| Total Number | 339.25 | 104.172 | 23.294 | 376.8 | 126.163 | 28.211 |
| Omissions | 41.25 | 64.213 | 14.358 | 41.45 | 68.814 | 15.387 |
| Comissions | 27.35 | 45.23 | 10.114 | 16.8 | 33.568 | 7.506 |

[a] $n = 20$.

**Table 6**

*Post-Test Group D2 Statistics*

| Measures | Intervention Group [a] | | | Control Group [a] | | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *SE* | *M* | *SD* | *SE* |
| Total Number | 330.35 | 86.348 | 19.308 | 410.15 | 146.296 | 32.713 |
| Omissions | 15.30 | 17.054 | 3.813 | 34.55 | 52.705 | 11.785 |
| Comissions | 11.75 | 21.781 | 4.870 | 11.15 | 26.66 | 5.961 |

[a] $n = 20$.

## Discussion

Utilizing this unique classroom-based SE intervention, we were able to gain insights into our aims for the study and support further research in the field with quantitative data. Our findings support how incorporation of a short SE routine before academic work may increase the ability for students with NDC to have sustained concentration in the classroom. Teachers reported that the students in the intervention groups behavior significantly improved immediately following their SE routine throughout the 4 weeks.

Results from D2 concentration testing directly following SE for the intervention group vs the control group scores found significance between group differences at the $p<.05$ level for post-SE intervention total processed. This is an indication of speed of processing time, recording the total amount of opportunities students were able to score during the entire test. Reading and writing answers quickly may indicate increased student motivation to finish the task yet does not

necessarily ensure that answers are being marked correctly. This is an important distinction to make as high TN scores may also mean students were not carefully answering questions and may have been working quickly yet less effectively. Therefore, it is important that other aspects of the D2 attention scores are tested such as omission and commission errors.

This is an especially important factor for students with NDC because they often lack motivation for academic tasks, and often work impulsively without carefully following directions. Examining the other significant results from different aspects of D2 testing is necessary to get a broader more accurate perspective of the results of the intervention. The following results support that the lowered TN for the intervention group helped reduce errors and students answered more carefully, indicating a possible increase in overall attention levels directly following SE.

Omission errors were another major attentional factor we measured. These errors refer to the total number of times a student missed marking an answer during their testing. For example, if a student was working very fast and skipped over a letter which they were told to cross out. A decrease in omission errors increases accuracy in scores. The intervention group significantly lowered their omission errors when compared to the control group when testing was done directly following their SE. This finding confirmed part of the second social hypothesis that at least one of the major attention factors (omission errors) would be significantly reduced for the intervention group only when D2 testing was done following SE. The lower omission errors combine with the lower TN which further supports that students may have increased their sustained attention during the D2 testing following SE.

Another major attention measure with a significant finding was commission errors. This occurs when a student marks an answer incorrectly. This differs from omission errors in that

there is an action taken where the student marks an answer incorrectly not just misses or "skips" an answer. Commission errors between the groups at mid-point were extremely close to being statistically significant and would likely have been significant if the sample size were larger. It is worth reporting these results because they continue to support the possible attention improvements immediately following SE in the classroom. Students in the intervention group decreased their commission errors and were much lower than the control group. A larger sample size would likely make this result significant and should encourage researchers to conduct further SE testing for larger groups of students.

However, the significant results in this study are quite powerful factoring in the sample size of 40 students. These findings should encourage further testing of the immediate effects of in classroom SE which may lead to higher levels of attention. This could improve academic work as well as help students who struggle with attention during standardized testing. Socially, students also may benefit from SE in a group, specifically students with NDC who generally have much lower rates of participation in sports teams and other group activities.

PALMS findings indicated an increase in affiliation as motivation for SE for students in the intervention group. Affiliation is a social motivation that involves feelings of belonging to a group and being part of a team or community. High rates of affiliation are an indication that the students were connecting and feeling they were part of a group. These are important socialization skills which students with NDC struggle to develop in typical academic contexts. Increased PALMS scores for Other's Expectations suggest that students with NDC may develop social skills from the types of skills used such as modeling and mirroring behavior utilizing SE during school with a teacher guiding the SE routines. This intervention incorporated methods which have been successful helping students with NDC address social deficits, increase self-regulation

skills and improve attention to task. This allowed for examination of how SE was utilized to enhance the development of these skills for students with NDC. Peer relationships may have been strengthened. Gestures and physical motor movements are often nonverbal methods which are used by not only students with NDC but typically developing individuals of all ages to communicate. The ability to communicate through movement increase quality of social interaction and allows for students with NDC to send (Downey & Rapport, 2012; Movahedi et al., 2013) Social signals are often sent through movement, actions that can be both externally and internally rewarding for students (Chevallier et al., 2012). When SE is incorporated consistently with a group of peers performing the same physical actions, a sense of commitment and adherence often can facilitate positive affect, a sense of bonding and belonging which is a struggle for many students with NDC (Smith, 2003; Srinivasan et al., 2014; Vazou et al., 2005).

**Limitations**

Several limitations were expected because of the population of students chosen and the type of intervention, which was unique and being implemented for the first time in this school. Recognizing the limitations and how they might play a role in result outcomes is helpful for implementing future interventions. While the quantitative data collected is necessary and valuable for examining the impact of this intervention it has several important limitations.

Tests such as the D2 are not like a blood type test in medicine. The D2 scores may improve over time naturally as students become more familiar with the structure of the testing. To help reduce this limitation three testing times were used to assess the impact of the intervention on D2 scores. Teachers also administered the D2 for the control group post-test and principal investigator was not there each time to observe how they administered the test. The D2 test results could be influenced by who administered the test. These results could also vary based

on the environment in the classroom that day.

Some students had improvements in behavior, yet their D2 test result was not improved following SE. For example, a student was able to sit calmly in their seat for the duration of the test, which was an improvement in behavior, yet their score on the D2 did not improve following the SE. These more subtle type of behavior improvements were not collected as data in this study yet were observed often. Future research would benefit from recording these types of behavior improvements in addition to attention data collection.

Additionally, PALMS data scores may not accurately represent the complexity of student motivational feelings about exercise. Students were only able to use the numbers 1-5 to represent their feelings for each question, limiting more specific differences between students. PALMS scores attempt to measure motivation with this number system, yet this specific population of students have highly variable social skills and sometimes struggled to answer questions by using numbers only. Therefore, some of the PALMS scores may not have accurately represented student motivations for exercise.

Students with NDC are especially resistant to changes in their daily routines. This is a common and expected problem which often makes intervention studies difficult to find consistent participants in special needs populations – particularly NDC. Some classrooms may differ in their routines and teaching methods. For example, some classrooms had teachers with a style which was more restrictive, while others allowed more leniency over off task behavior. This may have influenced some groups of students to act differently depending on their teacher's style of running a classroom.

Parents of participants may not fill forms out carefully or may not accurately report their child's activity levels. For example, some parents may not be home when their child is home and

not know that they are physically active during those times.

Some of the students also had great difficulty with instructions during the intervention and did not participate in exercise routines appropriately for physical or mental health reasons every few days, even if they assented/consented to the study. This could influence the rest of the classroom because the students all participate in the intervention at the same time as a class. However, it was necessary for the purpose of the intervention that students all participate in their natural classroom setting at the same time even if some students did not follow instructions or distracted other students. This allowed data to be examined for the classroom, including the impact of any interference.

## Conclusion

Several strengths of this study maximized the possibility to discover valuable findings for this intervention and attempted to address shortcomings of previous research in the field. The exercises which were used have previously been found to be effective for improving concentration as well as for the age and functioning level of the participant population within classrooms. All participants were from the same school and were grouped in classes according to age and ability level. Several strengths discussed below maximized contributions to current literature, providing valuable findings for this intervention which seek to address shortcomings of previous research in the field.

One major strength was that the exercises which were used have previously been found to be effective for improving concentration for the ages and functioning levels of the participant population within classrooms. All participants were also from the same school and are grouped in classes according to age and ability level.

All participating teachers were also trained on how to implement the physical activities involved in the classroom prior to the start of the study. Teachers practiced the specific exercises with the primary researcher and research assistants. The SE intervention had the same specific steps that each classroom follows. Teachers of the intervention classrooms practiced the routines together with the primary researcher prior to incorporation in the classroom. This led to greater consistency, reducing the possibility that the SE intervention differs significantly between classrooms.

Consistency in motor activity has been found to have a greater positive effect on pro-social behavior reducing repetitive, interfering behaviors and increased mastery of exercise skills (Downey & Rapport, 2012). Classrooms also incorporated SE at the same time each day which also increased consistency and helped develop a routine. Students with NDC have often been found to improve behavior and attention to task when they are provided a consistent schedule with clearly defined times (Morrison et al., 2011).

The SE routine involved the teacher leading the classroom exercise movements with students following along. Through observation of appropriate behavior students with NDC have been found to increase their ability to self-regulate and participate appropriately in activities (Gallese et al., 2012; Ingersoll, 2008) Mirroring or imitation of appropriate physical exercises when observed through in person physical movement (as opposed to images on a TV screen) of peers/teachers/parents often improves self-regulation, improves eye contact and implicit communication skills (Foti et al., 2014; Ingersoll, 2008; Morrison et al., 2011).

Also, students were able to practice social skills by not only mirroring and observing their teacher, but also their peers around them in the classroom. Studies have found that when students with NDC are following the same instructions their performance accuracy is increased,

participation rates are higher and off task behaviors are reduced (Foti et al., 2014; Ingersoll, 2008; Pan et al., 2011). However, when students with NDC attempt activities solo or with one-on-one instruction their off-task behaviors increase and ability to correctly follow directions are reduced.

To ensure these factors were implemented, during the week prior to the first intervention session, the primary researcher and assistants went to each classroom and practiced the routine alongside the teacher. This practice run allowed for as consistent a routine as possible between all classrooms. For example, if one teacher was performing the exercises incorrectly, they could observe the primary researcher to ensure they correctly replicate the SE routine. Additionally, during the intervention the primary researcher and/or research assistants personally observed classrooms while the exercises took place each session to ensure they were being correctly implemented. The primary researcher and assistants completed a simple check list after observing each session. Exercise intervention and data collection took place within classrooms with students participating at the same time together.

While the control group did not participate in the SE routine, they filled out the same questionnaires about their motivation towards SE during the pre / post PALMS collection. This study was strengthened by having the control group participate in an alternative activity – watching 5 minutes of an educational video each day relating to their classwork. The active control group was also tested once with the D2 immediately (along with pre-post testing) after watching the video at the midpoint of the study. An active control strengthens the validity of this study by controlling for the possibility of changes occurring because of simply introducing a novel activity (intervention) in the classroom.

The SE routines were also incorporated in the same classroom environment which students do academic work. This reduced the chance of external distractions and disruptions that can occur from changing location to participate in the activity such as gym. This also allows immediate testing of concentration levels for the intervention group with the D2. Students with NDC have been found to have reductions in anxiety when allowed to have movement breaks prior to engaging in physical activities (McGimsey & Favell 1988; Morrison et al., 2011). In addition, antecedent exercise has been found to reduce problem behaviors such as stereotypy and self-regulation (Bachman & Sluyter, 1988; Kern et al., 1982; Rosenthal-Malek, & Mitchell, 1997). Antecedent exercise has been found to increase attention and self-regulation, but the effect is stronger immediately following exercises (McGimsey & Favell 1988; Morrison et al., 2011; Zach et al., 2017). This intervention study allowed for instant testing of concentration with all students at the same time as a group with the utilization of the D2 Test of Attention.

This is important for examining participation, motivation, and the social influence of SE because students were in their typical classroom observing each other, their teacher and immersed in natural school environment. While most of the previous SE research has taken place outside classrooms, findings from Manuscript 2 are unique because of the opportunity to examine students in a classroom environment, which is rare and beneficial (Zach et al., 2017). The opportunity to research students during school hours and within their own classrooms allowed for a more novel intervention. Instead of simply observing their behaviors in the classroom or judging changes based on their concentration scores on the D2 Test of Attention, the students themselves additionally answered a social motivational questionnaire, PALMS. Each student completed the PALMS form pre and post intervention with the primary researcher and research assistant present.

This intervention also offered an opportunity for students to be more physically active. Limited opportunities for general physical activity and even less opportunities for group SE such as participation on sports teams are available for students with NDC (Hilton et al., 2008; Pan & Frey, 2006; Smith, 2003; Srinivasan et al., 2014). The SE routine offered the students an opportunity to bond as a group as the exercises were simple, consistent, non-competitive and performed over a period of four weeks. Students received praise and were offered the opportunity to participate as equals in a group of their peers.

Another strength of this study was that attention data from the D2 test was gathered immediately following the SE routine in the classrooms. Students had their attention levels measured without a significant amount of time passing or change of environment which could affect the impact of their energy expenditure or concentration. The tests also could be administered to all students at once at the same time ensuring that conditions were as similar as possible. Students only needed a pencil and paper to mark answers for the D2 for under 6 minutes, making the test simple and brief while still providing valuable quantitative data.

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# Chapter 6. Summary of Main Findings of Manuscripts & Contributions to the Field Future Directions

Findings from both manuscripts can be used to better understand why and what motivates students with developmental disorders to participate in exercise. The social findings may lead to changes in how SE can be used in specific, easy to incorporate ways, to increase social skills for students with NDC. In addition, findings may support the importance of increased data-based research about the effects of SE socially and cognitively, which is far less common than studies regarding the physiological impact of SE. Results from Manuscript 2 can also be shared and be informative for educators and other researchers in the field.

Results in this dissertation support recommendations increasingly made in literature related to the study of exercise and kinesiology, that teachers of students with NDC explore methods to incorporate more SE into their programs to possibly increase attention, self-regulation and social development. Researchers should be encouraged by the results from the data in this intervention to continue to explore how increased acute SE opportunities in school may provide immediate attentional increases and increase development of social skills in classroom settings.

In the future, it is likely that teachers could incorporate simple physical activities in the classroom for students with NDC. Jogging in place, jumping jacks, throwing and catching a ball are all activities which can take place within a classroom environment. This likely will help students increase attention during the activity, as well as following the activity, improving attendance to academic work. Self-regulation skills may be increased if students are able to independently monitor their progress with the use of a fitness wearable watch, such as a Fitbit.

The use of a fitness wearable could provide immediate feedback as well as measure student progress allowing for more accurate data collection.

A fitness wearable would allow for far more specific and accurate data collection based on each individual student. A wearable could collect data such as heart rates or steps taken which would then be collected and examined over longer periods of time to monitor progress and changes. This could lead to more effective exercise programs incorporated into the school curriculum, as their effectiveness could be measured with data collected from fitness wearables. These wearables may also be beneficial for student's physical health, in addition to social and cognitive benefits.

Further investigation into how feedback and goal setting can enhance student motivation to participate in increased SE is a goal for current research in the field (Zach et al., 2017). Students and or teachers could utilize a wearable fitness device to set and monitor goals which are specific to the unique needs of each student. Important feedback would also be provided for the instructor as to which type of exercise activities are the most engaging for students. For example, group exercise (basketball, soccer) data could be compared with individualized exercises (jogging, weight-lifting). There is a lack of research which has examined adherence to fitness goals for students during PE classes. Utilizing a fitness wearable in the future would allow for more accurate data collection, as well as novel findings about motivation for SE and the social and cognitive benefits for students.

The intervention study, manuscript 2, also contributes and promotes further research, which seeks to incorporate and investigate outcomes from acute exercise routines. For example, a larger sample size such as an entire school may reveal greater significance and allow for more testing points following exercise in both very small and very large groups. Also, these findings

were significant for students with NDC, and it is possible that there might be a greater effect for typically functioning students. Investigation into the effectiveness for SE use in different types of populations would increase our understanding of the impact of SE.

## Conclusion

In conclusion, this dissertation demonstrates how structured exercise can have a positive impact on attention immediately following exercise for a brief period of time, reducing errors during paper pencil testing. In addition, social development is increased following group participation in SE over time with increased levels of affiliation among students with NDC. This research builds upon on existing knowledge of the benefits of increased physical activity by examining measurable attentional and social effects from a particular form of PA, SE. Thus, the findings in this dissertation constitutes an important and unique contribution to literature in the field.

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## Appendix A

### PALMS Motivational Assessment

**Structured interview -15 minutes Pre-Test and 15 minutes Post-Test**

**Students are asked if they understand each question.**

**The primary researcher or research assistants record student answers.**

**If a student does not understand a question it is circled.**

**Students are also asked if they understand the 1-5 rating system.**

**They can choose to answer with their words if it is easier for them to understand.**

**All participants are verbal but can choose to point to a number to indicate their feelings.**

**Why do I participate in Physical Activities?**

**Record each question with a number 1 (Strongly Disagree) through 5 (Strongly Agree)**
**Items and sub-scales in the PALMS.**

| Answer | Item | Sub-scale |
|---|---|---|
| ___ | Because I perform better than others | Competition/Ego |
| ___ | To be best in the group | Competition/Ego |
| ___ | To work harder than others | Competition/Ego |
| ___ | To compete with others around me | Competition/Ego |
| ___ | To be fitter than others | Competition/Ego |
| ___ | To define muscle, look better | Appearance |
| ___ | To improve body shape | Appearance |
| ___ | To improve appearance | Appearance |
| ___ | To lose weight, look better | Appearance |
| ___ | To maintain trim, toned body | Appearance |

**PALMS Motivational Assessment**

**Structured interview -15 minutes Pre-Test and 15 minutes Post-Test**

**Students are asked if they understand each question.**

**The primary researcher or research assistants record student answers.**

**If a student does not understand a question it is circled.**

**Students are also asked if they understand the 1-5 rating system.**

**They can choose to answer with their words if it is easier for them to understand.**

**All participants are verbal but can choose to point to a number to indicate their feelings.**

**Why do I participate in Physical Activities?**

**Record each question with a number 1 (Strongly Disagree) through 5 (Strongly Agree)**
**Items and sub-scales in the PALMS.**

| Answer | Item | Sub-scale |
|---|---|---|
| ___ | To earn a living | Others expectations |
| ___ | Because I get paid to do it | Others expectations |
| ___ | To manage medical condition | Others expectations |
| ___ | Because people tell me I need to | Others expectations |
| ___ | Because it was prescribed by doctor, physio | Others expectations |
| ___ | Because I enjoy spending time with others | Affiliation |
| ___ | To do activity with others | Affiliation |
| ___ | To do something in common with friends | Affiliation |
| ___ | To talk with friends exercising | Affiliation |
| ___ | To be with friends | Affiliation |
| ___ | Because it helps maintain a healthy body | Physical condition |

**PALMS Motivational Assessment**

**Structured interview -15 minutes Pre-Test and 15 minutes Post-Test**

**Students are asked if they understand each question.**

**The primary researcher or research assistants record student answers.**

**If a student does not understand a question it is circled.**

**Students are also asked if they understand the 1-5 rating system.**

**They can choose to answer with their words if it is easier for them to understand.**

**All participants are verbal but can choose to point to a number to indicate their feelings.**

**Why do I participate in Physical Activities?**

**Record each question with a number 1 (Strongly Disagree) through 5 (Strongly Agree)**
**Items and sub-scales in the PALMS.**

| Answer | Item | Sub-scale |
|---|---|---|
| ___ | Be physically fit | Physical condition |
| ___ | To maintain physical health | Physical condition |
| ___ | Because it keeps me healthy | Physical condition |
| ___ | To improve cardiovascular fitness | Physical condition |
| ___ | Because it helps me relax | Psychological condition |
| ___ | To better cope with stress | Psychological condition |
| ___ | To get away from pressures | Psychological condition |
| ___ | Because it acts as a stress release | Psychological condition |
| ___ | To take mind off other things | Psychological condition |
| ___ | To get better at an activity | Mastery |
| ___ | To improve existing skills | Mastery |

**PALMS Motivational Assessment**

**Structured interview -15 minutes Pre-Test and 15 minutes Post-Test**

**Students are asked if they understand each question.**

**The primary researcher or research assistants record student answers.**

**If a student does not understand a question it is circled.**

**Students are also asked if they understand the 1-5 rating system.**

**They can choose to answer with their words if it is easier for them to understand.**

**All participants are verbal but can choose to point to a number to indicate their feelings.**

**Why do I participate in Physical Activities?**

**Record each question with a number 1 (Strongly Disagree) through 5 (Strongly Agree)**
**Items and sub-scales in the PALMS.**

| Answer | Item | Sub-scale |
|---|---|---|
| ___ | To do my personal best | Mastery |
| ___ | To obtain new skills/activities | Mastery |
| ___ | To keep current skill level | Mastery |
| ___ | Because it's interesting | Enjoyment |
| ___ | Because it makes me happy | Enjoyment |
| ___ | Because it's fun | Enjoyment |
| ___ | Because I enjoy exercising | Enjoyment |
| ___ | Because I have a good time | Enjoyment |

## Appendix B

## Parent Consent

## An Invitation to Participate in an Exercise Study

**Institution:** McGill University

**Title of Project:** Use of Physical Activity to Increase Attention and Socialization Abilities for Students with NDC.

**Project Leader:** Kian Habib, Ph.D candidate
Education and Counselling Psychology

**Project Supervisor**: Armando Bertone, PhD
Department of Educational and Counselling Psychology

Dear Legal tutor,

This letter is an invitation for your child to participate in a research study which seeks to improve concentration for students through small increases in exercise within their classroom. This study will be conducted by an educational psychology PhD student from McGill University working in conjunction with Summit School. Short increases of physical activity have recently been found by researchers as a possible method to improve concentration and educational performance for students in the classroom. The ability to pay attention and concentrate is crucial for learning both inside and outside of the classroom. Short increases of physical activity have been found to possibly increase attention for students as well as may lead to a decrease in behavior problems. We are interested in assessing the potential benefits of five minutes of increased physical activity in the classroom a day at school for students as well as measuring physical activity levels overall.

### What will participation involve for students?

Participants in three classrooms of this study will incorporate a simple exercise routine lead by their teacher. The study will be carried out in your child's classroom during the school day. Physical activity will consist of 5 minute simple and short exercise sessions during the week. This exercise routine consists of a series of simple exercises which are performed while standing once a day, for a period of 5 minutes, over 4 weeks. The total exercise routine will take around 5 minutes.

A routine will consist of two minutes of arm circles (from a standing position, straightening arms out to the sides and rotating in circles) which start small and become larger. The next two minutes will be jumping jacks or a similar movement. The final minute will consist of stretching with students reaching for their toes for 10-15 seconds then returning to standing position. Essentially, the exercise routine is: (while standing) 2 minutes of arm circles, 2 minutes jumping jacks and 1 minute stretching for intervals. The difficulty of the task will be adapted to your child's ability and their participation will be voluntary. Students in a 4$^{th}$ classroom will serve as a control group and will not participate in any exercise routine. However, they will complete all other steps described in this study.

During the study, concentration levels will be recorded on 3 separate days for all participants, once before once in the middle and once after the physical activity program by the principal investigator outside of the classroom but during class time. Your child will be given a brief concentration test known as D2. This test takes approximately 5 minutes to complete and has been used extensively to measure attention for students of all ages. Using this test, attention levels by pen and paper asking students to make a check mark when they see a certain shape they are asked to identify. This test is used to measure any increase in attention from increased physical activity participation for the students.

Similarly, your child will be asked to complete a short and reliable measure of intelligence for use in educational and research settings known as the WASI-II. This is will occur outside of the classroom during class time and be administered by the principal investigator during class time but outside the classroom and takes 20 minutes to complete.

In addition, your child will complete a brief attention (Conners 3) and motivation (PALMS) questionnaire and about your child's feelings towards exercise and fitness before (pre-test) and after (post-test) the physical activity routine. This will occur before they have begun to incorporate exercises and upon completion of the study. These questionnaires take approximately 20 minutes in total administered by teachers within the classroom during class time once before the program begins and once upon completion of the program. All student scores, data and questionnaires will be confidential and only accessed by individuals directly involved in this study, the primary researcher and supervisor.

**Parent Participation**

You will also be asked to complete a parent version of the Conners 3 attention questionnaire before and after the physical activity program. Additionally, you will also be asked to fill out a brief background questionnaire about your child's age, medical, educational history and physical activity levels. When completed, you are asked to return these forms to your child's teacher.

**Potential benefits and risks**

This study may lead to a greater understanding of how attentional abilities develop through the use of exercise and may in the future. Findings may also be used for create novel age-specific learning approaches, teaching methods and educational materials. Studying these methods may potentially improve student concentration, academic performance and behavior in the classroom.

Potential risks in this study relate to physical activity. The brief exercises and simple movements involved are unlikely to be harmful for healthy individuals. Students who have any medical issues which are negatively affected by exercise or the movements described in this routine should not participate. Any time an individual exercises there is always the potential for strain or sprain etc. However, this routine is non-contact, brief and in a controlled environment led by the teacher. These factors reduce the typical risks of injury during physical activity. Students will also never be required to participate as participation will be voluntary.

**Confidentiality**

You are asked to place all questionnaires in an envelope that will be provided to you, and send it back to the teachers sealed. Your child will be assigned a study number and the information will be filed using this unique identifier code. Only this code will link the participant to the sample. Apart from the researcher and supervisor, only members of regulatory agencies or members of the Research Ethics Board may have access to the data. Completed forms by parents will be handed in to only their student's classroom teacher at Summit who will then store the forms in a secure location protected by a lock in a file cabinet.

Participant file numbers and any information about the study will be kept in a separate, private, locked cabinet and which can only be accessed by key by the principal investigator and supervisor at our research facility on the McGill University campus. To ensure that no one other than the applicant will have access to any participant information, all data collected electronically will be saved in encrypted files as well as be password protected with only the principal investigator and supervisor having access. If data from this study is published or presented at scientific meetings, any personal information will never be used. Although the research findings may be disseminated at scholarly conferences and in the writing of scientific articles, results from individual participants will remain strictly confidential.

**Participation**

Your consent and child's participation is voluntary. You may refuse your child's participation or withdraw your child from the study at any time. In the case that you do withdraw your child from the study, all previous data collected will be destroyed. Any questions regarding this study will be explained to you, upon your request by contacting me through email or contacting Summit school. If you choose not to sign this consent form, your child will not be given any tests or questionnaires related to this project. Instead their teacher will provide them with an appropriate alternative academic activity during testing times which may occur for other students in the classroom. In addition, your child can choose to sit out or participate with the class during exercise sessions but they will not involve data collection or any record of their participation.

**Contact Numbers:** If you have any questions about the research, please contact Kian Habib kian.habib@mail.mcgill.ca (514) 398-6908 or Armando Bertone, armando.bertone@mcgill.ca or Ed Cukier at Summit School (514) 744-2867 ecukier@summit-school.com

If you have any questions or concerns regarding your rights or welfare as a participant in this research study, please contact the McGill Ethics Officer at 514-398-6831 or lynda.mcneil@mcgill.ca.

Sincerely,
Kian Habib
Ph.D. candidate
Department of Educational and Counselling Psychology
McGill University

**Please sign if you agree to your student's participation.**

---

Name of Child Name of Parent (Legal tutor) Signature of Parent (Legal tutor) Date

## Appendix C

## Assent Form for Students (12-16 years)

**Institution:** Faculty of Education, McGill University

**Title of Project:** Physical Activity to Increase Attention and Socialization Abilities for Students

**Project Leader:** Kian Habib, PhD candidate

Education and Counselling Psychology

Human Development, McGill University

**Project Supervisor**: Armando Bertone, PhD

Department of Educational and Counselling Psychology

Faculty of Education, McGill University

**Would you like to participate in a study?**

I am an educational psychology PhD student from McGill University who has been working with Summit School. This letter is an invitation for you to participate in a research study which seeks to improve concentration for students through small increases in exercise within their classroom for 5 minutes a day for 4 weeks. You will also answer some questions on a form which asks questions about how much you enjoy physical activity and what exercises you do inside and outside the classroom before and after the study.

**Why are we doing this project?**

We are doing these tasks to better understand how students might improve their attention by participating in exercise in the classroom.

**What will happen during testing?**

You will be offered the opportunity for a movement break to exercise for about five minutes where you can choose to move using your arms and making circles, jumping jacks and stretching.

**Can I decide if I want to do these tests?**

Your parents have given me permission for you to participate in this research project. You do not have to participate in these activities if you do not want to. If you do want to participate, you do not have to answer any of the questions and we can stop at any time.

**Who will know what I did during these activities?**

All of the responses given throughout these activities are confidential. This means that only my supervisor and I will examine what happened during activities. You will also use a number instead of your name when you complete an activity so your answers will be confidential. The results from this project may be published or presented, but your name or other personal information will never be used and no one will know that you participated in this study.

Do you have any questions?

Do you want to participate?

**Assent- Completed by the Researcher**

I read this to ..... and acknowledge that he/she gave me verbal assent to participate.

Signature.....
Date.....

## Appendix D

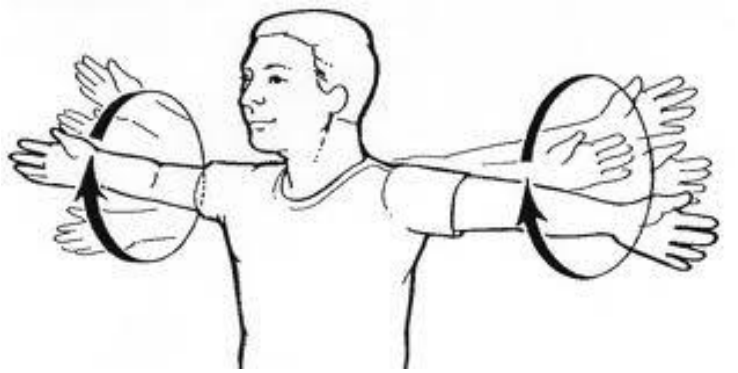
## Structured Physical Activity Guide for Teachers

Teachers should model each of these exercises and let students practice before the first exercise session for this project. Also, physical activity should be the words used to describe each exercise session. (“It’s time for your physical activity break.”) Teachers start with one exercise and model the exercise while encouraging their students to participate the goal for students is to follow along but more importantly that they are attempting to exercise using movement. The teacher controlled music which they can stop, switch songs and verbally indicate to students to switch to a new exercise after approximately one-minute. Teachers will then begin different exercise and the students should follow the teacher but more importantly be attempting to exercise. There is approximately 1 minute for each exercise for a total of 5 minutes, once a day at a designated time before a class for 4 weeks.

1. **Airplane**

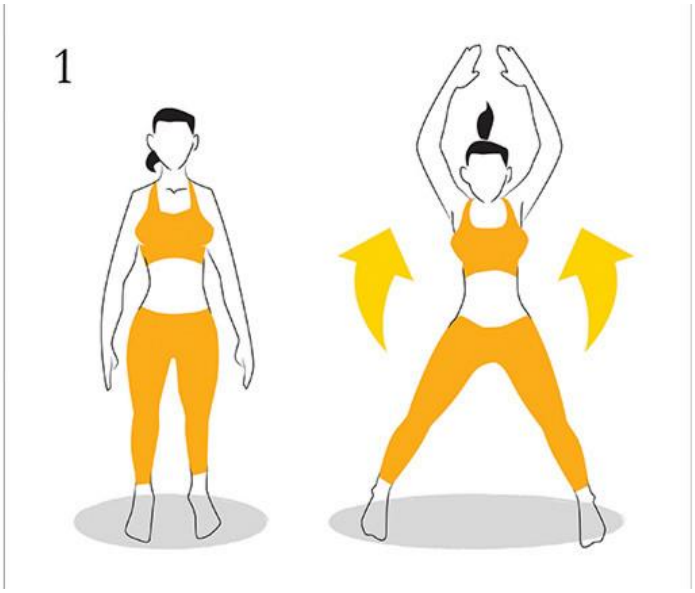
The student should extend their arms away from her shoulders like the wings of an airplane, bend forward at the waist and extend one leg at a time backward, balancing on the opposite leg for 5 to 10 seconds.

2. **Arm Circles**



Students stand beside their desks with their feet about shoulder-width apart. Next, press their palms together in front of their chests with their elbows pointed outward. Then extend their hands upward, in front of their face, turn their palms away from each other, arc their hands to their hips while bending their knees slightly, and return to the starting position. Continue this process repeatedly for 30 seconds.

3. **Jumping Jacks**




Assume an erect position, with feet together and arms at your side. Slightly bend your knees and jump a few inches into the air. While in air, bring your legs out to the side about shoulder

width or slightly wider. As you are moving your legs outward, you should raise arms up over your head; arms should be slightly bent throughout the entire in-air movement. Your feet should land shoulder width or wider as your hands meet above your head with arms slightly bent.

4. **Sunrise/Sunset**

The sunrise/sunset is another exercise is that you can include in your students' daily movement routine. The exercise elongates the spine and stretches the gluteal muscles and hamstrings. The students stand upright with their arms at their sides and breathe deeply several times. Next, on an inhalation, they reach both arms above their heads as high as possible. Then, on the ensuing exhalation, they bend forward at the waist and reach for their toes. Then alternating between the two movements for five to 10 breath cycles. The students should flex their knees slightly during the downward-movement phase of the exercise to reduce the stress on the lower back.

5. **Trunk Twists**

Performing trunk twists is an exercise that targets a variety of muscles throughout the body. The students stand with their feet slightly wider than their shoulders and begin twisting their hips, torso and head back and forth, allowing their arms to swing naturally. They should initiate the movement with their hips rather than their shoulders and keep their knees flexed slightly. They should also keep their feet planted firmly on the floor throughout the exercise.

## Appendix E

### Physical Activity Session and Control Group Checklist Example

| | |
|---|---|
| **Researcher/Teacher(s) Name(s)** | **xxxxxx** |
| **Date** | **xx/xx/xxxx** |
| **Classroom** | **X** |
| **Number of participants present** | **X** |
| **Were exercises correctly modeled by the teacher? (Intervention only)** | **Yes**<br>**No** |
| **Was the exercise routine/video approximately 5 minutes in length?** | **Yes**<br>**No** |
| **Were all research participants participating correctly or attempting to participate correctly? (Intervention only)** | **Yes**<br>**No** |
| **How many students did not participate correctly or follow instructions from their teacher? (If applicable)** | |
| **Please list any additional observations or issues which may be of concern or interest to the right.** | |