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Motor Competency's Relationship To Interpersonal Coordination In Stationary Basketball Dribbling

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MOTOR COMPETENCY'S RELATIONSHIP TO INTERPERSONAL COORDINATION IN STATIONARY BASKETBALL DRIBBLING

by

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This thesis, submitted by Daniel Bell in partial fulfillment of the requirements for the Degree of Master of Science in Kinesiology from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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This thesis is being submitted by the appointed advisory committee as having met all of the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.

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Chris Nelson
Dean of the School of Graduate Studies

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Title	Motor Competency's Relationship to Interpersonal Coordination in Stationary Basketball Dribbling
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Daniel Bell
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Abstract

A gold standard for student pairing strategies in a physical education setting has still yet to be discovered and is a widely debated topic in the field. Inclusion and equitable learning environments are areas of emphasis for practitioners while trying to find new ways to elicit these things to benefit students. Interpersonal coordination (IC), a social phenomenon on which this study focused, has direct applications for pairing strategies in physical education. In essence, IC is a state in which two individuals non-consciously mimic each other's motor patterns. IC was measured between 182 student pairings performing stationary basketball dribbling. Participants included elementary aged students from area elementary schools and were randomly assigned partners. It was found that dribbling competence was not a significant factor for IC. However, gender was found to be a significant factor. Specifically, female pairings were found to have significantly higher rates of IC than male pairings.

Introduction

In a physical education learning environment, a grand debate has been waged to determine the best way to pair students when working on skills needed for life-long physical activity (Shimon, 2019). It has been found that being chosen last for teams, lacking perceived competence in the activity or sport, being made to feel incompetent by the PE instructor or other classmates, or embarrassment from injury will result in decreased participation during class time (Ladwig et al., 2018). This could then lessen an individual's willingness to try new things and feel less competent with the task at hand. If a student with a low motor competence is paired with a student of higher motor competency, could this be detrimental to the success of both students? Additionally, in recent years it has been speculated that there should be a further emphasis placed on pairing strategies due to a phenomenon referred to as interpersonal coordination. It has been speculated that interpersonal coordination could be a powerful mediator of student learning (Rhoades & Hopper, 2017;2019). If this is true, pairing students to encourage interpersonal coordination may be another reason to concentrate attention on student pairings.

In physical education, it is essential to find the best method to develop a student's ability to process new information and perform a given task to their highest ability. Socialization is also a skill needed to gain more knowledge on a topic, ask questions, and even provide peer feedback on misunderstandings. Socialization is not always spoken; it can be conveyed through body language or mannerisms.

This study will concentrate on the phenomenon of Interpersonal Coordination (IC). This phenomenon is generally demonstrated through the automatic imitation of gestures, postures, mannerisms, and other motor movements (Chartrand, 2012). "This has also been coined the term the chameleon effect, which refers to this nonconscious mimicry usually happening passively and unintentionally to match that of the others in one's current social environment" (Chartrand, Bargh 1999). Just as chameleons change their coloring to blend in with their current environment, an experimental demonstration of a behavioral chameleon effect should incorporate, as a within-subjects factor, variability in the behavior of interaction partners, to show that the participant's behavior changes accordingly (Chartrand, Bargh 1999).

Physical Education

Childhood obesity has been on the rise for the past three decades, and the statistics prove it (CDC). Increases in childhood overweightness and obesity have become a significant public health problem in nearly all industrialized nations. In Canada, rates of overweight and obesity among children have more than doubled in the past three decades, with the most recent estimates indicating that about 30% of children are overweight or obese (Veugelers, 2005). In 2003, a study surveyed grade five students, their parents, and school principals in Nova Scotia. The methods indicated that height and weight were measured, as well as assessing dietary habits using Harvard's Youth/Adolescent Food Frequency Questionnaire as well as measuring physical and sedentary activities. The results indicated that physical education classes two or more

times a week at school were associated with a decreased risk of overweight (OR 0.61, 95% CI 0.43-0.87) and obesity (OR 0.54, 95% CI 0.33-0.88). Tracking data supports the persistence of obesity, at least in later childhood, as well as cardiovascular risk factors (Steinbeck, 2008). Physical activity is the discretionary component of energy expenditure, and there is evidence that falling levels of physical activity are contributing to the obesity epidemic. Physical education is slowly being cut out of educational curricula being seen as "less important" and, in some cases, unimportant in comparison to other core subjects. Those core subjects being Mathematics, English, and Sciences. To improve standardized test scores, the time spent in the classroom is beginning to increase while the time in physical education classes is decreasing (Wilkins et al., 2003).

Quality Daily Physical Education

"Physical activity every day has shown many health benefits like bone and muscle strength, improved muscular strength and endurance, reduced risk for developing chronic disease risk factors, improved self-esteem, and reduced stress and anxiety" (Rasberry et al., 2011). It is estimated that nearly half of youths meet the U.S. Department of Health and Human Services *Physical Activity Guidelines for Americans* recommendation of at least 60 minutes of daily moderate-to-vigorous physical activity. A study conducted examining the relationship between physical fitness and academic achievement in 259 public school students in third and fifth grades found that field tests of fitness were positively related to academic success. Specifically, aerobic capacity was

positively associated with achievement, whereas BMI was inversely related (Castelli et al., 2007). This article suggests that physical fitness may be related to academic performance in preadolescents.

Trends in high motor competence in preadolescents have shown positive correlations in academic achievement globally. A cross-sectional study conducted in Portugal evaluated the relationship between gross motor coordination and academic performance in native children. Gross motor coordination (MC) was evaluated using a German test called Korperkoordination Test fur Kinder. Academic achievement (AA) was assessed using the Portuguese Language and Mathematics National Exams that are mandatory for all 4th-grade students. Some of the physical fitness aspects measured were cardiorespiratory fitness, balance, lateral jumping, one leg hops, and shifting platforms (Lopes et al., 2013). It was found that children with insufficient MC or MC disorders exhibited a higher probability of having low AA. This study suggests that early identification of children with poor MC is crucial to implementing activities that develop health-related behaviors. As a result of the implementation of these new behaviors, students should show signs of increased MC, therefore, increasing their academic success in a classroom setting.

Student Perceptions of Physical Education

While physical education is slowly being taken out of curricula across the country, student perceptions of physical education is potentially a contributor. Many individuals can either say positive things about physical education or negative things.

These negative experiences in physical education could be a reason physical inactivity is continuing to climb. Memories of experiences in the past are there forever; they are not things that are forgotten. Recently, a study examined memories of enjoyment or no enjoyment of physical education, present attitudes and intentions for physical activity, as well as present physical activity and sedentary behavior. It was found that being chosen last for teams, lacking perceived competence in the activity or sport, being made to feel incompetent by the PE instructor or other classmates, or embarrassment from injury (Ladwig et al., 2018). This feeling of incompetence has been a reoccurring trend causing this disconnect with the willingness to participate in physical activity. In the article titled *"My Best Memory Is When I Was Done with It: PE Memories Are Associated with Adult Sedentary Behavior"* by Matthew Ladwig:

> There are various hypotheses as to why PE experiences during childhood and adolescence may influence adult PA attitudes and behavior. For example, according to Hausenblas et al., the most reliable predictor of exercise intention and, subsequently, the behavior is the attitude one has toward exercise. More specifically, the affective component of attitude (i.e., whether exercise is evaluated as pleasant versus unpleasant) has been shown to be a stronger predictor of exercise participation than the cognitive component of attitude (i.e., whether exercise is evaluated as healthy or beneficial versus unhealthy or useless). Such findings suggest that strongly valanced emotional experiences, such as embarrassment from being chosen last for a team due to lack of skill or pride from

being chosen first, may have powerful, long-lasting effects on attitudes and behavior.

The attitudes that are associated with physical activity have shown to have huge impacts on the way we go about participating in the exercise. National standards that address the three learning domains, psychomotor, cognitive, and affective, are required for physical education lessons to assess student growth through academic curricula in K-12 education. These domains are all the attainable goals that educators put in place for students based on grade level and age for skill development. A great example stated in the quote above discusses the embarrassment of being chosen last for a team. Generally, higher-skilled students are swallowed up first, leaving lower-skilled students for last, dampening positive attitudes and behaviors towards physical activity. This then spirals into participation, and students then spend less time developing the skills needed to make exercise more enjoyable; therefore, the goal of lifelong fitness is skewed as a result.

Physical Activity

Physical inactivity is a global problem today. Physical activity is one of several factors that influence the growth and development of children and adolescents (Hills et al., 2007). During childhood and adolescence, nutrition and physical activity affect the growth and development of numerous body tissues, including body fat, skeletal muscle tissue, and bone (Kirk et al., 2005). Unfortunately, the opportunity for many youngsters to be physically active has reduced over time. Contributing factors may include a series of changing environmental factors (Dollman, 2005). Physical activity is vital for the

physical, social, and cognitive development of adolescents. According to the Center for Disease Control and Prevention, children and adolescents should have 60 minutes or more of physical activity daily. With physical education, students could be achieving nearly half of the national recommendations during school which in turn would leave time for them after school to reach the remainder of that recommendation.

The value of physical activity to health, fitness, growth, and development is undisputed (Hills, 1995). Lack of physical activity in childhood has its risk factors, including cardiovascular disease, diabetes, and obesity. Physical activity may also affect future susceptibility to chronic diseases. Patterns in physical activity developed during adolescence carry over to later life and affect morbidity and longevity. The amounts of physical activity one can endure changes during puberty, as factors like strength, skills, and endurance increase with these changes. Self-efficacy refers to a judgment about one's capability to successfully perform a task at given levels. A study examined how differences in children's self-efficacy, age, and gender impact motivational intentions, future self-efficacy, and attributions following perceptions of failure (Chase, 2001). Children, ages 8-14 years (N=289), were assigned to either high or low self-efficacy groups. They were then measured on intentional effort, persistence, choice, future self-confidence, and attributions for failure. Results indicated that children with higher confidence chose to participate and had higher future self-efficacy scores than those with lower self-efficacy. Participants were asked to choose a sports-related skill that they had a

high self-efficacy in, and some examples included skills in basketball, soccer, dancing, softball or baseball, running, pull-ups, or gymnastics.

In conclusion, perceived self-success or self-efficacy can directly be related to participation and willingness to engage in physical activity. If students believe they can perform a given skill, they are more likely to attempt, and if they feel peer pressure or less sufficient chances are they will not even try. These reasons could be detrimental to one's confidence.

Physical Education and Academic Achievement

Physical education is vital for children to develop physically and cognitively, as well as the development of their social skills. Being a physical educator is teaching students locomotor, non-locomotor, and manipulative skills that they will use and further develop throughout their lifetime. With the use of physical education, students will be able to develop these skills that will increase their motor competency, therefore, increasing their physical activity as well as their willingness to participate in physical activity. As Americans, the amount of time spent in front of screens has increased, therefore decreasing the times per day engaging in physical activity. A more recent study that took place in Massachusetts looked at physical activity on academic achievement in the Massachusetts Comprehensive Assessment System (MCAS). This cross-sectional study design assessed fitness achievement based on the number of physical fitness tests passed during physical education (PE) as well as scoring on the MCAS. Multivariate logistic regression analyses were conducted to assess the probability of passing the

MCAS tests, controlling for students' weight status (BMI), ethnicity, gender, grade, and socioeconomic status based on school lunch enrollment. Results indicated that the odds of passing both the MCAS Mathematics test and the MCAS English test increased as the number of fitness tests passed increased ($p < .0001$ and $p < .05$, respectively) (Chomitz, 2008). Some of the limitations of the study indicated researching the promotion of physical activity during PE, recess, and out of school physical activity may also support academic achievement. Another study used an intervention program called Sports, Play, and Activity Recreation for Kids (SPARK) to be implemented in classes. One group used SPARK, while another used implementation of the curriculum and the last was the control to carry out their usual programs. According to the data, it was shown that health-related physical education might have favorable effects on students' academic achievement (Sallis, 2013). Children with higher self-efficacy are more likely to participate in physical activity than those with lower-self efficacy (Chase, 2001). For example, if an individual believes that he or she can complete a motor task, that individual will be more likely to continue participating in that activity. Bandura's social cognitive theory has been applied to physical activity on multiple occasions. The Society of Health and Physical Educators (SHAPE) has created National Standards & Grade-Level Outcomes for K-12 Physical Education (NASPE) which targets what students should know and what they should be able to accomplish in an effective physical education classroom. Through these standards students who successfully achieve one or

more are gathering positive information about their performance, following they develop a higher self-efficacy and increasing their motor competency (Castelli, 2007).

Interpersonal Coordination

Interpersonal coordination is typically described with two terms: behavioral mimicry and interactional synchrony; they are similar or identical in form, or they occur at roughly or precisely the same time. Interpersonal coordination is the tendency for individuals to implicitly synchronize their behavioral and linguistic communication patterns during social interactions. If an individual is observing his or her partner complete a task, that individual may try their best to replicate the behavior to be as close to their companion as possible. This is where the phenomena of interpersonal coordination shine through. "Behavioral mimicry is defined as a form of interpersonal coordination and the automatic imitation of gestures, postures, mannerisms, and other motor movements" (Chartrand, 2012). A variety of factors determine more or less mimicry of an interaction partner like motivational, social, emotional, and personality factors. Based on recent research, there are many downstream consequences of mimicking or being mimicked by another person, including increased prosociality between interactants and other unexpected effects like cognitive processing style, attitudes, consumer preferences, self-regulatory ability, and academic performance (Chartrand, 2012). Mimicry is assessed by people that are engaging in the same action at a specific time, or a particular behavior is repeated by an interaction partner within a short window of time, typically no longer than three to five seconds. Behavioral mimicry

has been explored in a variety of motor movements like yawning, body posture, face touching, foot shaking, and even food consumption.

Intentional imitation happens all the time, and this is an essential component of social learning (Bandura, 1977). The mimicry of gross and fine motor movements (e.g., gestures, mannerisms, finger movements), facial expressions, and vocalizations are often nonconscious, unintentional, and effortless (Chartrand, 2012). Mimicry has been of interest to researchers for decades, and this interest has yielded an extensive literature replete with fascinating examples and demonstrations of the ways individuals mimic others (Lakin 2003). Based on the information provided about this subconscious behavior on motor movements, these unintentional matching movement patters in a physical education classroom. The saying "monkey see, monkey do" suggests that primates, including humans, are quite good at imitation; and has generally been considered to be an intentional, goal-directed activity (Chartrand, Bargh 1999).

Behavioral mimicry always yields behaviors that are similar in form and close in timing, interactional synchrony may or may not yield behaviors that are similar in form (Chartrand, Lakin 2013). The timing of behaviors is critical to determine whether one person is in sync with others. "The complexity of the issue of timing in interactional synchrony cannot be underestimated; because interactional synchrony involves more than one person, it requires anticipation of another person's behaviors so that movement can be coordinated" (Chartrand, Lakin 2013). An individual may be trying to synchronize with their peer counterpart by catching up to their rhythm, creating a brief lag when

observing the recorded pairing. With the use of software, there will be the ability to offset the delay to ensure true synchronization is occurring. Interactional synchrony is generally explored in infancy when the subject mirrors the actions of another person. Facial expressions and body movements like moving their body in tune with the rhythm of their caregiver or mother. Basketball dribbling is a rhythmic manipulative skill when performed correctly; these rhythms can be detected when comparing two interactants engaging in the skill. This synchrony is defined as "the precise coordination of body movement between interactants."

It has been speculated that interpersonal coordination, could be a powerful facilitator of learning within physical activity based learning environments (Rhoades & Hopper, 2017;2019). Thus, all of the benefits for motor competency which have been sited earlier in this manuscript, would benefit from a determination of significant factors for interpersonal coordination.

Constructivism

The foundation for the hypothesis of interpersonal coordination as a moderator of psychomotor learning can be found in constructivism (Rhoades & Hopper, 2017;2019). Constructivism is the belief that people construct their understanding and knowledge of the world. As humans, this experience of new things happens quite often, causing us to reconcile them with our previous ideas or experiences. Daily, humans go through this process of acquiring new information that may change a current belief or discard the new information. Constructivist teachers are always encouraging students to assess an activity,

allowing them to gain understanding. As an individual continuously reflects on their experiences, students find their ideas gaining complexity and power with a strong ability to integrate new information. There was a belief that constructivism removes the active role of the teacher; in reality, it is a role modification allowing students to construct knowledge rather than reproduce facts. Constructivism consistently gets this schema of changing education and learning theories, but it makes learning more curious and questioning to generate new ideas from previous knowledge. When observing interpersonal coordination through a lens of constructivism, it becomes apparent that either interactional synchrony or behavioral mimicry is not merely the replication of observed actions. These phenomena would represent construction of knowledge at the student's local level. That is the knowledge that has been constructed through their interactions with others at a non-conscious level. Essentially, this phenomenon represents an underlying non-conscious learning network, which is particularly impactful for motor learning.

Motor Learning and Physical Activity

Motor learning is when complex processes in the brain occur in response to practice and experience a particular skill resulting in changes in the central nervous system that allow a new motor skill to be acquired. In an article titled "*The Dynamic Association Between Motor Skill Development and Physical Activity"* by David Stodden:

> Motor skill competence is defined in terms of common fundamental motor skills (FMS): object control (e.g., throw and kick) and locomotor skills (e.g., run and

> hop). A common misconception is that children "naturally" attain proficient levels of FMS; however, many children do not (Clark, 2007; Goodway & Branta, 2003; Goodway, Suminski, & Ruiz, 2003; Langendorfer & Roberton, 2002a, b). Many of these children may not attain sufficient competence in FMS to apply these skills to lifelong physical activity in adolescence or adulthood (Goodway & Branta, 2003; Goodway et al., 2003).

This article from the above quote goes on to discuss the importance of students learning and developing the skills needed to participate in lifelong physical activity. It is essential to understand the chain of events that all cause this obesity epidemic, to safely say that the problem is beginning to develop rapidly at a younger age. This article goes on to discuss mediating variables and that the sum of these mediating variables promotes either a negative or positive spiral of engagement in physical activity. "The low-skilled children ultimately perceive themselves as having little motor skill competence, and thus they choose not to engage in physical activity, become less fit, and move further into the negative spiral of disengagement from physical activities, games, and sports" (Stodden et al., 2007). An essential aspect of developing motor skills is the type of feedback you receive, which is a massive component of a physical education classroom. If students get the reassurance they need to feel competent in any given skill, they will likely continue to develop their competence in that skill and encounter the positive spiral of engagement.

This could then result in high levels of physical activity, and minimal sedentary behavior will place the individuals at a smaller risk for obesity during adolescence and adulthood.

As a country facing an obesity epidemic, identifying new factors that affect the growth and development of children during adolescence is crucial. Physical activity through physical education has been proven to positively reinforce standardized test scores in various regions around the world (Chomitz, 2008). Physical education teachers need to show support through physical education curricula. These student perceptions of their physical education class will, in turn, affect how physically active they are for the remainder of their life (Ladwig, 2018). Structuring feedback while leading with importance and beneficial versus negativity and repression, students will be more likely to engage in physical activity if they feel inclusion in the physical education classroom. While it is known that daily physical activity should be approximately 60 minutes, this benchmark also helps develop body fat tissue, skeletal muscle tissue, and bone (Kirk, 2005). If physical educators develop an understanding and ability to harness interpersonal coordination in their classes, students will become more motor competent. Finally, in turn, this will combat the overarching problem our country is facing with unhealthy habits leading to obesity.

Significance and Purpose

It has been speculated that Interpersonal coordination may have considerable positive impacts on learning within physical education (Rhoades & Hopper, 2017;2019).

Constructivism as a learning theory also points to this possibility. If interpersonal coordination does amplify learning, carefully understanding factors which modulate interpersonal coordination will be vital for curriculum designers. With this in mind, interpersonal coordination and its factors for emergence, has been heavily examined within the laboratory environment (Chartrand and Lakin, 2013) and factors for coordination have been determined for a wide variety of situations. However, two specific factors within physical education have yet to be examined, gender and motor competency. Understanding these two additional factors for interpersonal coordination in physical education could allow instructional designers to create learning environments in which interpersonal coordination would emerge at higher rates. If interpersonal coordination has an effect on achievement in physical education, better understanding these factors will be essential for instructional design. Additionally, once these factors are better understood, the effects of interpersonal coordination can be researched more effectively. Essentially, the establishment of control and experimental groupings within physical education will be made easier, if rates of interpersonal coordination can be increased within experimental groupings. Until we better understand specific methods increase interpersonal coordination among groupings testing the underlying effects of interpersonal coordination of on student learning will need to wait. Thus, the purpose of this study was to assess factors for interpersonal coordination, in an effort to determine factors for increasing this phenomenon within a physical activity based learning environment.

Research Question

1. How does pre-existing motor competence affect interpersonal coordination between paired students during stationary basketball dribbling.
2. How does gender of pairings affect interpersonal coordination during stationary basketball dribbling.

Methods

This study utilized stationary basketball dribbling as a task by which we elicited spontaneous social synchronization. Interpersonal coordination has been examined extensively in a sociology setting but never ventured into the realm of physical education. The intention of this study is to determine if gender or motor competence in physical education students could display signs of interpersonal coordination.

Experimental Design

This study was designed in such a way as to examine interactional synchrony between students participating in stationary dribbling. All of the students were enrolled or are currently enrolled in a physical education class within their elementary school. Although various motor movements through mimicry have been studied in a lab setting, no such study has yet examined these behaviors in a gymnasium. The three factors this study plans to compare are gender (male vs. female), motor competency (high vs. low), and social coordination (social bonding). This study will assess the contribution of these factors to overall observed interactional synchrony, assessing factors for the amplification of interactional synchrony. If dominance is seen in one of these factors, it

could then be used as a pairing strategy in a physical education setting to develop further student ability to complete a task required in physical education. Identifying which factor has the most significant impact through a skill like a basketball dribbling will give educators a better understanding of how to optimize student motor learning.

Participants

Participants will be selected from Third and Fourth-grade students within the Grand Forks Public School system. This study will require between 150 and 200 participants. The need to recruit this number of participants is because this study examined dyadic relationships between the students. Factors will classify students; these factors are social connections within their respective class, gender, and motor competence. The combined factors will allow for twenty different dyadic combinations. Thus, the N for this study will be much higher than the number of participants due to these dyadic combinations. Institutional review and approval were provided for this study. Informed consent documentation will be sent home with the participants for their parents and them to review and signed if they want to participate. The gender of each participant will also be self-reported before data collection.

Measures

Motor Competency

Motor competence in stationary basketball dribbling will be measured using the Gross Motor Development (TGMD-2) protocol. This tool is used to assess the motor development of children ages three to eleven who may have a developmental delay or lag

in development in comparison to their peers. This assessment can be used for a variety of locomotor skills like running, galloping, hopping, leaping, and also includes an assessment of manipulative skills like stationary dribbling. The evaluation of each student's motor competence in stationary dribbling will be assessed through three individual trials in which they were not paired with any other students. This will allow a baseline assessment for each student's dribbling motor abilities with no influence from other students.

Social Connections

Socialization is prominent in early childhood and adolescence and plays a significant role in child development. "Children spend significant amounts of time with other children and, in so doing, have extensive opportunities to influence one another" (Hartup, 1999). Children tend to influence one another through modeling, talk, and social reinforcement is no longer in doubt. Some things discussed when considering socialization are non-verbal cues like smiles, laughs, eye-contact, and feedback. Most importantly looking at the critical elements of socialization to form a coding criterion when assessing dribbling film. Students will be evaluated using a socialization coding instrument. These assessments will be conducted to see how socially connected each of the pairings was during each of the trials. During data collection, participants will be given short breaks, during which the cameras will still capture their interactions. These short break times will be coded, as the students are not engaged in their activity, but must be near their partner.

Once individual motor competence and pairing socialization have been assessed, each pairing will be coded using these data. Essentially, each pairing will be given a code which indicates the combined, motor competence, socialization rating, and the gender make-up of the pairing. This code will then be used for groupings during regression analysis.

Interactional Synchrony

Interactional synchrony will be assessed through the output from Optical Flow Analyzer (OFA) which will be assessed through Correlational Mapping Analysis (CMA). Once film data is gathered, optical flow analysis will be conducted utilizing the program OFA. This program, through total pixel movement based on the frame to frame comparisons, provides total horizontal and vertical movement for captured video. OFA additionally, allowed for the delimitation of regions of interest (ROI) within collected film data (Latif, Barbosa, Vatiokiotis-Bateson, Castelhano & Munhall, 2014; Barbosa, Yehia & Vatikiotis-Bateson, 2008). In this experiment, the ROIs were from the top of the participants head to the base of their feet. Because they were performing a stationary dribble, this ROI captured the totality of participant movement during the dribbling trials. Because OFA provides a measurement of total motion in the X and the Y directions of the 2D frame captured, (Latif, Barbosa, Vatiokiotis-Bateson, Castelhano & Munhall, 2014; Barbosa, Yehia & Vatikiotis-Bateson, 2008) this process provided two motion signals for each trial, one for each participant.

Correlational Mapping Analysis. For each of the dyadic pairings, the total movement moment signals will be compared between each participant in a dyadic pairing. A plan to utilize the correlational mapping analysis (CMA) for OFA signal comparisons. CMA allows for the instantaneous comparisons of two signals. Additionally, this allows a positive and negative lag analysis of the signals (Barbosa, Oberg, Dechanine, & Vatikiotis-Bateson, 2010; Latif, Barbosa, Vatiokiotis-Bateson, Castelhano & Munhall, 2014). Essentially, CMA will allow for the determination of correlation between the two identical points in time as well as the correlation between future or past events within the same signal. This feature is particularly well suited for the determination of synchronization between two signals, which in synchronization, there would be expected to be a lag time for the synchronizing participant to implement motion features that could be identified as correlated with the mimicked participant. If CMA only provides the instantaneous correlation between the two signals, it may very well appear there is no instantaneous correlation while a correlation between movement's milliseconds apart may be missed because of the inherent lag with synchronization. Additionally, CMA will provide through the lag mapping of instantaneous correlations to the identification of active correction towards synchronization between participants. With these considerations, it was determined that OFA and CMA provided the necessary data collection and analysis tools to determine if synchronization will occur.

Data Collection

During data collection, four Sony Handycam HDR-CX160 cameras, filming at 60 frames per second, were placed in such a way as to film the entire participant from a profile position in order to capture the motion of each participant dribbling. In this manner, arm motion, as well as basketball motion, was captured within the 2D frame. During this time, students participated in three independent trials ranging from 25-30 seconds using the TGMD-2 protocol for basketball dribbling. Additionally, each participant was positioned in such a way as only to allow them to dribble without distractions. Following these independent trials, students performed dribbling within dyadic pairings. On this day, students were randomly assigned to another participant to dribble with and were assessed using the TGMD-2 protocol. During this paired session, participants were positioned in such a way as only to allow them to see the dribbling of their paired participants. Thus, the only information that the pairings would receive would be visual information, which is a significant factor in the emergence of spontaneous social synchronization. Participants performed three randomized trials with each of the participants.

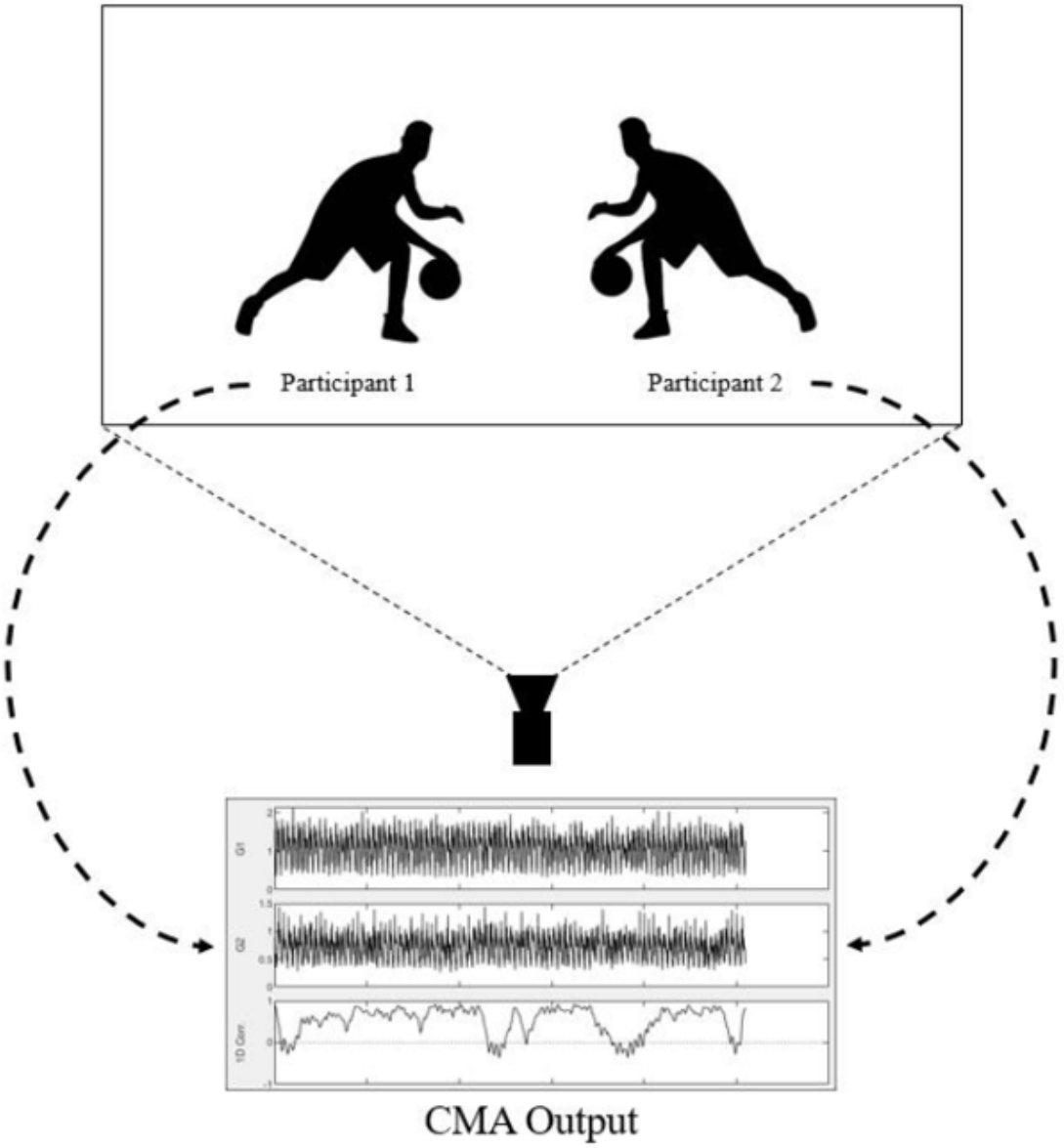

Figure 1: Collection setup

Data Analysis

Optical Flow Analysis. FlowAnalyzer is a piece of software based on Optical Flow Analysis (OFA), a common technique for extracting 2D/3D motion measures from video sequences. When given two pictures, for every pixel, the two-dimensional vector is

needed, which provides displacement of each of the pixels compared to previous frames in this case using segmentation, where dissection in the motion of the basketball. In order to get the most precise measurement of optical flow, it is essential to minimize motion in the camera, causing pixels to change and not the subject or objects motion.

Correlational Mapping Analysis. The CMA method takes two signals as input and computes the correlation coefficient between them as a function of both time and time offset between the signals. This method is used to evaluate the strength of the relationship between two quantitative variables. A high correlation means that two or more variables have a strong relationship with each other, while a weak correlation means that the variables are hardly related. This technique is also connected to the regression analysis that is a statistical approach for modeling the association between a dependent variable or response, and one or more explanatory independent variables.

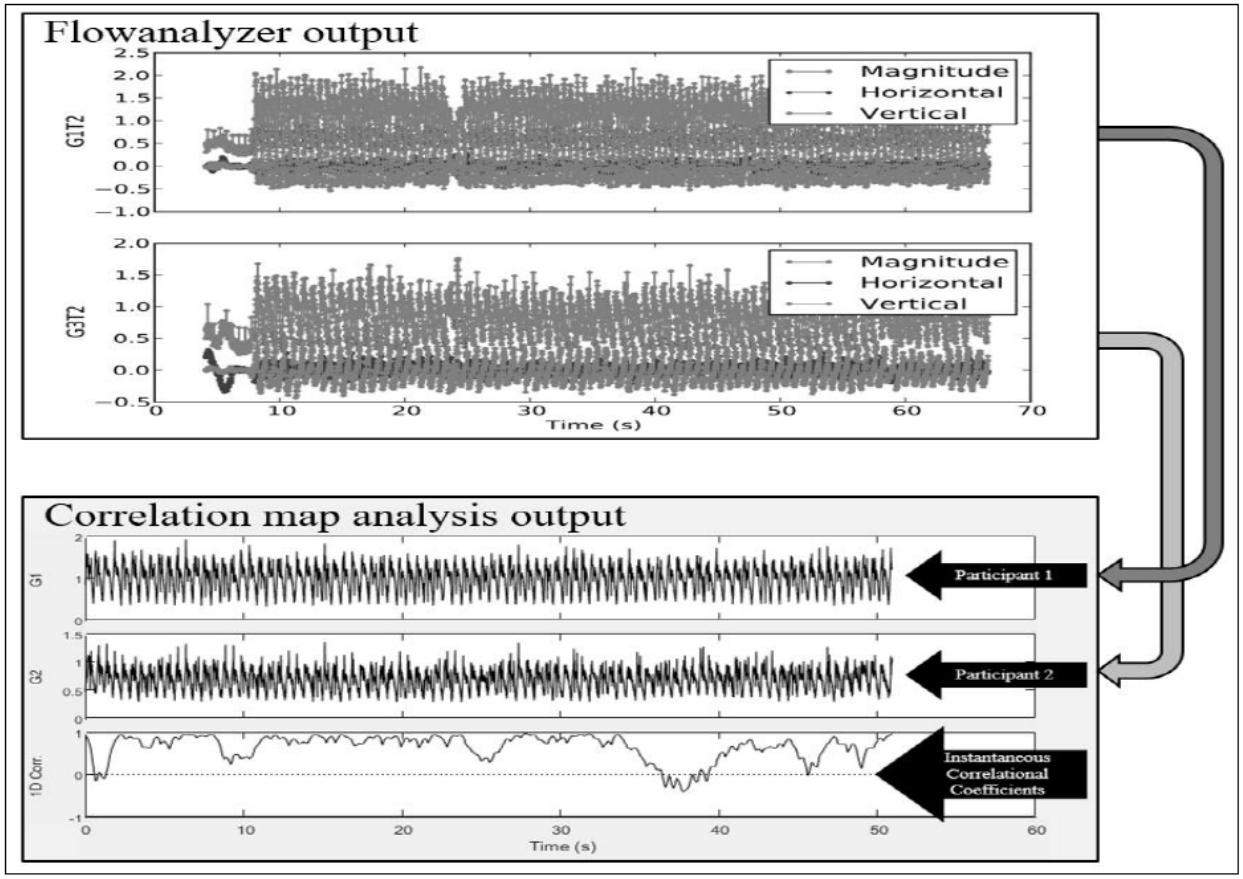

Figure 2: Correlational Mapping Analysis

Statistical Analysis

One way ANOVA's were the primary statistical treatment employed in this study. Specifically, this study sought to determine significant differences in synchronization between different gender pairing configurations as well as significant differences in synchronization scores between delineated groupings of motor competence among partners.

Results

Two primary factors for pairing synchronization were examined in this study, first gender, and secondly, motor competence. Normality testing was conducted for means within these groupings. Histogram findings indicated a normal distribution within these data.

Gender

Results of one way ANOVA indicated significant differences between gender groupings (p=0.003). Post hoc analysis indicates that female pairings synchronize at a higher rate than do male pairings, and mixed-gender pairings also synchronize at a higher rate than male pairings. No significant differences were found between female and mixed-gender pairings.

Table 1. Gender by Synchronization Score Descriptive Statistics

	N	Mean	SD	95% Confidence Interval		Min	Max
				Lower Bound	Upper Bound		
Male Pairings	50	0.08	0.05	0.06	0.09	-0.02	0.21
Mixed Pairings	84	0.12	0.12	0.10	0.15	-0.08	0.62
Female Pairings	48	0.15	0.11	0.11	0.18	-0.01	0.40
Total	182	0.12	0.10	0.10	0.13	-0.08	0.62

Table 2. One-Way ANOVA Gender X Synchronization Score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.12	2	0.06	5.93	0.003
Within Groups	1.81	179	0.01		
Total	1.93	181			

Table 3. Bonferroni Post Hoc Analysis

(I) Group Type Gender Code	(J) Group Type Gender Code	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1	2	-0.05	0.02	0.034	-0.09	0.00
	3	-0.07	0.02	0.003	-0.12	-0.02
2	1	0.05	0.02	0.034	0.00	0.09
	3	-0.02	0.02	0.691	-0.07	0.02
3	1	0.07	0.02	0.003	0.02	0.12
	2	0.02	0.02	0.691	-0.02	0.07

Motor Competency

Additionally, one-way ANOVA testing was conducted between delineated groupings of motor competency. The delineated motor competency was established as follows. Pairings that were perfectly matched that is, a partner with excellent motor skill being paired with a similarly skilled partner would have a ratio of skill – 1, where partners who were paired inequitably would have a ratio nearing 0. In this study, a large number of participants were nearly perfectly matched. Thus the delineated of perfect match vs. non-perfect match was developed. The determination of a perfect match was a motor competence ratio of .9 or higher. Not perfect was determined to be less than .9.

One way ANOVA testing indicated that there were no significant differences in synchronization scores between perfect pairings and non-perfect pairings. P=(0.172)

Table 4. Motor Competence Pairings by Synchronization Score Descriptive Statistics

Motor Competency Pairings	N	Mean	SD	95% Confidence		Min	Max
				Lower Bound	Upper Bound		
Imperfect	57	0.10	0.07	0.08	0.12	-0.01	0.33
Perfect	125	0.12	0.11	0.10	0.14	-0.08	0.62
Total	182	0.12	0.10	0.10	0.13	-0.08	0.62

Table 5. One-Way ANOVA Motor Competency Pairings X Synchronization Score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.02	1	0.02	1.88	0.172
Within Groups	1.91	180	0.01		
Total	1.93	181			

Discussion

It has been speculated that a phenomenon known as interpersonal coordination could have a positive effect on achievement within physical education (Rhoades & Hopper, 2017;2019). In academia, student learning and engagement is held to a high standard by practitioners. Research has extensively conducted on this phenomenon within sociology (Chartrand & Lakin, 2013); however, within physical education, this is a much less explored area.

Interpersonal coordination is highly dependent on a variety of interpersonal factors. Namely, pre-existing rapport and affiliation are strong predictors of interpersonal coordination. Additionally, in physical education, pairing strategies are used daily to allow students opportunities to socialize and develop skills. These pairing strategies are essential to give students more time to build on pre-existing skills or begin to develop new skills. It is known that humans in general can be conceptualized as complex adaptive neurobiological systems (Rhoades, Hopper. 2018). Students in a physical education setting fit this description based on the combination of muscles, neurons, and bone while exchanging energy, matter, and information within their environment as they are influence it and each other within it. Through partnerships and this exchange in information in their environment; it is thought to have a positive impact on interpersonal coordination, specifically synchronization between students demonstrating and practicing skills associated with physical education. Through the ecological task analysis model that has been adapted from Davis and Burton on three main criteria; task, learner, and

environment. Task constraints are those that include the goal of the specific task, riles, and implements or equipment that can assist in the learning experience. (Rhoades, Hopper. 2017;2019). Learner constraints are those that students must individually address. Some examples to consider are cognitive ability, expected social interaction, and past experience which all directly affect the student and cause changes in overall emergent behaviors as the individual ages and becomes more experienced in the task. The primary focus is the environmental constraints which consist of surroundings, social setting, ambient noise, and anything within the learning environment (Rhoades & Hopper, 2017;2019). These social settings like peer groups, social, and cultural expectations all play an important role. "Motor learning is often strongly influenced by group expectations, trends and fashions, and the presence of critical group members such as the teacher or classmates" (Chow et al., 2007, p. 264). With the establishment of partnerships in the physical education setting it is assumed based on the above literature that environment could elicit the characteristics of interpersonal coordination. It is through this established relationship between partners within physical education that researchers have speculated that interpersonal coordination could have a powerful impact on achievement within physical education. However, before the effect of synchronization can be adequately studied within physical education a better understanding of the underlying factors for interpersonal coordination within physical education must be gained.

Gender

The data gathered in this study suggest females tend to synchronize their behaviors at a bit of a higher rate than their male counter parts. Interestingly it was also found that when males were paired with females, they tended to synchronize at a higher rate than when they were paired only with other males. This finding is not necessarily surprising in that there is a preponderance of literature with indicates that females tend to socialize differently than males. "…the idea that males learn masculinity and masculine impressions in opposition to femininity and feminine behavior is examined" (Carter, 2014). The emphasis is that there is a stigma placed on roles and tasks in society can be found. "Doing yard work, cooking in the kitchen, caring for children, working on a presentation for one's boss-activities such as these often carry some form of gendered meaning…" (Carter, 2014). The female population is socialized to be caring and less competitive than males being socialized to be competitive. The speculation is that the data gathered on female counterparts are due to societal constraints forcing them to be competitive; in this case alter the pace of their dribbling which would in turn support these findings. Socialization, preexisting rapport, affiliation, desire to affiliate, have all been found to have significant effects on interpersonal coordination. Thus, it isn't extremely surprising that females would synchronize at a higher rate than their male counterparts.

Motor Competence

Interestingly motor competence was not found in any way to influence the propensity for synchronization within pairings. This finding has no other study to depend on for support. However, this is a very impactful finding in the framework of this study. Specifically, one major goal of this research is to identify methods by which a teacher could increase interpersonal coordination among their students. This finding indicates that motor competence is not necessarily a predicate ability for interpersonal coordination. Importantly, this indicates that while it is not necessarily a predicate for the emergence of interpersonal coordination, it is neither a hinderer. Which is extremely important. If a teacher were to pair students in such a way as to increase interpersonal coordination, motor competence would not be an inhibitor in this effort. Specifically, a teacher would be able to pair outside of inclusive motor competency groupings which typically are the basis for groupings within physical education().

Limitations

Interactional synchrony has been examined heavily in a laboratory setting but has never been explored in the physical education setting. There is some question in regard to this being strictly a phenomenon in physical education. Another argument one could make is that there is rarely any stationary activities done in physical education. The idea of observing interactional synchrony through stationary basketball dribbling could be seen as invalid. Physical education curricula requires students to be moving and active for the larger duration of their class period, very rarely is there going to be stationary tasks

done within the setting. One problem that was discovered when testing motor competency was the ratio of perfect versus non-perfect TGMD-2 scores. There was a much larger number of perfect scores in comparison to their non-perfect counterparts that what was ideal from a validity standpoint.

Conclusion

Following the study, gender was found to be a significant predictor for interpersonal coordination. Previous literature has shown that males and females socialize differently for a variety of reasons so this resulted in an expectation for both genders to socialize at a different rate. Motor competency was found to have no significance as an inhibitor of interpersonal coordination. When developing physical education curricula, if there was a push to elicit interpersonal coordination; motor competency could be swept over and have little effect to increase student learning. Educators and curricula developers dissect an entire subject and select the most important learning objectives for their students to achieve. The push to acquire a different look at pairing strategies should be considered by pairing students according to gender to show an increase in student learning.

In physical education, it has been extensively debated as to the perfect way to pair students for optimal learning. In many instances, pairing students is required to hone in on specific skills that their instructor wants them to accomplish or needed for space constraints. The ideal situation would be to have a solution that was best for the students to enhance learning of new skills or reviewing previously learned skills.

In this study it was determined that gender is a significant predictor, yet motor competency is not a significant predator. These findings are significant, in that, if interpersonal coordination is a moderator of achievement, then teachers should be able to amplify the amount of learning through mixed gender groupings.

Additionally, and seemingly more importantly, motor competency as an insufficient factor of interpersonal coordination, suggests that differentiated ability groupings would still allow for interpersonal coordination to emerge within a group of students. These findings should allow researchers to specifically examine student pairings to determine leaning outcomes from the interpersonal coordination.

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APPENDIX A

Motor Competency's Relationship to Interpersonal Coordination in Stationary Basketball Dribbling

Abstract

Inclusion and equitable learning environments are areas of emphasis for practitioners while trying to find new ways to elicit these things to benefit students. Interpersonal coordination (IC), a social phenomenon on which this study focused, has direct applications for pairing strategies in physical education. The phenomenon represents a compelling possibility for student learning through an ecological cognition perspective.

Methods: IC was measured between student pairing performing stationary basketball dribbling. Participants included elementary aged students from area elementary schools and were randomly assigned partners. All pairings performed three dribbling trials of thirty seconds. Trials were filmed with a video recorder collecting at 60fps. Overall, data for 182 pairings were collected. Optical Flow Analysis (OFA) allowed the quantification of dribbling motions, was performed for each student in each pairing for all trials. Correlational Mapping Analysis (CMA) determined the degree of coordination between partners for pairings during each trial. Dribbling competence was measured using the Test of Gross Motor Development version two (TGMD-2) for stationary dribbling. Gender categories were male, female, and mixed pairings. Stepwise regression was conducted to determine significant factors for IC within pairings. In addition, ANOVAs compared means of IC between gender pairings.

Results: It was found that dribbling competence was not a significant factor for IC. However, gender was found to be a significant factor. Specifically, female pairings were found to have significantly higher rates of IC than male pairings. More so, mixed pairings had significantly higher IC than male pairings.

Discussion/Conclusion: Foremost, gender as a factor for IC is not necessarily surprising in that previous observations of IC have linked it as an affiliative social response. Gender, being a strong social motivator should have some influence on IC. Interestingly, male pairings had significantly lower IC than female and mixed pairings. This finding suggests that an instructional designer with aspirations of increasing IC should have the ability to accomplish this at a higher rate through inclusive mixing of genders rather than separation. Surprisingly, motor competence through basketball dribbling was not a significant factor. This result suggests that a teaching strategy could be designed in which motor competence may not be as big of a barrier than the previous literature suggests. An instructional designer that would like to see an increase in IC could be possible without segregating based on skill level. In conclusion, these findings suggest that high rates of IC may be achievable through an inclusive pairing strategy.

Wordcount: 400

Keywords: Interpersonal Coordination, Student learning, Curricular Design

In a physical education learning environment, a grand debate has been waged to determine the best way to pair students when working on skills needed for life-long physical activity (Shimon, 2019). It has been found that being chosen last for teams, lacking perceived competence in the activity or sport, being made to feel incompetent by the PE instructor or other classmates, or embarrassment from injury will result in decreased participation during class time (Ladwig et al., 2018). This could then lessen an individual's willingness to try new things and feel less competent with the task at hand. If a student with a low motor competence is paired with a student of higher motor competency, could this be detrimental to the success of both students? Additionally, in recent years it has been speculated that there should be a further emphasis placed on pairing strategies due to a phenomenon referred to as interpersonal coordination. It has been speculated that interpersonal coordination could be a powerful mediator of student learning (Rhoades & Hopper, 2017;2019). If this is true, pairing students to encourage interpersonal coordination may be another reason to concentrate attention on student pairings.

In physical education, it is essential to find the best method to develop a student's ability to process new information and perform a given task to their highest ability. Socialization is also a skill needed to gain more knowledge on a topic, ask questions, and even provide peer feedback on misunderstandings. Socialization is not always spoken; it can be conveyed through body language or mannerisms.

This study will concentrate on the phenomenon of Interpersonal Coordination (IC). This phenomenon is generally demonstrated through the automatic imitation of gestures, postures, mannerisms, and other motor movements (Chartrand, 2012). "This has also been coined the term the chameleon effect, which refers to this nonconscious mimicry usually happening passively and unintentionally to match that of the others in one's current social environment" (Chartrand, Bargh 1999). Just as chameleons change their coloring to blend in with their current environment, an experimental demonstration of a behavioral chameleon effect should incorporate, as a within-subjects factor, variability in the behavior of interaction partners, to show that the participant's behavior changes accordingly (Chartrand, Bargh 1999).

Physical Education

Childhood obesity has been on the rise for the past three decades, and the statistics prove it (CDC). Increases in childhood overweightness and obesity have become a significant public health problem in nearly all industrialized nations. In Canada, rates of overweight and obesity among children have more than doubled in the past three decades, with the most recent estimates indicating that about 30% of children are overweight or obese (Veugelers, 2005). In 2003, a study surveyed grade five students, their parents, and school principals in Nova Scotia. The methods indicated that height and weight were measured, as well as assessing dietary habits using Harvard's Youth/Adolescent Food Frequency Questionnaire as well as measuring physical and

sedentary activities. The results indicated that physical education classes two or more times a week at school were associated with a decreased risk of overweight (OR 0.61, 95% CI 0.43-0.87) and obesity (OR 0.54, 95% CI 0.33-0.88). Tracking data supports the persistence of obesity, at least in later childhood, as well as cardiovascular risk factors (Steinbeck, 2008). Physical activity is the discretionary component of energy expenditure, and there is evidence that falling levels of physical activity are contributing to the obesity epidemic. Physical education is slowly being cut out of educational curricula being seen as "less important" and, in some cases, unimportant in comparison to other core subjects. Those core subjects being Mathematics, English, and Sciences. To improve standardized test scores, the time spent in the classroom is beginning to increase while the time in physical education classes is decreasing (Wilkins et al., 2003).

Quality Daily Physical Education

"Physical activity every day has shown many health benefits like bone and muscle strength, improved muscular strength and endurance, reduced risk for developing chronic disease risk factors, improved self-esteem, and reduced stress and anxiety" (Rasberry et al., 2011). It is estimated that nearly half of youths meet the U.S. Department of Health and Human Services *Physical Activity Guidelines for Americans* recommendation of at least 60 minutes of daily moderate-to-vigorous physical activity. A study conducted examining the relationship between physical fitness and academic achievement in 259 public school students in third and fifth grades found that field tests of fitness were positively related to academic success. Specifically, aerobic capacity was positively associated with achievement, whereas BMI was inversely related (Castelli et al., 2007). This article suggests that physical fitness may be related to academic performance in preadolescents.

Trends in high motor competence in preadolescents have shown positive correlations in academic achievement globally. A cross-sectional study conducted in Portugal evaluated the relationship between gross motor coordination and academic performance in native children. Gross motor coordination (MC) was evaluated using a German test called Korperkoordination Test fur Kinder. Academic achievement (AA) was assessed using the Portuguese Language and Mathematics National Exams that are mandatory for all 4th-grade students. Some of the physical fitness aspects measured were cardiorespiratory fitness, balance, lateral jumping, one leg hops, and shifting platforms (Lopes et al., 2013). It was found that children with insufficient MC or MC disorders exhibited a higher probability of having low AA. This study suggests that early identification of children with poor MC is crucial to implementing activities that develop health-related behaviors. As a result of the implementation of these new behaviors, students should show signs of increased MC, therefore, increasing their academic success in a classroom setting.

Interpersonal Coordination

Interpersonal coordination is typically described with two terms: behavioral mimicry and interactional synchrony; they are similar or identical in form, or they occur

at roughly or precisely the same time. Interpersonal coordination is the tendency for individuals to implicitly synchronize their behavioral and linguistic communication patterns during social interactions. If an individual is observing his or her partner complete a task, that individual may try their best to replicate the behavior to be as close to their companion as possible. This is where the phenomena of interpersonal coordination shine through. "Behavioral mimicry is defined as a form of interpersonal coordination and the automatic imitation of gestures, postures, mannerisms, and other motor movements" (Chartrand, 2012). A variety of factors determine more or less mimicry of an interaction partner like motivational, social, emotional, and personality factors. Based on recent research, there are many downstream consequences of mimicking or being mimicked by another person, including increased prosociality between interactants and other unexpected effects like cognitive processing style, attitudes, consumer preferences, self-regulatory ability, and academic performance (Chartrand, 2012). Mimicry is assessed by people that are engaging in the same action at a specific time, or a particular behavior is repeated by an interaction partner within a short window of time, typically no longer than three to five seconds. Behavioral mimicry has been explored in a variety of motor movements like yawning, body posture, face touching, foot shaking, and even food consumption.

Intentional imitation happens all the time, and this is an essential component of social learning (Bandura, 1977). The mimicry of gross and fine motor movements (e.g., gestures, mannerisms, finger movements), facial expressions, and vocalizations are often nonconscious, unintentional, and effortless (Chartrand, 2012). Mimicry has been of interest to researchers for decades, and this interest has yielded an extensive literature replete with fascinating examples and demonstrations of the ways individuals mimic others (Lakin 2003). Based on the information provided about this subconscious behavior on motor movements, these unintentional matching movement patters in a physical education classroom. The saying "monkey see, monkey do" suggests that primates, including humans, are quite good at imitation; and has generally been considered to be an intentional, goal-directed activity (Chartrand, Bargh 1999).

Behavioral mimicry always yields behaviors that are similar in form and close in timing, interactional synchrony may or may not yield behaviors that are similar in form (Chartrand, Lakin 2013). The timing of behaviors is critical to determine whether one person is in sync with others. "The complexity of the issue of timing in interactional synchrony cannot be underestimated; because interactional synchrony involves more than one person, it requires anticipation of another person's behaviors so that movement can be coordinated" (Chartrand, Lakin 2013). An individual may be trying to synchronize with their peer counterpart by catching up to their rhythm, creating a brief lag when observing the recorded pairing. With the use of software, there will be the ability to offset the delay to ensure true synchronization is occurring. Interactional synchrony is generally explored in infancy when the subject mirrors the actions of another person. Facial expressions and body movements like moving their body in tune with the rhythm of their

caregiver or mother. Basketball dribbling is a rhythmic manipulative skill when performed correctly; these rhythms can be detected when comparing two interactants engaging in the skill. This synchrony is defined as "the precise coordination of body movement between interactants."

It has been speculated that interpersonal coordination, could be a powerful facilitator of learning within physical activity based learning environments (Rhoades & Hopper, 2017;2019). Thus, all of the benefits for motor competency which have been sited earlier in this manuscript, would benefit from a determination of significant factors for interpersonal coordination.

Constructivism

The foundation for the hypothesis of interpersonal coordination as a moderator of psychomotor learning can be found in constructivism (Rhoades & Hopper, 2017;2019). Constructivism is the belief that people construct their understanding and knowledge of the world. As humans, this experience of new things happens quite often, causing us to reconcile them with our previous ideas or experiences. Daily, humans go through this process of acquiring new information that may change a current belief or discard the new information. Constructivist teachers are always encouraging students to assess an activity, allowing them to gain understanding. As an individual continuously reflects on their experiences, students find their ideas gaining complexity and power with a strong ability to integrate new information. There was a belief that constructivism removes the active role of the teacher; in reality, it is a role modification allowing students to construct knowledge rather than reproduce facts. Constructivism consistently gets this schema of changing education and learning theories, but it makes learning more curious and questioning to generate new ideas from previous knowledge. When observing interpersonal coordination through a lens of constructivism, it becomes apparent that either interactional synchrony or behavioral mimicry is not merely the replication of observed actions. These phenomena would represent construction of knowledge at the student's local level. That is the knowledge that has been constructed through their interactions with others at a non-conscious level. Essentially, this phenomenon represents an underlying non-conscious learning network, which is particularly impactful for motor learning.

Motor Learning and Physical Activity

Motor learning is when complex processes in the brain occur in response to practice and experience a particular skill resulting in changes in the central nervous system that allow a new motor skill to be acquired. In an article titled "*The Dynamic Association Between Motor Skill Development and Physical Activity"* by David Stodden:

> Motor skill competence is defined in terms of common fundamental motor skills (FMS): object control (e.g., throw and kick) and locomotor skills (e.g., run and hop). A common misconception is that children "naturally" attain proficient levels of FMS; however, many children do not (Clark, 2007; Goodway & Branta, 2003;

> Goodway, Suminski, & Ruiz, 2003; Langendorfer & Roberton, 2002a, b). Many of these children may not attain sufficient competence in FMS to apply these skills to lifelong physical activity in adolescence or adulthood (Goodway & Branta, 2003; Goodway et al., 2003).

This article from the above quote goes on to discuss the importance of students learning and developing the skills needed to participate in lifelong physical activity. It is essential to understand the chain of events that all cause this obesity epidemic, to safely say that the problem is beginning to develop rapidly at a younger age. This article goes on to discuss mediating variables and that the sum of these mediating variables promotes either a negative or positive spiral of engagement in physical activity. "The low-skilled children ultimately perceive themselves as having little motor skill competence, and thus they choose not to engage in physical activity, become less fit, and move further into the negative spiral of disengagement from physical activities, games, and sports" (Stodden et al., 2007). An essential aspect of developing motor skills is the type of feedback you receive, which is a massive component of a physical education classroom. If students get the reassurance they need to feel competent in any given skill, they will likely continue to develop their competence in that skill and encounter the positive spiral of engagement. This could then result in high levels of physical activity, and minimal sedentary behavior will place the individuals at a smaller risk for obesity during adolescence and adulthood.

As a country facing an obesity epidemic, identifying new factors that affect the growth and development of children during adolescence is crucial. Physical activity through physical education has been proven to positively reinforce standardized test scores in various regions around the world (Chomitz, 2008). Physical education teachers need to show support through physical education curricula. These student perceptions of their physical education class will, in turn, affect how physically active they are for the remainder of their life (Ladwig, 2018). Structuring feedback while leading with importance and beneficial versus negativity and repression, students will be more likely to engage in physical activity if they feel inclusion in the physical education classroom. While it is known that daily physical activity should be approximately 60 minutes, this benchmark also helps develop body fat tissue, skeletal muscle tissue, and bone (Kirk, 2005). If physical educators develop an understanding and ability to harness interpersonal coordination in their classes, students will become more motor competent. Finally, in turn, this will combat the overarching problem our country is facing with unhealthy habits leading to obesity.

Significance and Purpose

It has been speculated that Interpersonal coordination may have considerable positive impacts on learning within physical education (Rhoades & Hopper, 2017;2019). Constructivism as a learning theory also points to this possibility. If interpersonal coordination does amplify learning, carefully understanding factors which modulate

interpersonal coordination will be vital for curriculum designers. With this in mind, interpersonal coordination and its factors for emergence, has been heavily examined within the laboratory environment (Chartrand and Lakin, 2013) and factors for coordination have been determined for a wide variety of situations. However, two specific factors within physical education have yet to be examined, gender and motor competency. Understanding these two additional factors for interpersonal coordination in physical education could allow instructional designers to create learning environments in which interpersonal coordination would emerge at higher rates. If interpersonal coordination has an effect on achievement in physical education, better understanding these factors will be essential for instructional design. Additionally, once these factors are better understood, the effects of interpersonal coordination can be researched more effectively. Essentially, the establishment of control and experimental groupings within physical education will be made easier, if rates of interpersonal coordination can be increased within experimental groupings. Until we better understand specific methods increase interpersonal coordination among groupings testing the underlying effects of interpersonal coordination of on student learning will need to wait. Thus, the purpose of this study was to assess factors for interpersonal coordination, in an effort to determine factors for increasing this phenomenon within a physical activity based learning environment.

Research Question

1. How does pre-existing motor competence effect interpersonal coordination between paired student during stationary basketball dribbling.
2. How does gender of pairings effect interpersonal coordination during stationary basketball dribbling.

Methods

This study utilized stationary basketball dribbling as a task by which we elicited spontaneous social synchronization. Interpersonal coordination has been examined extensively in a sociology setting but never ventured into the realm of physical education. The intention of this study is to determine if gender or motor competence in physical education students could display signs of interpersonal coordination.

Experimental Design

This study was designed in such a way as to examine interactional synchrony between students participating in stationary dribbling. All of the students were enrolled or are currently enrolled in a physical education class within their elementary school. Although various motor movements through mimicry have been studied in a lab setting, no such study has yet examined these behaviors in a gymnasium. The three factors this study plans to compare are gender (male vs. female), motor competency (high vs. low), and social coordination (social bonding). This study will assess the contribution of these factors to overall observed interactional synchrony, assessing factors for the

amplification of interactional synchrony. If dominance is seen in one of these factors, it could then be used as a pairing strategy in a physical education setting to develop further student ability to complete a task required in physical education. Identifying which factor has the most significant impact through a skill like a basketball dribbling will give educators a better understanding of how to optimize student motor learning.

Participants

Participants will be selected from Third and Fourth-grade students within the Grand Forks Public School system. This study will require between 150 and 200 participants. The need to recruit this number of participants is because this study examined dyadic relationships between the students. Factors will classify students; these factors are social connections within their respective class, gender, and motor competence. The combined factors will allow for twenty different dyadic combinations. Thus, the N for this study will be much higher than the number of participants due to these dyadic combinations. Institutional review and approval were provided for this study. Informed consent documentation will be sent home with the participants for their parents and them to review and signed if they want to participate. The gender of each participant will also be self-reported before data collection.

Measures

Motor Competency

Motor competence in stationary basketball dribbling will be measured using the Gross Motor Development (TGMD-2) protocol. This tool is used to assess the motor development of children ages three to eleven who may have a developmental delay or lag in development in comparison to their peers. This assessment can be used for a variety of locomotor skills like running, galloping, hopping, leaping, and also includes an assessment of manipulative skills like stationary dribbling. The evaluation of each student's motor competence in stationary dribbling will be assessed through three individual trials in which they were not paired with any other students. This will allow a baseline assessment for each student's dribbling motor abilities with no influence from other students.

Social Connections

Socialization is prominent in early childhood and adolescence and plays a significant role in child development. "Children spend significant amounts of time with other children and, in so doing, have extensive opportunities to influence one another" (Hartup, 1999). Children tend to influence one another through modeling, talk, and social reinforcement is no longer in doubt. Some things discussed when considering socialization are non-verbal cues like smiles, laughs, eye-contact, and feedback. Most importantly looking at the critical elements of socialization to form a coding criterion when assessing dribbling film. Students will be evaluated using a socialization coding instrument. These assessments will be conducted to see how socially connected each of the pairings was during each of the trials. During data collection, participants will be given short breaks, during which the cameras will still capture their interactions. These

short break times will be coded, as the students are not engaged in their activity, but must be near their partner.

Once individual motor competence and pairing socialization have been assessed, each pairing will be coded using these data. Essentially, each pairing will be given a code which indicates the combined, motor competence, socialization rating, and the gender make-up of the pairing. This code will then be used for groupings during regression analysis.

Interactional Synchrony

Interactional synchrony will be assessed through the output from Optical Flow Analyzer (OFA) which will be assessed through Correlational Mapping Analysis (CMA). Once film data is gathered, optical flow analysis will be conducted utilizing the program OFA. This program, through total pixel movement based on the frame to frame comparisons, provides total horizontal and vertical movement for captured video. OFA additionally, allowed for the delimitation of regions of interest (ROI) within collected film data (Latif, Barbosa, Vatiokiotis-Bateson, Castelhano & Munhall, 2014; Barbosa, Yehia & Vatikiotis-Bateson, 2008). In this experiment, the ROIs were from the top of the participants head to the base of their feet. Because they were performing a stationary dribble, this ROI captured the totality of participant movement during the dribbling trials. Because OFA provides a measurement of total motion in the X and the Y directions of the 2D frame captured, (Latif, Barbosa, Vatiokiotis-Bateson, Castelhano & Munhall, 2014; Barbosa, Yehia & Vatikiotis-Bateson, 2008) this process provided two motion signals for each trial, one for each participant.

Correlational Mapping Analysis. For each of the dyadic pairings, the total movement moment signals will be compared between each participant in a dyadic pairing. A plan to utilize the correlational mapping analysis (CMA) for OFA signal comparisons. CMA allows for the instantaneous comparisons of two signals. Additionally, this allows a positive and negative lag analysis of the signals (Barbosa, Oberg, Dechanine, & Vatikiotis-Bateson, 2010; Latif, Barbosa, Vatiokiotis-Bateson, Castelhano & Munhall, 2014). Essentially, CMA will allow for the determination of correlation between the two identical points in time as well as the correlation between future or past events within the same signal. This feature is particularly well suited for the determination of synchronization between two signals, which in synchronization, there would be expected to be a lag time for the synchronizing participant to implement motion features that could be identified as correlated with the mimicked participant. If CMA only provides the instantaneous correlation between the two signals, it may very well appear there is no instantaneous correlation while a correlation between movement's milliseconds apart may be missed because of the inherent lag with synchronization.

Additionally, CMA will provide through the lag mapping of instantaneous correlations to the identification of active correction towards synchronization between participants. With these considerations, it was determined that OFA and CMA provided the necessary data collection and analysis tools to determine if synchronization will occur.

Data Collection

During data collection, four Sony Handycam HDR-CX160 cameras, filming at 60 frames per second, were placed in such a way as to film the entire participant from a profile position in order to capture the motion of each participant dribbling. In this manner, arm motion, as well as basketball motion, was captured within the 2D frame. During this time, students participated in three independent trials ranging from 25-30 seconds using the TGMD-2 protocol for basketball dribbling. Additionally, each participant was positioned in such a way as only to allow them to dribble without distractions. Following these independent trials, students performed dribbling within dyadic pairings. On this day, students were randomly assigned to another participant to dribble with and were assessed using the TGMD-2 protocol. During this paired session, participants were positioned in such a way as only to allow them to see the dribbling of their paired participants. Thus, the only information that the pairings would receive would be visual information, which is a significant factor in the emergence of spontaneous social synchronization. Participants performed three randomized trials with

<INSERT FIGURE 1 HERE>

Data Analysis

Optical Flow Analysis. FlowAnalyzer is a piece of software based on Optical Flow Analysis (OFA), a common technique for extracting 2D/3D motion measures from video sequences. When given two pictures, for every pixel, the two-dimensional vector is needed, which provides displacement of each of the pixels compared to previous frames in this case using segmentation, where dissection in the motion of the basketball. In order to get the most precise measurement of optical flow, it is essential to minimize motion in the camera, causing pixels to change and not the subject or objects motion.

Correlational Mapping Analysis. The CMA method takes two signals as input and computes the correlation coefficient between them as a function of both time and time offset between the signals. This method is used to evaluate the strength of the relationship between two quantitative variables. A high correlation means that two or more variables have a strong relationship with each other, while a weak correlation means that the variables are hardly related. This technique is also connected to the regression analysis that is a statistical approach for modeling the association between a dependent variable or response, and one or more explanatory independent variables.

<INSERT FIGURE 2 HERE>

Statistical Analysis

One way ANOVA's were the primary statistical treatment employed in this study. Specifically, this study sought to determine significant differences in synchronization between different gender pairing configurations as well as significant differences in synchronization scores between delineated groupings of motor competence among partners.

Results

Two primary factors for pairing synchronization were examined in this study, first gender, and secondly, motor competence. Normality testing was conducted for means within these groupings. Histogram findings indicated a normal distribution within these data.

Gender

Results of one way ANOVA indicated significant differences between gender groupings (p=). Post hoc analysis indicates that female pairings synchronize at a higher rate than do male pairings, and mixed-gender pairings also synchronize at a higher rate than male pairings. No significant differences were found between female and mixed-gender pairings.

Motor Competency

Additionally, one-way ANOVA testing was conducted between delineated groupings of motor competency. The delineated motor competency was established as follows. Pairings that were perfectly matched that is, a partner with excellent motor skill being paired with a similarly skilled partner would have a ratio of skill – 1, where partners who were paired inequitably would have a ratio nearing 0. In this study, a large number of participants were nearly perfectly matched. Thus the delineated of perfect match vs. non-perfect match was developed. The determination of a perfect match was a motor competence ratio of .9 or higher. Not perfect was determined to be less than .9. One way ANOVA testing indicated that there were no significant differences in synchronization scores between perfect pairings and non-perfect pairings. P=(.05)

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Discussion

It has been speculated that a phenomenon known as interpersonal coordination could have a positive effect on achievement within physical education (Rhoades & Hopper, 2017;2019). In academia, student learning and engagement is held to a high standard by practitioners. Research has extensively conducted on this phenomenon within

sociology (Chartrand & Lakin, 2013); however, within physical education, this is a much less explored area.

Interpersonal coordination is highly dependent on a variety of interpersonal factors. Namely, pre-existing rapport and affiliation are strong predictors of interpersonal coordination. Additionally, in physical education, pairing strategies are used daily to allow students opportunities to socialize and develop skills. These pairing strategies are essential to give students more time to build on pre-existing skills or begin to develop new skills. It is known that humans in general can be conceptualized as complex adaptive neurobiological systems (Rhoades, Hopper. 2018). Students in a physical education setting fit this description based on the combination of muscles, neurons, and bone while exchanging energy, matter, and information within their environment as they are influence it and each other within it. Through partnerships and this exchange in information in their environment; it is thought to have a positive impact on interpersonal coordination, specifically synchronization between students demonstrating and practicing skills associated with physical education. Through the ecological task analysis model that has been adapted from Davis and Burton on three main criteria; task, learner, and environment. Task constraints are those that include the goal of the specific task, riles, and implements or equipment that can assist in the learning experience. (Rhoades, Hopper. 2017;2019). The primary focus is the environmental constraints which consist of surroundings, social setting, ambient noise, and anything within the learning environment (Rhoades & Hopper, 2017;2019). These social settings like peer groups, social, and cultural expectations all play an important role. “Motor learning is often strongly influenced by group expectations, trends and fashions, and the presence of critical group members such as the teacher or classmates” (Chow et al., 2007, p. 264). With the establishment of partnerships in the physical education setting it is assumed based on the above literature that environment could elicit the characteristics of interpersonal coordination. It is through this established relationship between partners within physical education that researchers have speculated that interpersonal coordination could have a powerful impact on achievement within physical education.

Gender

The data gathered in this study suggest females tend to synchronize their behaviors at a bit of a higher rate than their male counter parts. Interestingly it was also found that when males were paired with females, they tended to synchronize at a higher rate than when they were paired only with other males. This finding is not necessarily surprising in that there is a preponderance of literature with indicates that females tend to socialize differently than males. “…the idea that males learn masculinity and masculine impressions in opposition to femininity and feminine behavior is examined” (Carter, 2014). The emphasis is that there is a stigma placed on roles and tasks in society can be found. “Doing yard work, cooking in the kitchen, caring for children, working on a presentation for one’s boss-activities such as these often carry some form of gendered meaning…” (Carter, 2014). The female population is socialized to be caring and less

competitive than males being socialized to be competitive. The speculation is that the data gathered on female counterparts are due to societal constraints forcing them to be competitive; in this case alter the pace of their dribbling which would in turn support these findings. Socialization, preexisting rapport, affiliation, desire to affiliate, have all been found to have significant effects on interpersonal coordination. Thus, it isn't extremely surprising that females would synchronize at a higher rate than their male counterparts.

rom a validity standpoint.

Conclusion

Following the study, gender was found to be a significant predictor for interpersonal coordination. Previous literature has shown that males and females socialize differently for a variety of reasons so this resulted in an expectation for both genders to socialize at a different rate. Motor competency was found to have no significance as an inhibitor of interpersonal coordination. When developing physical education curricula, if there was a push to elicit interpersonal coordination; motor competency could be swept over and have little effect to increase student learning. Educators and curricula developers dissect an entire subject and select the most important learning objectives for their students to achieve. The push to acquire a different look at pairing strategies should be considered by pairing students according to gender to show an increase in student learning.

In physical education, it has been extensively debated as to the perfect way to pair students for optimal learning. In many instances, pairing students is required to hone in on specific skills that their instructor wants them to accomplish or needed for space constraints. The ideal situation would be to have a solution that was best for the students to enhance learning of new skills or reviewing previously learned skills.

In this study it was determined that gender is a significant predictor, yet motor competency is not a significant predator. These findings are significant, in that, if interpersonal coordination is a moderator of achievement, then teachers should be able to amplify the amount of learning through mixed gender groupings.

Additionally, and seemingly more importantly, motor competency as an insufficient factor of interpersonal coordination, suggests that differentiated ability groupings would still allow for interpersonal coordination to emerge within a group of students. These findings should allow researchers to specifically examine student pairings to determine leaning outcomes from the interpersonal coordination.

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