A Review of Factors Influencing Participation in Physical Activities and Use of a Dance Simulation Video Game Among a Cohort of 7-8 Year Old North Carolinian Children

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Abstract

SADYE PAEZ: A Review of Factors Influencing Participation in Physical Activities and Use of a Dance Simulation Video Game among a Cohort of 7-8 Year Old North Carolinian Children

(Under the direction of Angela M. Rosenberg)

The epidemic of pediatric obesity stems from multiple factors, including decreased participation in physical activities. Despite national health agendas and prevention goals for recommended amounts of physical activity, few North Carolinian youth meet these requirements. A number of reviews examining obesity prevention programs have also investigated the initial and sustained effort in physical activity and have found that opportunities for fun, economical and easily accessible modes of physical activity are limited, particularly in the home environment. Dance Dance Revolution (DDR) is a popular dance simulation video game. Numerous subjective reports indicate that DDR is a viable option for addressing concerns of pediatric obesity through promotion of physical activity. However, objective evidence for DDR is limited, particularly in determining how to most effectively promote DDR. Using an adaptation of the Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation planning model, this dissertation focused on the potential role of various constructs to promote participation in general physical activity and DDR for 7-8 year old North Carolinian children. The first manuscript describes associations between predisposing factors of children's prior exposure to physical activity and self perception in physical competence with participation in physical activity and DDR. The second manuscript presents associations between general parental

support (i.e., participation, encouragement, enjoyment, and transportation) and DDR-specific environmental support (i.e., size of television, other videogames, and DDR participation by others) as reinforcing factors for participation in physical activity and DDR. The third manuscript describes the development of a motor learning-based DDR coaching protocol and the association between this enabling factor with participation in physical activity and DDR. The combined results of these manuscripts indicate that first, previous physical activity exposure influences participation in vigorous physical activity, and second, that presence of other videogames and DDR participation of others influences participation in DDR. None of the other factors significantly influenced participation in moderate or vigorous physical activity or DDR. These findings warrant further investigation to understand the role of potential constructs that may act to influence initial and sustained participation in physical activity and DDR.

To: Angela
For believing in me from the first to the last…

To: Keith
For putting up with “the Bear”…

“The use of body movement, particularly dance, as a cathartic and ‘therapeutic’ tool is perhaps as old as dance itself.”

Block & Kissell

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List of Abbreviations

BMI	body mass index
BP	blood pressure
CDL	Clinical Center for the Study of Development & Learning
DDR	Dance Dance Revolution
EM	Expectation Maximization algorithm
GAQ	GEMS Activity Questionnaire
GEMS	Girls health Enrichment Multi-site Studies
METs	metabolic equivalents
M-GAQ	Modified-GEMS Activity Questionnaire
MPA	moderate physical activity
MTI/CSA	Actigraph® accelerometer model
MVPA	moderate and vigorous physical activity
PA	physical activity
PAL	Parent Activity Learning and Child Learning questionnaire
PRECEDE	Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation (planning model)
SCT	(Bandura's) Social Cognitive Theory
SD	standard deviation
SE	standard error
VPA	vigorous physical activity

CHAPTER I

INTRODUCTION

Background

Brief historical perspective of overweight and obesity in the United States:

The epidemic of pediatric overweight and obesity was not considered to be a serious health problem in the United States until the later 1960's [1]. Since then, research has focused on defining and establishing guidelines on the prevalence, etiology, and treatment of overweight and obesity for both adult and pediatric populations. Although there is a greater understanding today of the causes and possible therapies for child and adolescent overweight and obesity, overall knowledge on the causes of this condition, as well as the best interventions, are still greatly limited [2].

Prevalence and costs of childhood overweight and obesity

The occurrence of childhood overweight and obesity is at endemic proportions and is only increasing [3]. The 1999-2000 National Health and Nutrition Examination Survey (NHANES) reported that over 15% of children and adolescents between the ages of 6-19 years and over 10% of children between the ages of 2-5 years were obese [4]. Concurrent with childhood overweight and obesity is a trend in escalating medical and economic costs. Pediatric overweight and obesity has numerous medical consequences that may manifest in adulthood [5-7]. In addition, the costs of treating childhood obesity has more than tripled from $35 million in 1997 to over $127 million in 1999 [8].

Activity related causes of childhood overweight and obesity

The etiology of overweight is complex, stemming from multiple factors that result in an energy imbalance [9]. A number of strategies including nutrition education, behavior

modification, decreasing sedentary activity, parent involvement and changes in the school food environment have shown equivocal results; however, some of the more successful interventions to reduce pediatric overweight and obesity have focused on the incorporation of enjoyable types of physical activity [10, 11].

In general, participation in physical activities is important for child growth and development [7, 12]. Before pubescence, children are naturally active and tend to be the most active segment of the population; however, by age six, physical activity levels begin to decline, especially during adolescence, when school, work and leisure activities become more prominent [13]. Although national health agendas and prevention goals recommend 60 minutes of daily participation in physical activities for children and adolescents [12, 14-16], only 35.8% of American youth report having met this criteria on at least five or more of days per week [17].

New strategies are needed

Reviews have shown that an increase and maintenance of participation in physical activities is a viable and feasible option to prevent and moderate pediatric overweight and obesity [18-21]. In order to address this problem, children must have an increased opportunity to engage in fun, economical, and easily accessible modes of physical activities [22-24].

Digital media presents an innovative and relevant strategy to increase physical activity among children and adolescents. Today's youth are the first generation to grow up immersed in a rich multi-media and digital environment [25], greatly impacting how children develop [26]. A national study of youth media consumption found that 100% of

children ages 2-7 years old have at least one television in their home and 52% have a video console [27]. Moreover, this same study indicated that the number of households with video consoles increases to 82% for children ages 8-13 years old, further suggesting that videogame use is an enduring behavior and increases as children get older.

Dance Dance Revolution (DDR)

Dance Dance Revolution (DDR), a long running series of arcade games with enthusiastic followings in Japan, Korea, and parts of Europe, represents one of several videogames that utilizes "active" play. In 1999, Konami released an arcade version in the United States that now has more than 10 separate DDR versions, many of which are available for the 100 million Playstation, Playstation 2, and Xbox game consoles in American homes [28]. (See *Operational Definitions* for further explanation of DDR).

While DDR may not appeal to all children, it can provide a viable outlet for physical activity that's not inherently limited by facility use, weather, or participation of others. Numerous testimonials of weight loss and physical enjoyment credited to DDR are posted on the internet (non-peer reviewed, for example, see www.getupmove.com) and on various news media forums (for example, see CNN.com and ABCNews.com). Yet, to date, there has been little evidence-based research available exploring the effectiveness of providing active alternatives to increase physical activity, such as DDR, which can be promoted as play and utilized within the home environment.

North Carolina

Increased involvement in physical activity may be of particular importance in North Carolina. The 2001 North Carolina Nutrition and Physical Activity Surveillance System (NC NPASS) conveyed a prevalence of obesity between 20-25% for children and adolescents between the ages of 5-18 years [29], an additional 5-10% above the national prevalence level. Further, a 2005 summary report indicated that unhealthy lifestyle choices, including physical inactivity, cost North Carolinians more than $24 billion each year; for an overweight young adult in North Carolina, this adds up to more than $22,000 in direct medical care expenses by the midpoint of their working years that can be attributed to excess weight alone [30].

The DANCER study

DANCER was one of eight pilot projects funded under the Linking Interventions for Children (LINC) project at the University of North Carolina at Chapel Hill (UNC-CH). LINC is a series of childhood obesity prevention pilot projects funded by Get Kids in Action, a four-year, $4 million partnership initiated in 2001 between UNC-CH and the Gatorade Corporation. The purpose of this partnership was to develop and evaluate strategies to prevent childhood obesity through promotion of physical activity and healthy diet using education, outreach, and research, ultimately linking primary care and family-based interventions. The broad objective of the DANCER study was to evaluate the efficacy of a dance simulation videogame, Dance Dance Revolution (DDR), to increase physical activity in children 7-8 years old living in North Carolina.

Dissertation theoretical framework

The DANCER study aims included investigation of the interrelationships among physical activity, sedentary behavior, environmental factors, and social and behavioral functioning of children exposed to regular DDR activity. Using an adaptation of the Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation (PRECEDE) planning model [31], this dissertation will focus upon the potential role of predisposing, reinforcing and enabling factors to promote participation in moderate and vigorous physical activities and DDR for North Carolinian children participating in the DANCER study (see Appendix B).

The predisposing factors that were considered in the DANCER study were each child's previous physical activity exposure and self-perception in physical competence. Prior exposure to physical activities was hypothesized to promote participation in moderate and vigorous physical activity and DDR through experiential learning [32-34] of critical elements inherent to this activity, such as timing and rhythm. Perceived physical competence has been established as a predictor of moderate and vigorous physical activity [35-40] and may be an important indicator of which children will sustain participation in DDR over the ten-week period of the intervention.

Evidence-based literature [41-43] and anecdotal reports (for example, www.getupmove.com and www.ddrfreak.com) suggest that familial and environmental supports may act as reinforcing factors to influence a child's participation in moderate and vigorous physical activity and DDR. Direct parental supports included in this dissertation were 1) parental participation in physical activities, 2) parental enjoyment, and 3) parental encouragement. DDR-specific environmental supports included in this dissertation were 1)

size of television, 2) other videogames in home, 3) location of DDR, and 4) DDR participation by others.

In the case of DDR, challenging parameters, such as the complexity of arrows, are intrinsic to the activity, and coaching holds the potential to facilitate a child's speed of learning and accuracy of movement [44, 45] by promoting a specific DDR skill set based on motor learning principles [46, 47]. "Coaching" versus "no coaching" was considered as the enabling factor.

Purpose

The purpose of this dissertation is to describe and identify the strength of association between predisposing, reinforcing, and enabling factors and children's participation in moderate and vigorous physical activity and Dance Dance Revolution.

Outcome Measures

Participation in physical activity was based on two outcome variables, accelerometer data and DDR compliance. Change in total physical activity was measured by accelerometer data at weeks 0 and 10. Moderate physical activity was set *a priori* to be readings between 1,160 – 5,200 counts per minute; vigorous physical activity was set *a priori* to be readings above 5,200 counts per minute. Participation in DDR was measured by a self-report log between weeks 1 and 10. Data was reported as the average daily minutes of participation in DDR.

This dissertation will analyze data generated from the DANCER study, a randomized controlled trial of DDR within the home environment, to identify and describe the factors associated with participation in DDR among a cohort of 7-8 year old children in North

Carolina. Data were collected during the execution of this ten week intervention between September 2004 and December 2004. The UNC-CH Biomedical Institutional Review Board (IRB # 04-PSYCH-476) reviewed and approved this study.

Factors associated with participation in moderate and vigorous physical activity and Dance Dance Revolution among children in the DANCER study will be described in a series of three manuscripts.

Manuscript one: Associations between previous physical activity exposure and self-perception of physical competence with physical activity among children participating in an active dance video game

Aims:

a) To describe predisposing factors (i.e., previous physical activity exposure and self-perception in physical competence) for children participating in the DANCER study
b) To identify the strength of association between these predisposing factors (i.e., previous physical activity exposure and self-perception in physical competence) with participation in moderate and vigorous physical activities and DDR at 1st and 10th week of the DANCER study.

Manuscript two: ***Parental and environmental factors associated with physical activity among children participating in an active dance video game***

Aims:

a) To describe the reinforcing factors (i.e., direct parental support and DDR-specific environmental support) for children participating in the DANCER study
b) To identify the strength of association between reinforcing factors (i.e., direct parental support and DDR-specific environmental support) with participation in moderate and vigorous physical activities and DDR at 1st and 10th week of intervention of the DANCER study

Manuscript three: ***Design and implications of motor learning-based coaching for children participating in an active dance video game***

Aims:

a) To describe the development of a motor learning-based DDR coaching protocol for children participating in the DANCER study
b) To identify the strength of association between the enabling factor of coaching with participation in moderate and vigorous physical activities and DDR at 1st and 10th week of the DANCER study

Operational Definitions

Appraisal support: "the provision of information that is useful for self-evaluation purposes," [48].

Behavioral factors: those "behaviors or lifestyles of the individuals at risk that contribute to the occurrence and severity of the health problem" [49]

Bemani: Konami's music video game division, named in honor of Konami's first and most successful game, Beatmania (www.wikipedia.com).

Dance Dance Revolution (DDR): Conceptually, DDR is a simple game. DDR measures the precision of the dance steps and encourages the individual to earn points and sustain combinations of footwork. The machine provides auditory ("Boo!, "Great!") and visual feedback, tracks scores over time, and tracks total time on the machine. The machine sets thresholds for advancing to the next difficulty level such as increasing the density of foot movements and unlocks new songs (games) as users improve [50].

Music can vary from esoteric Japanese rave to American pop or R&B. The DDR MAX2 chosen for this intervention has 70 songs and 64 of those songs have variations in difficulty: Beginner, Light, Standard, and Heavy. Difficulty is also registered on a continuous scale from 1 to 9 measured in feet. DDR MAX2 has 18 songs with 1-foot ratings, hence every child has the potential to find a song he/she likes at a level he/she can master. At the other end of the spectrum are 28 songs with 8 or 9-foot ratings with speed

and complexity affectionately referred to as “maniac” or “catastrophic” in DDR lingo. [51-53]

Ecological model: models proposing that behaviors are influenced by intrapersonal, sociocultural, policy, and physical-environmental factors; these variables are likely to interact, and multiple levels of environmental variables are described that are relevant for understanding and changing health behaviors [54]

Enabling factors: antecedents to behavior that allow a motivation to be realized;” [31] refers to the skills, resources or programs that can indirectly or directly influence the attainment of specific behaviors [31, 49].

Environmental factors: “social and physical factors external to the individual, often beyond his or her personal control, that can be modified to support the behavior or influence the health outcome” [49].

Environment: the space outside the person, contrasted with intrapersonal variables [54]

Exercise: physical activity that is planned, structured, repetitive, and designed to improve or maintain one or more components of physical fitness (ASCM Guidelines – 30 min exercise 3 times per week, day off between) [55]

informational support: “provision of advice, suggestions, and information that a person can use to address problems” [48]

MET: the unit of the estimated amount of oxygen used by body during PA; 1 MET is the energy used by the body sitting quietly

Overweight status in children: An NIH convened Expert Panel on Obesity in the late 1990’s determined that body mass index (BMI) would be the most appropriate method to use to identify an adult as being overweight or obese [56]. BMI, an expression of weight in relation to height, is easy and rapid to calculate, inexpensive, and correlates well to body fat for the majority of people (ACSM reference?). In adults, this method is quite reliable. However, this method is not appropriate for children and adolescents. Instead, BMI-for-age is used to determine status of overweight [57]. BMI-for-age uses CDC height and weight charts based on the child’s gender and age (2-20 years) to account for normal developmental differences in body fat distribution [58, 59]. The following established percentile cutoff points have been identified to determine overweight in children:

- Normal: BMI-for-age 5^{th} percentile to $< 85^{th}$ percentile
- At risk of overweight: BMI-for-age 85^{th} percentile to $< 95^{th}$ percentile
- Overweight: BMI-for-age $\geq 95^{th}$ percentile

There is no definition for overweight or for obesity based on health risks. Further, the terms “overweight” and “obesity” are used most commonly in place of “at risk of overweight” and “overweight”, respectively, for the pediatric population in research literature and popular media. This dissertation proposal will use the terms “overweight” and “obese”

for simplicity of reading, although note the proper definitions and use of terminology as above when referring to a pediatric population (ages 2-20 years).

Physical activity: any bodily movement produced by skeletal muscles that results in an expenditure of energy with a range of activities, such as occupational work, household chores, and leisure time activities [55]

Moderate:

- Talk test: should be able to carry on a conversation comfortably while engaging in the activity
- Target heart rate: 50-70% of max heart rate (220 – age; typically used for ages 20+)
- Borg's perceived exertion: 11-14 (6 is no exertion – 20 max exertion)
- Metabolic Equivalent (MET) Level: 3-6 METs or 3.5-7 kcal/min

Vigorous:

- Talk test: individual becomes winded or too out of breath to carry on a conversation
- Target heart rate: 70-85% max heart rate
- Borg's: 15 or greater
- MET: > 6 METs or > 7 kcal/min

Recommended amounts of physical activity:

- *CDC Recommendations* for young people: at least 60 minutes of moderate intensity PA most days of the week, preferably daily [61]
- *US Surgeon General* recommended 60 MVPA minutes for children and adolescents

- *National Association of Sports and Physical Education* (NASPE): infants, toddlers, and pre-schoolers should engage in at least 60 min of PA daily and should not be sedentary for more than 60 min. at a time except when sleeping; for children 5 to 12 years of age, recommends accumulating 60 min., and up to several hours of PA per day; activity can be accumulated in bouts of 15 minutes or more each day [63]
- *Healthy People 2010*: A national health promotion and disease prevention initiative which is the basis for coordinated public health action; publishes national health goals and objectives for the years 2001-2010 designed to identify preventable threats to health and to establish goals to reduce these threats [64]
    - Two goals: 1) increase quality and years of healthy life, and 2) eliminate health disparities
    - These goals illuminate the vision of a healthy nation by providing the leadership and motivation for a systematic approach to health improvement through focus areas, of which "PA and Fitness" and "Overweight/Obesity" are leading health indicators
    - 22.6 Increase the proportion of adolescents who engage in moderate PA for at least 30 minutes on 5 or more of the previous 7 days; target is 35% (currently 27%, YRBSS)
    - 22.7 Increase the proportion of adolescents who engage in vigorous PA that promotes cardiorespiratory fitness 3 or more days per week for 20 or more minutes per occasion; target is 85% (currently 65%, YRBSS)
    - Also have objectives for school PE participation and trips made by bicycling and walking to school

- 22.11 Increase the proportion of adolescents who view television 2 or fewer hours on a school day; target is 75% (currently 57%, YRBSS)
- 19.3 Reduce the proportion of children and adolescents who are overweight or obese; target is 5% (based on NHANES 1994 prevalence of 11% - note that 1999 prevalence is over 15%)

Predisposing factors: "antecedents to behavior that provide the rationale or motivation for the behavior" [31]; any characteristic of a person or population that motivates behavior prior to the occurrence of the behavior [31], may include an individual's knowledge, attitudes, beliefs, personal preferences, existing skills, self-efficacy beliefs [49], cultural beliefs and readiness to change [60]

Reinforcing factors: rewards or punishments either follow or are anticipated as a consequence of a behavior and can serve to strengthen the motivation for or against the behavior [31]; examples include social support, peer influences, advice and feedback [31], praise, reassurance [60] and vicarious reinforcements [49]

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CHAPTER II

MANUSCRIPT ONE: ASSOCIATIONS BETWEEN PREVIOUS PHYSICAL ACTIVITY EXPOSURE AND SELF-PERCEPTION OF PHYSICAL COMPETENCE WITH PHYSICAL ACTIVITY AMONG CHILDREN PARTICIPATING IN AN ACTIVE DANCE VIDEO GAME

Abstract

Purpose: Previous physical activity exposure and self-perception in physical competence were explored as potential predisposing factors for moderate and vigorous physical activity and use of a dance simulation video game, Dance Dance Revolution (DDR), among a cohort of 7-8 year old children participating in the DANCER study. **Method:** Sixty children (7.5 ± 0.5 years) were randomized in a 2:1 ratio to receive DDR or to a wait-list control group (10 week delay). Physical activity was measured objectively with accelerometry (at baseline and week 10) and DDR participation logs signed by parents (weeks 1 through 10). A modified Girls Health Enrichment Multi-site Studies Activity Questionnaire was used to assess the quality and quantity of previous physical activity exposure (frequency of participation over the past year) prior to participating in DANCER. Self-perception in physical competence was evaluated in 7- and 8-year old children in the DANCER study using the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children and the Self-Perception Profile for Children, respectively (at baseline). **Results:** At baseline, previous physical activity exposure was not significant for differences in participation in moderate and vigorous physical activity or DDR. At follow-up, previous physical activity exposure explained differences for participation in vigorous physical activity, but not for participation in moderate physical activity or DDR. Self-perception in physical competence was not significant for differences in participation in moderate and vigorous physical activity or DDR at baseline or follow-up. Qualitative findings suggest that DDR was well received by the children in this cohort (95%). Additionally, the majority of children reported that they felt they became more active during the DANCER study (91%) and felt that they had achieved a level of proficiency by week 10 of the intervention (71%). **Conclusions**: This pilot study suggests that in general, previous physical activity exposure or

self-perception in physical competence do not predict participation in physical activity or DDR. However, participation in vigorous physical activity was associated with previous physical activity exposure at follow-up and may be indicative of habitual tendencies in youth. Qualitative findings also suggest that dance movement is an enjoyable form of physical activity. Further study is needed to evaluate the role of these factors to motivate and promote children's participation in physical activity.

Key phrases: self-perception, physical competence, transfer of learning, Dance Dance Revolution

Introduction

Over the past three decades the prevalence of overweight has more than doubled for adolescents ages 12 to 19 years and has nearly tripled for children ages 6 to 11 years [1]. Moreover, the National Longitudinal Survey of Youth indicates that the prevalence of childhood overweight has increased annually by 6.2% in the South, a significantly higher rate than has been observed in other U.S. regions [2, 3].

Child and adolescent overweight and obesity are associated with a host of medical and psychosocial health outcomes, such as non-insulin dependent diabetes, sleep apnea, negative body image and depression [4, 5]. Negative financial consequences are also associated with overweight and obesity, with direct obesity-related hospital costs in 6 to 17 year old children and adolescents reaching yearly sums of over $127 million in 1999 alone [6]. In addition, several studies indicate that childhood overweight tends to track into adulthood [7-9] and is additionally associated with numerous medical conditions ranging from heart disease to osteoarthritis and cancer (endometrial, breast, colon) to stroke [10]. This lifespan of overweight and obesity and associated co-morbidities further highlights the significance of this problem, as well as the prolific costs.

Decreased participation in physical activities and increased participation in sedentary activities are primary contributors to the child and adolescent overweight epidemic. Several studies indicate that children do not meet guidelines for adequate physical activity [11, 12], including one study that reported that only 3% of youth in first through third grade met the Healthy People 2010 guidelines of engaging in 20 minutes of vigorous physical activity at least three days per week [12].

Moreover, American youth ages 2-7 and 8-18 spend an average of 2.5 and 4.5 daily hours, respectively, watching television [13]. Children and adolescents also expend significant amounts of recreational time using computers and video games. Among a cohort of children and adolescents (age 8-18 years), recreational computer time was found to increase substantially with age, with the majority spending most of that time playing computer games [14]. This same study reported that 52% of the cohort also played some kind of sedentary video game each day, averaging 49 minutes daily. Adding to this trend is a report by Stettler and colleagues [15] which noted a nearly two-fold increased risk for obesity among European children ages 6.5 to 10 years for each daily hour spent playing sedentary or traditional video games.

Dance Dance Revolution (DDR) is an active dance videogame that has shown possibility as a medium to increase physical activity in children. DDR uses a game console that links to dance pad sensors to measure whether each individual player is dancing the correct steps in the correct sequence with proper timing. The resultant DDR feedback reports the accuracy of the dance steps, encouraging the individual to earn points by sustaining footwork precision. The machine provides auditory ("Boo!, "Great!") and visual feedback and tracks scores and total time on the machine. DDR has gained broad appeal among youth and among some, has lead to significant weight loss, as evidenced through non-peer reviewed testimonials at www.getupmove.com.

DANCER, a ten-week intervention studying the feasibility of DDR to increase physical activity, was one of eight pilot studies which aimed to develop and evaluate strategies to prevent childhood obesity through promotion of physical activity and healthy diet using education, outreach, and research, ultimately linking primary care and family-based interventions. Several studies indicated that children and adolescents who participate in DDR have demonstrated

considerable increased energy expenditure compared to sedentary screen time [16] and playing tennis [17]. However, a six-month study using DDR as a weight management intervention for obese children and adolescents reported that playing DDR in isolation may not sufficiently motivate youngsters to sustain their use of DDR [18]. Data from this study suggested that peer or family support, competitions, a greater variety of music, and group participation may be associated with increased DDR use, however, these and other potential contributing factors have not been rigorously studied.

A number of theories and models have postulated the potential role of factors that may act to influence health behavior change. One model that has been widely used to describe the variables surrounding changes in health behavior is the Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation (PRECEDE) planning model. The PRECEDE planning model suggests that predisposing factors are any existing characteristics of a person or population that motivates behavior prior to the occurrence of a particular behavior [19]. Predisposing, or motivating, factors can thus act to influence any particular health behavior, including participation in physical activity.

Previous motor experiences can have a direct influence on the acquisition of new skills through the transfer of skills from one learning situation to another [20]. The ability to transfer knowledge across situations is especially advantageous in learning new but related skills [21]. The influence of previous experiences has been noted as important in facilitating the learning and performance of novel motor tasks [22]. Further, various studies indicate that previous patterns of physical activity and participation in community sports have been consistently associated with children and adolescents future physical activity levels [23-25], plausibly mediated through the accumulation of motor experiences [19].

According to Harter [26], self-perception of physical competence is defined as global belief in one's ability to perform physical activities, including sports and outdoor games. In general, self-perception has been shown to be an important indicator of motivation and psychological well-being [27]. More specifically, physical self-perception is related to performance, self-confidence and involvement with physical activity [28, 29] and has been found to discriminate between active and inactive children [28, 30-32]. Perceived physical competence has a profound influence on children's participation in physical activities [33].

The aims of this study were to explore the role of predisposing factors, previous physical activity exposure and self-perception in physical competence, in promoting participation in moderate and vigorous physical activity and DDR. It was hypothesized that children with more previous physical activity exposure prior to DANCER would participate in moderate and vigorous physical activity and DDR at greater levels than children with less previous physical activity exposure. It was also hypothesized that children with a higher self-perception of physical competence would participate in moderate and vigorous physical activity and DDR at greater levels than children with a lower self-perception of physical competence.

Methods

Study Population

DANCER was conducted in the homes of 7-8 year old children (n = 60) living in North Carolina. Recruitment of children was based on parent consent for their child to participate in DANCER in either the intervention (n = 40) or control (n = 20) condition. The majority of parents responded to an email sent through the listserv of UNC Chapel Hill. Fliers were also

distributed in post offices, community centers, and shopping malls throughout Raleigh, Durham, and Chapel Hill.

Enrolled children all lived within a 30-mile radius of UNC-CH. Potential participants were screened for the following inclusion criteria, 1) boys and girls between the ages of 7 and 8 years 10 months, 2) any ethnic or racial group, 3) any weight or BMI, 4) guardian willing to give medical release for their child's participation, 5) guardian willing to record DDR sessions for the child. Exclusion criteria included individuals with significant somatic or mental illness that precluded regular use of DDR (i.e., photosensitive epilepsy, broken bones, exercise-induced asthma, etc.) or individuals with extensive prior experience with DDR, Stepmania, or other forms of Bemani videogames. Extensive experience with DDR was operationalized as any child who had played DDR more than twice prior to enrollment in the DANCER study.

Following a phone screening for inclusion and exclusion criteria as detailed above, one hundred and sixty-six (166) children were screened for participation in the DANCER study. Of these, sixty-one (61) children attended a baseline assessment at the UNC Clinical Center for the Study of Development & Learning (CDL), Chapel Hill, NC. Parent(s) provided written informed consent and children gave verbal assent, after which extensive demographic, environmental, and physical data was acquired. The UNC-CH Biomedical Institutional Review Board reviewed and approved this study.

Study Design

Overview

The DANCER study was conducted in two phases. Phase 1, the Acute phase, was a 10-week, randomized, parallel comparison of experimental (DDR) and control (no DDR) groups. A second computer generated randomization schedule assigned children in the experimental group

to receive either Basic DDR (no coaching) or Enhanced DDR (coaching), however, all statistical analyses controlled for this second randomization by analyzing Basic and Enhanced DDR groups as one experimental group.

Phase 2, the Maintenance phase allowed for a semi-structured, long-term (16 week) follow-up of children exposed to DDR during the Acute phase. In addition, children initially assigned to the control condition were offered DDR equipment and the same initial training as the experimental group during the Maintenance phase of the study. This design guaranteed that all children would gain access to DDR during the study period.

This manuscript will focus on Phase 1, the Acute phase, to explore the association between children's previous exposure to physical activity and self-perception in physical competence with participation in moderate and vigorous physical activity and DDR.

Randomization

Comparable treatment groups were generated through a computer randomization schedule. The presence of sibling pairs required a slight modification. Sibling pairs were randomized as a single child to avoid confounding influences; however, analysis of results will treat all study participants as individuals. Twenty (20) children were randomized to the control group and forty (40) children were randomized to the experimental group[1]. A randomized wait list delay controlled study design was integral to provide rigor to minimize biased sampling from a small sample size and provide information regarding the occurrence of adverse events.

DDR module

Families were supplied with all equipment necessary to play DDR in the home. The primary items provided were the PlayStation2 game console (Sony Corporation of America,

[1] Note: 61 children participated in the baseline assessment, however, one child was unable to continue participation in DANCER due to a medical exclusion.

New York, NY), DDRMAX2 game (Konami of America, Redwood City, CA), and two padded dance mats. Each child and his/her parent(s) were instructed to designate one dance pad for use only by the child participating in DANCER. These materials were obtained commercially and are available from multiple vendors.

Acute Phase Experimental Group

Each child in the experimental group and his/her parent(s) were provided with the necessary DDR equipment (as detailed above) during an initial standardized training session (approximately 45-60 minutes) in their home. The initial training session included a detailed, personalized tutorial introducing all the necessary machinery to connect and maintain the Playstation2 console and an explanation of the DDR game. In addition, study staff provided DDR instructions (a DDR Tip Sheet) and an opportunity for the child to participate in accessing and navigating the various components of the DDR tutorial and game menus. Ample time was provided for further questions from child and parent(s).

Each child and their parent(s) were "prescribed" 120 minutes per week of DDR, distributed over at least 4 days during each week of the 10 week acute phase, however, children had unlimited access to the game throughout the intervention to participate more frequently or for more extended periods. This DDR "prescription" was present on the consent forms, repeated frequently by study staff, and given as a written prescription to all children with access to DDR during the Acute phase. Participants in the experimental cohort were instructed to use any games or songs they wished and to use DDR in a solitary or social fashion with another player. Each child was also given a disposable camera and asked to take a photograph of game scores they were particularly proud of each week.

Acute Phase Control Group

Children and parent(s) randomized to the control group were asked to wait 14 weeks to begin the DDR intervention and to withhold engaging in DDR in any setting during this period. They were not given any other prescriptions regarding physical activity or diet. After the 14-week waiting period was completed, the control group received the Basic DDR intervention with the same initial training and prescription for 120 minutes of DDR activity each week. The DANCER staff was available by pager to address any equipment malfunctions. This phase of the intervention was provided to encourage participation in the study and to provide additional exploratory data. Children in this group were not involved in a maintenance phase due to time and financial constraints of this pilot study.

Technical assistance

The DANCER research team set up the majority of the Playstation2 systems to minimize installation problems. After initial installation, families received ongoing technical support via a dedicated pager, email, and telephone. Hardware and software problems were typically resolved within 48 hours. No direct assistance was provided with regard to game play during these visits but in the case of any reported problems, children and their parent(s) were directed to review the game tutorials and the DDR Tip Sheet.

Study Measures

Demographic data

The *About You* form used for this study consisted of 21 questions which detailed demographic information about each child's age, ethnicity, number of siblings and adults in the home, as well as parents' education and income levels and employment status. The form also

included questions about the number of TVs, VCRs, and DVD players in the home and whether the study participant had these in his/her bedroom.

Physical exam

A licensed medical doctor performed a brief physical exam comparable to the pre-participation health examination screen for school-aged sports. The primary purpose of the physical exam was to exclude children with health contraindications to participate in the study.

Basic anthropometric data was also collected during the physical exam. The Tanita TBF-310 (Tanita Corporation of America, Arlington Heights, IL) provided weight, bioelectric impedance body fat percentage, and calculated BMI. The Tanita-derived BMI percentiles were later matched against age-specific tables published by the Centers for Disease Control (CDC 2000). The Omron 938 (Omron Healthcare, Kyoto, Japan) is an automated, wrist sphygmanometer which yielded heart rate and blood pressure for the majority of children. A small percentage of the children needed manual determinations of blood pressure and heart rate because the sphygmanometer did not compute these measures automatically.

Outcome Variables

Accelerometer-determined physical activity

The primary outcome measure was total counts of activity over a seven-day period detected by the MTI/CSA Actigraph® accelerometer (CSA; MTI Health Systems, Ft. Walton Beach, FL) acquired at Baseline (Week 0), Week 10, and Week 26. The Actigraph accelerometer is widely used for physical activity research [34-37]. It is a small, lightweight, uniaxial accelerometer designed to detect acceleration ranging in magnitude between 0.05 G to 2.00 G with frequency response from 0.25 to 2.50 Hz. The Actigraph has been shown to be both reliable and valid [34, 36] in estimating the energy expenditure resulting from treadmill walking

and running in children ages 10-14 (r-0.87) [35]. The CSA was used to capture the intensity of physical activity in 1-minute epochs, logging intensity, duration, and total physical activity.

Participants were instructed to wear the activity monitor above the iliac crest of the right hip during waking hours for seven consecutive days. Monitors were affixed by way of a comfortable belt to the child's right hip by a trained technician who gave instructions to the child and parent to remove the monitor during showering, water sports, and at bedtime. If removed, the time of removal and reattachment should have been noted on the log form. The minimum acceptable wearing time was set *a priori* at 80% of waking hours for at least 4 weekdays plus one weekend day during each 7-day monitoring period.

DDR-determined physical activity

The daily DDR log was a self-report tool used in order to obtain a rough estimate of total minutes played each week. Parents counter-signed this log in order to increase accuracy of reported play time.

Factor Variables

Physical activities

The GEMS Activity Questionnaire (GAQ) was designed by the Girls health Enrichment Multi-site Studies(GEMS) team [36] as a self-report checklist of activities, each depicted with a small picture, comparing how much each activity was performed by the child "yesterday" and how much each activity is "usually" performed by the child. With the assistance of a parent, each child is instructed to complete the GAQ checklist [29 active items (e.g., sports, chores, etc) and 7 non-active items (e.g., homework, computer games, etc)].

The GAQ provides a total activity summary score for usual activities based on frequency of physical activity performed (none=0, a little=1, a lot=10). This method allows for more credit

if a few activities are performed with higher frequency than if many activities are performed at a lesser frequency; thus, this scoring attempts to differentiate between very active and less active participants [38]. Reliability for the GAQ for physical was r=0.80, $p < 0.0001$. Validity between the MTI/CSA accelerometer and "yesterday" and "usual" GAQ activity scores was low (r=0.27, $p = 0.003$ and r=0.29, $p = 0.02$, respectively).

The Modified-GEMS Activity Questionnaire (M-GAQ) used for this pilot captured the quality and quantity of some specific activities that are common in most child cohorts: basketball, soccer, dance, gymnastics, and martial arts. The M-GAQ was used to minimize subjectivity by allowing parents to respond on a more precise, objective scale. The purpose of the questionnaire was to determine prior physical activity exposure by measuring frequency of participation for each child over the past year as reported by the parent. Parents completed this form for the specified activities, but were also able to report any additional physical activities that the child participated in within the past year[2]. A total summary score for the M-GAQ was determined using similar methods as for the GAQ.

Child self-perception

The Self-Perception Profile for Children [26] and the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children [39] are instruments that tap children's domain specific judgment of their perception. While the former is administered to eight-year olds and the latter for seven-year olds, both of these scales measure self-perception using a variety of subscales, including physical competence[3], content related to sports and outdoor

[2] Note : Only activities included on the GAQ were scored on the M-GAQ.

[3] Note: The "athletic competence" subscale for 8 year old children will be termed "physical competence" as in the original version, Perceived Competence Scale [**26.** Harter S: Manual for the Self-Perception Profile for Children (Revision of the Perceived Competence Scale for Children). University of Denver, 1985.

games. Each subscale is scored on a scale of 1-4, with 1 being "low" perceived competence or the "least adequate" self-judgment and 4 being "high" perceived competence or the "most adequate" self-judgment, to determine a subscale mean. Cronbach's alpha for the physical competence subscales on the Self-Perception Profile and the Pictorial Scale averaged .8275 and .57, respectively [26, 39].

In the DANCER study, eight-year old children were administered three subscales, social acceptance, physical competence, and physical appearance, from The Self-Perception Profile for Children [26] using a standardized interview format. The Pictorial Scale was administered to seven-year old children as outlined by Harter and Pike [39] using a similar standardized interview format accompanied by gender-specific pictures.

Rater Standardization

Staff received extensive training (11-12 sessions, each lasting approximately 45 minutes) comprising all aspects of DANCER. Trainings consisted of detailed explanations, demonstration, and practice of all assessment measures. Staff members were tested on all methods until able to consistently perform as indicated on the protocols. In addition, to further insure uniformity, specific measures were collected by the same staff member at each specific time point (baseline at week 0 and follow-ups at weeks 10 and 26).

Statistical Analysis

Participation in physical activity was based on two outcome variables: CSA data at weeks 0 and 10 and DDR log records at weeks 1 and 10. Factor variables were collected using the M-GAQ and self-perception scales at week 0 (**Table 2.1**).

CSA Data Reduction

At the end of each assessment week, the Actigraph monitors' stored activity counts were downloaded into a computer for subsequent data reduction and analysis. Minute by minute activity counts were used to determine daily total minutes of physical activity and minutes of moderate-to-vigorous physical activity (MVPA) during each 30-minute segment of the seven day monitoring period at weeks 0 and 10.

Accelerometer readings were processed using methods similar to those reported by Puyau and colleagues [40] which reported data as means $\pm$ SD (activity counts/day). Readings between 1160 to 5200 counts per minute were considered as moderate physical activity, a threshold that corresponds to 3.0 metabolic equivalents (METs) using a calibration equation developed by Treuth and colleagues [36]. This equation was based on regression lines for MET score versus accelerometer counts: MET = 2.01 $\pm$ 0.000856 (counts $60s^{-1}$). Vigorous physical activity was defined as readings greater than 5200 counts/minute, a threshold that corresponds to 6.0 METS.

For this pilot, minute by minute activity counts were used to determine daily minutes of moderate to vigorous physical activity during 30-minute segments of each day in the week-long monitoring period at week 0 and at week 10. Activity counts were then summed between the hours of 6am to midnight to provide the outcome variable, total minutes of physical activity per day. It was assumed that the child was not wearing the device if 20 minutes of consecutive zeroes were obtained.

Method of Imputation of missing CSA data

Missing accelerometer data within a 7-day monitoring period were replaced via imputation based on the Expectation Maximization (EM) algorithm [41]. The EM algorithm is analogous to imputing missing item responses on multi-item questionnaires. For the DANCER

study, the EM algorithm used observed data for each child to predict activity levels for segments of the day when the activity monitor was not worn; summary statistics were then estimated from this "pseudo-complete" data set. If data was missing for 20% of waking hours or if there were no available data from a least one weekend day, imputation procedures were not performed. Instead, all accelerometer data were disregarded as missing from that time point.

DDR Compliance

Data were initially reported as means ± SD minutes/day playing DDR at weeks 1 and 10. Based on subgroup analysis, the outcome variable of DDR exposure was dichotomized at week 1 and at week 10 as an average of 127.95 and 61.69 minutes, respectively, into high versus low exposure groups for DDR compliance at each week.

Individual Factor Variables

The M-GAQ used a similar method as the GAQ [36] to determine a previous physical activity exposure summary score:

When your child is participating in this activity, about how often do they participate?

- 1x/week = 0 points
- 2x/per week = 1 point
- 3x+/week =10 points

About how much time does your child spend in this activity each time they participate?

- A little (30 minutes per practice) = 0 points
- Average (31-60 minutes per practice) = 1 point
- A lot (over 60 minutes per practice) = 10 points

Using this method, a M-GAQ total previous physical activity exposure summary score was determined for each child by summing the total points of each reported activity to differentiate between very active and less active participants. Only activities reported to have occurred within the past year were included in analyses. Based on subgroup analysis, M-GAQ

total previous physical activity exposure summary scores were dichotomized based on the group's mean total previous physical activity exposure summary score of 11.26.

Physical competence was first reported as subscale means, with 1 being low perceived competence and 4 being high perceived competence. Subscale means for the experimental group at week 0 were dichotomized into high and low perceived competence categories for further analyses based on reported psychometrics for 8 year olds (2.8450) and 7 year olds (3.5) on the Self-Perception Profile for Children [26] and the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children [39], respectively.

Data treatment

Data was compiled in an Access database for subsequent analysis in SPSS (v.14.1, Chapel Hill, NC). Descriptive statistics were used to summarize characteristics of the factor variables. Given the sample size, DDR compliance, M-GAQ previous physical activity exposure summary scores, and self-perception in physical competence were dichotomized (as previously described) to maximize differences in further analyses. Independent-samples t-tests were computed between previous physical activity exposure and participation in moderate and vigorous physical activity as measured by the CSA accelerometer at weeks 0 and 10. Independent sample t-tests were also computed between self-perception in physical competence and participation in moderate and vigorous physical activity as measured by the CSA accelerometer at weeks 0 and 10. Chi-square tests were calculated between previous physical activity exposure and participation in DDR as measured on the DDR logs at weeks 1 and 10. Chi-square tests were also calculated between self-perception in physical activity and participation in DDR as measured by the DDR log (**Table 2.1**).

Results

Sample Characteristics

One hundred twenty two prospective participants were screened to participate in DANCER, of which 60 participants were enrolled (**Figure 2.1**). The experimental and control groups were similar in age, sex, race, physical measurements, and family characteristics (**Table 2.2**).

Descriptive Statistics

One-hundred percent of parents in the experimental group completed the M-GAQ at baseline. Physical activity summary scores on the M-GAQ ranged from 0 to 53 with a mean of 12.30 $\pm$ 11.469. The most frequently reported physical activities within the past year for this cohort were basketball and soccer (22.9% each); **Table 2.3** shows the frequencies of all reported physical activities.

The age-appropriate subscale for self-perception in physical competence was administered to each child in the experimental group (n=18 for 8 year olds, n=22 for 7 year olds) at baseline. Subscale values for physical competence in 7 and 8 year olds ranged from 2.83-4.00 and 1.50-4.00, respectively. Seven year old children (n=22) had a mean of 3.47 $\pm$ 0.37 and 8 year old children (n=18) had a mean of 2.97 $\pm$ 0.67.

Accelerometers were worn by 100% of participants for each 7-week monitoring period. Mean wearing times were 90% and 73% of waking hours at weeks 0 and 10, respectively. DDR participation logs were returned at rates of 75% and 55% at weeks 1 and 10, respectively.

Hypothesis Test Results

Independent samples t-tests were conducted to evaluate the hypothesis that children with more previous physical activity exposure prior to participating in the DANCER study would

demonstrate higher levels of participation in moderate and vigorous physical activities than children with less previous physical activity exposure. At baseline (week 0), mean differences between previous physical activity exposure and moderate and vigorous physical activity were not significant [$t_{mpa}(37) = .817$, $p = .419$; $t_{vpa}(37) = .594$, $p = .556$]. Post-intervention (week 10), mean differences between previous physical activity exposure and moderate physical activity were not significant [$t_{mpa}(36) = -.897$, $p = .375$]. However, mean differences between previous physical activity exposure and vigorous physical activity was significant [$t_{vpa}(36) = 2.446$, $p = .019$].

Chi square tests were conducted to evaluate the hypothesis that children with more previous physical activity exposure would have greater DDR participation than children with less previous physical activity exposure. The variables were: DDR minutes (high, low) with M-GAQ previous physical activity exposure summary scores (high, low). At baseline (week 1), differences in previous physical activity exposure as measured by M-GAQ was not significant for differences in participation in DDR (X^2 (1, N=40) = .082, $p = .775$). At week 10, previous physical activity exposure as measured by M-GAQ did not account for differences in DDR participation either (X^2 (1, N=40) = .123, $p = .726$).

Independent samples t-tests were conducted to evaluate the hypothesis that children with a higher self-perception in physical competence would demonstrate higher levels of participation in moderate and vigorous physical activities than children with a lower self-perception in physical competence. At baseline (week 0), mean differences between self-perception in physical competence did not account for differences in moderate and vigorous physical activity [$t_{mpa}(35) = 1.571$, $p = .125$; $t_{vpa}(35) = -.455$, $p = .652$]. Post-intervention (week 10), changes in

self-perception in physical competence were not significant for differences in participation in moderate and vigorous physical activity [$t_{mpa}(34) = .944$, $p = .352$; $t_{vpa}(34) = .193$, $p = .848$].

Chi square tests were conducted to evaluate the hypothesis that children with a higher self-perception in physical competence would participate in DDR at greater levels than children with a lower self-perception in physical competence. The variables were DDR minutes (high, low) with self-perception in physical competence subscale means (high, low). At baseline (week 1), there were no significant differences for DDR minutes as measured by self-perception in physical competence (X^2 (1, N=38) = .001, $p = .973$). At week 10, there were also no significant differences for participation in DDR as measured by self-perception in physical competence (X^2 (1, N=38) = .473, $p = .492$).

Qualitative Findings

Nearly 95% of children reported that they liked DDR. Several themes emerged, however, "fun" was the primary reason stated for enjoying this mode of physical activity. Other reasons included: enjoyment of dance, movement, and the DDR music, and opportunities to socialize and/or compete with family and friends. Roughly 91% and 66% of children and parents, respectively, stated that they felt the child participating in DANCER became more active during the period of the study. Further, 71% of children reported that they felt they had reached "advanced" and "expert" levels of playing DDR; the majority of the remaining children (24%) felt they were "solid beginners".

Discussion

The aims of this study were to examine the association between predisposing factors, previous physical activity exposure and self-perception in physical competence, with

participation in moderate and vigorous physical activity and Dance Dance Revolution (DDR) among a cohort of children age 7-8 years living in North Carolina.

The M-GAQ previous physical activity exposure summary scores demonstrated considerable variance for previous physical activity exposure and frequency of participation over the year preceding the start of the DANCER study. Scores ranged from no exposure to physical activities (summary score of 0) to participation in four physical activities at a frequency of at least 2x/week for at least 30 minutes/session for each reported physical activity (summary score of 53). Although this cohort was relatively homogenous in their demographics, the M-GAQ range indicates that at baseline, participation in physical activity, and perhaps skill level in physical activities, was heterogeneous.

Children who had more previous physical activity exposure as measured on the M-GAQ before the DANCER study did exhibit greater participation in *vigorous* physical activity at follow-up. Further, subjective reports by parents and children also indicated that they perceived that the child in the DANCER study became more active as a result of being in the study. Several studies add credence to this finding. A 5-year population-based study of children and adolescents (mean age 10.55 years) reported that physical fitness and physical activity through puberty were predictors of continued participation in physical activities in later years [42]. Other studies reported that participation in school and community Physical Education and recreation [24, 43] and persistent participation in sports [44] were also predictors of future activity patterns.

However, the range of scores on the M-GAQ was not indicative of differences in participation in moderate physical activity as measured by accelerometers or participation in DDR as measured by the DDR participation log (at baseline or follow-up at 10 weeks). Although accelerometers have been used extensively as an objective and valid measure of

children's physical activity in field settings (at 6 days, stability was R = 0.81-0.84 [45]), reported validity between accelerometers and activity checklists, such as the GAQ, is low to moderate (r = 0.3-0.9) [35, 36, 45, 46]. In a previous study by Treuth and colleagues [36] examining the relationship between the GAQ and accelerometry, the authors reported social desirability effects (the child completed the activity questionnaire) and a short time frame of accelerometer monitoring (3 days) as possible confounders to their findings. The current study attempted to overcome these confounders by having *parents* complete the M-GAQ for the *year* preceding the DANCER study. However, it is possible that the same effects reported by Treuth and colleagues [36] occurred in this study. Recall bias may have unintentionally occurred as parents attempted to remember the specificity and frequency for which their child performed certain physical activities over a year and may be an additional confounder in this study. Although the authors believe that the modifications to the GAQ strengthened the reliability of the M-GAQ, the M-GAQ likely has flaws, in particular with respect to duration of recall. The M-GAQ may be further strengthened by decreasing the recall timeframe and by conducting validity and reliability testing for additional cohorts.

Specific to participation in DDR, another plausible explanation for the lack of association between the M-GAQ and participation in DDR is that DDR requires precise eye-foot coordination and children may have been cognitively processing the information more so than reacting to the information during the weeks of accelerometer measurements. At baseline, DDR would have been an entirely new concept to the children in this study and children were likely concentrating on the arrows on the screen but unable to move their feet freely and accurately. At week 10, although children has already been using DDR, they may have been attempting more

difficult stages of play, and thus, slowed down their actual movements as they cognitively processed the information.

However, the current study did not examine the association between sport-associated eye-foot coordination and participation in DDR. One area for future study would include testing for transfer of skills gained from previous motor learning experiences that emphasize eye-foot coordination, such as soccer and tap dancing. Several studies indicate that positive transfer of learning occurs between similar gross motor tasks [20, 21]. Similarly, if children playing DDR can acquire or improve their eye-foot coordination in a safe and relatively controlled environment, then DDR may have a role as an instructional medium for children wanting to learn how to then play a different but related activity, such as soccer, without as great of a risk of failure.

Despite the lack of statistical findings between the M-GAQ and participation in DDR, the majority of children and over half of the parents perceived that the child became more active during the 10 weeks of the DANCER study. In addition, Maloney and colleagues (in press, Obesity 2008) reported a primary finding from the DANCER study of children in the experimental group reporting a significant decrease in sedentary activity of over 4 hours per week as compared to the control group. Pediatric obesity has been linked to both decreased participation in physical activity and decreased participation in sedentary activities [11-15]. The current findings provide support for DDR as a plausible medium to prevent and treat pediatric obesity by influencing both participation in physical and participation in sedentary activity.

Physical competence subscale means for the DANCER were within one standard deviation to reported psychometrics for the Self-Perception Profile for Children [26] and the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children [39], with

7-year old children indicating that overall, they had higher self-perception in physical competence than 8-year old children. However, statistical findings did not show associations between self-perception in physical competence and participation in moderate and vigorous physical activity or DDR. This finding was contrary to other studies. Physical self-perception has been associated with physical activity among children and adolescents [47-50]. These findings have suggested that a child's self-perception influences how each child is motivated and thus, may be important for professionals to understand when planning content and difficulty of physical activity programs [43, 47].

Although statistical findings do not imply association, the majority of children (95%) in the DANCER study felt that they *had* achieved proficiency in playing DDR, perhaps indicative of high self-perception in physical competence for DDR. Although this study did not show a direct association between self-perception in physical competence with Dance Dance Revolution, it is probable that the duration of the study was too narrow and statistical power was too low to capture statistical changes. Further, the Self-Perception Profile for Children [26] and the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children [39] capture global self-perception of physical competence, the belief that one can be physically active, including sports and outdoor games; however, these measures were not designed to capture feelings of proficiency specifically for DDR. Children may have perceived becoming more proficient at DDR through an association of enjoying DDR. The majority of children reported that DDR was "fun" and children may have associated this enjoyment of dance, movement, music, and opportunities to socialize as perceived competence in DDR. Further, the authors did not qualitatively measure feelings of competence in DDR at week 1. Children in this cohort may not have compared their self-competence in DDR at week 1 versus week 10, but

rather, only at week 10; at this latter time point, it is probable that children had learned the basics of DDR and their responses reflect a change in their level of competence. However, a future study should measure self-competence at baseline and at follow-up to more accurately compare perceived change with actual proficiency.

However, general self-perception in physical competence *has* been linked with performance and involvement in physical activity among youth [28, 29, 33]. Understanding feelings of proficiency in a specific activity such as DDR may be imperative for future public health studies centering on the prevention and treatment of pediatric obesity. Better measures are needed to more accurately capture self-perception in *specific* physical activities in order to be able to determine which interventions lead to increased self-perception among individual children, and thus, to be able to more appropriately determine the allocation of social and financial resources.

The present study has several additional limitations. First, the data are not representative on a national level. The sample, although randomly drawn, was primarily from the area surrounding Chapel Hill. Second, the sample size is small; consequently, only large effects are visible between groups. Further, completion rates for the DDR participation logs were low to moderate, further reducing statistical power for hypothesis testing. Lastly, seasonal effects may have confounded results; families reported conflicting interests for other physical and recreational activities, holidays, and school.

In conclusion, this study indicates that previous physical activity exposure does explain differences in vigorous physical activity. Previous physical activity exposure and self-perception in physical competence did not predict children's participation in moderate physical activity and DDR in this study. However, qualitative findings support children's perception in physical

competence as being related to participation in DDR. The development of effective physical activity interventions for youth are dependent on understanding the predisposing or motivating factors that may act to influence participation in novel physical activities, such as DDR, for the development of healthy lifelong habits. The current findings support the need for further study in this area.

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Conflict of Interest

None to report; we were not supported by Sony or Konami.

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Table 2.1. Statistical analyses

	Dependent/Outcome Variables→	**Physical Activity Participation: MTI/CSA Accelerometer** means ± SD (minutes/day) > 1160 counts/minute = MPA > 5200 counts/minute = VPA (continuous variable)		**Physical Activity Participation: DDR Log** means ± SD (minutes/week) dichotomized from subgroup analysis into high/low exposure groups	
	Definitions of Dependent/Outcome variables →				
		Pre – (Week 0)	*Post – (Week 10)*	*Pre – (Week 1)*	*Post – (Week 10)*
Independent/Factor Variables ↓	**Definitions of Independent/Factor Variables ↓**				
Previous physical activity exposure (M-GAQ[4]) *Week 0*	summary score dichotomized from subgroup analysis into high/low exposure groups	Independent-samples t-test	Independent-samples t-test	Chi-square test	Chi-square test
Physical competence[5] *Week 0*	subscale mean ± SD dichotomized from reported psychometrics for each age group into high/low competence groups:	Independent-samples t-test	Independent-samples t-test	Chi-square test	Chi-square test

[4] Modified Girls health Enrichment Multi-Site Studies (GEMS) Activity Questionnaire (GAQ) = M-GAQ

[5] The Self-Perception Profile for Children (Harter, 1985) and the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (Harter & Pike, 1983)

Figure 2.1. Schematic of study design

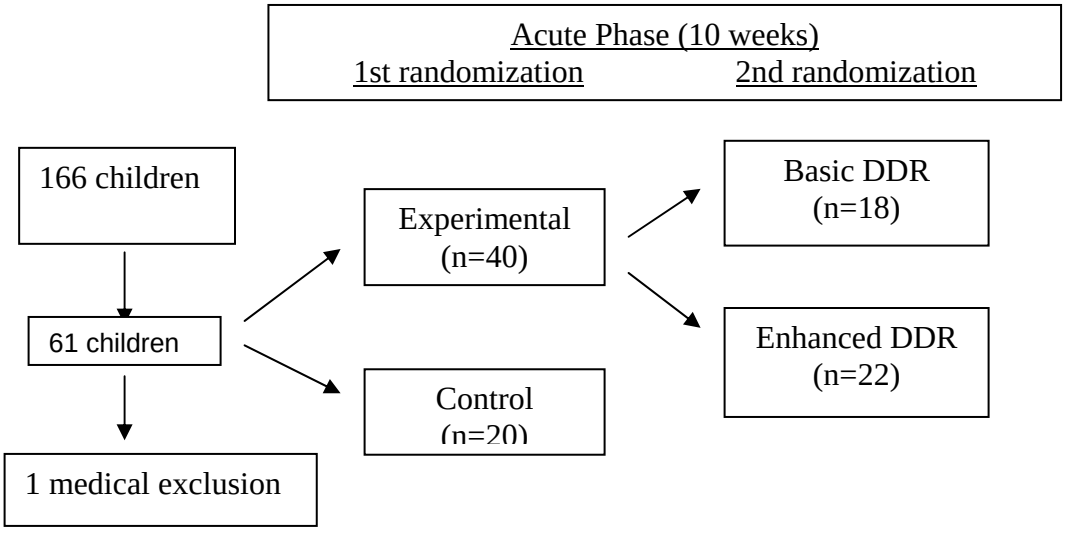

Table 2.2. Sample characteristics (n=60)

Variable	Control (n=20)	Experimental (n=40)
Age, mean years (SD)	7.6 (0.5)	7.5 (0.5)
Female	55%	48%
Non-Caucasian	33%	25%
BMI, mean kg/m^2 (SD)	18.0 (3.3)	17.2 (2.4)
Parent is College Graduate, %	100%	90%
Income > $60,000/yr, %	70%	73%

Table 2.3. M-GAQ physical activity frequencies

Reported physical activities (n=118)	Frequency
Basketball	22.9%
Soccer	22.9%
Dance	15.3%
Gymnastics	12.7%
Swimming	7.6%
Martial Arts	6.8%
Bicycle Riding	2.5%
Tennis	1.7%
Baseball	1.7%
Diving	1.7%
Softball	0.8%
Lacrosse	0.8%

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CHAPTER III

MANUSCRIPT TWO: PARENTAL AND ENVIRONMENTAL FACTORS ASSOCIATED WITH PHYSICAL ACTIVITY AMONG CHILDREN PARTICIPATING IN AN ACTIVE DANCE VIDEO GAME

Abstract

Purpose: General parental and intervention-specific environmental supports were examined as potential reinforcers for moderate and vigorous physical activity and use of a dance simulation video game, Dance Dance Revolution (DDR), among a cohort of 7-8 year old children participating in the DANCER study. **Method:** Sixty children (7.5 ± 0.5 years) were randomized into a DDR group (n = 40) or wait-list control group (n = 20). Each child's physical activity was measured objectively with accelerometry (at baseline and week 10) and DDR participation logs signed by parents (weeks 1 through 10). Parents completed a 4-item questionnaire (at baseline) regarding their general weekly support habits for their child's physical activity. Physical DDR-specific environmental supports were captured on an 11-item environmental home screen that was administered by staff members (at baseline). This screen provided information on location of DDR, size of television, and presence of other videogames. Social DDR-specific environmental support was collected via the DDR participation log. In addition to providing data on each child's DDR participation, the DDR log also provided information on the number of sessions family members and peers played DDR with the child. **Results:** General parental support habits ranged from 1 to 6 days per week, with *encouragement* of physical activity occurring most often (mean of almost 5 days per week). General parental support was not a significant predictor for children's participation in moderate and vigorous physical activity or DDR at baseline or follow-up. Parental, sibling, and friend DDR participation ranged from 0-61 sessions over the ten weeks of the intervention. At week 1, absence of other videogames was associated with child participation in DDR; in addition, at week 1, DDR participation of parents was associated with child participation in DDR. At week 10, DDR participation of siblings and friends was associated with child participation in DDR. Subjective reports by parents indicated

that 95% liked DDR as a form of physical activity for their child and 91% like DDR as a form of physical activity for themselves. Further, the majority of parents found DDR to be minimally disruptive and would recommend DDR to other families. **Conclusions**: National health agendas and healthcare professionals encourage parental and peer modeling and encouragement of physical activity practices to reinforce physical activity patterns in youth. The primary findings for this study also suggest that parental and peer participation in DDR may play a role in children's initial and sustained participation in DDR. The presence of other videogames also had an indirect role in initial DDR participation among children in DANCER. However, it is unequivocal that other DDR-specific environmental factors (i.e., television size and other videogames) have a role in supporting DDR participation. Further study is needed to better understand the roles of general parental and DDR-specific environmental factors that may act to influence short- and long-term participation in physical activity and DDR.

Key phrases: parental support, physical activity, Dance Dance Revolution

Introduction

The obesity epidemic is quickly becoming one of the premier public health crises in the United States and throughout the world. American body weights have increased by approximately 10% over the past two decades, nearly doubling the prevalence of clinical obesity and transcending all regions of the country, social strata, and ethnic groups [1]. During this period, the prevalence of overweight has more than doubled for adolescents (ages 12-19) and more than tripled for children (ages 6-11) [2]. Further, data from the National Longitudinal Survey of Youth indicated that the prevalence of childhood overweight in the South has increased by 6.2% annually between 1986-1998, a significantly higher rate than has been observed in other U.S. regions [3].

Many investigators and health care professionals have attempted to identify primary causal agents, such as biological, psychological, or behavioral factors, to explain the obesity epidemic.; However, there is little consensus around individual factors as sole predictors of current and future obesity [4]. A review of temporal trends over the last twenty years in the United States indicated an increased apathy towards physical activities [1]. This same review also indicated a simultaneous increased partiality towards sedentary lifestyles, such as the use of labor-saving devices (e.g., increased availability of convenience foods and increased use of automobiles and televised entertainment).

Regular participation in physical activity has been shown as imperative to pediatric development, including overall physical and psychosocial health [5, 6]. Yet, pre-pubertal children are only spending an average of 30 minutes per day participating in physical activity; pubertal and post-pubertal children spend even less time participating in physical activity, averaging 8-10 minutes per day [7]. Decreased participation in physical activity has been linked

to increased adiposity and body mass index [8], marking it as one of the root causes of the obesity epidemic [9, 10]. Further, there is also a trend of increased participation in sedentary activities such as computers and video games [11, 12]; this trend has also been associated with an increased risk for pediatric obesity [13].

Dance Dance Revolution (DDR) is an active dance videogame that has shown possibility as a medium to increase physical activity and to displace sedentary behaviors. DDR uses a game console that links to dance pad sensors to measure whether each individual player is dancing the correct steps in the correct sequence with proper timing. The resultant DDR feedback reports the accuracy of the dance steps, encouraging the individual to earn points by sustaining footwork precision. The machine provides auditory ("Boo!, "Great!") and visual feedback and tracks scores and total time on the machine. Dance Dance Revolution has gained broad appeal among youth and among some, has lead to significant weight loss, as evidenced through non-peer reviewed testimonials at www.getupmove.com.

DANCER, a ten-week intervention studying the feasibility of DDR to increase physical activity, was one of eight pilot studies which aimed to develop and evaluate strategies to prevent childhood obesity through promotion of physical activity and healthy diet using education, outreach, and research, ultimately linking primary care and family-based interventions. Recent peer-reviewed studies have demonstrated that among cohorts of children and adolescents, playing DDR increased energy expenditure by 172 $\pm$ 68% as compared to sedentary screen time [14]; more precisely, energy expenditure when playing DDR was equivalent to playing tennis [15]. However, a six-month study using DDR as a weight management intervention for obese children and adolescents reported that isolated use of DDR was not sufficiently motivating to

yield sustained use even over three months [16], suggesting that youth may need external motivators to continue participation in this activity.

The core assumption of interpersonal health behavior models is that each individual's social and physical environments have a profound impact on health-related behaviors and health status. One model that has been widely used to describe the psychosocial dynamics affecting health behavior and health behavior change is Bandura's Social Cognitive Theory (SCT) [17].

The SCT tenets of "observational learning" and "reinforcements" support the role of parents as credible sources to influence health behavior change in their child; in particular, parental support and modeling have been shown to reinforce children's participation in physical activity. Parents are household policy makers or "gatekeepers," acting to foster and reinforce healthy and unhealthy familial attitudes [18, 19]. Several studies have found that girls report higher levels of physical activity when at least one parent provides high levels of overall support [20-22]. Other reports have consistently noted that parental involvement in physical activities predicts youth physical activity [23-25] and may be imperative in reversing the trend in pediatric obesity [26]. Reports from a six-month feasibility study of DDR as a weight loss tool among a cohort of overweight children and adolescents recommended peer or family support as an incentive to increase sustained participation in this active videogame [16], however, the benefit of this support has not been rigorously studied. General parental supports for their child's physical activity included in this study were 1) parental participation in physical activities with their child, 2) parental enjoyment of participating in their own physical activity, 3) parental encouragement of their child's physical activity, and 4) parental transportation of child.

Environmental factors also play a significant role to reinforce children's participation in physical activities. The SCT constructs of "environment" and "situation" provides the

theoretical underpinning for the role of a DDR-specific milieu. Several studies have explored the association between physical environments, participation in physical activity, and obesity [1, 27, 28]. In general, supportive environments have led to greater youth participation in physical activities [29]. Findings from this study reported that children raised in environments of "low cognitive stimulation" resulted in a 2.3-2.7 fold increased risk of a child becoming obese as compared to a child raised in environments of "high cognitive stimulation". External motivators, such as the elimination of situational barriers, [27] have also been linked to the eradication of the obesogenic environment. Explicit to DDR, there is limited subjective and objective data supporting the role of specific factors to increase participation. DDR-specific environmental supports included in this study were 1) size of television, 2) other videogames in home, 3) location of DDR, and 4) DDR participation by others.

General parental and DDR-specific environmental supports were examined as potential factors to increase participation in moderate and vigorous physical activity and DDR. It was hypothesized that children with more general parental support (e.g., participation, enjoyment, encouragement, and transportation) prior to participating in the DANCER study will demonstrate greater participation in moderate and vigorous physical activity and DDR than children with less general parental support. It was also hypothesized that children with greater DDR-specific environmental support (e.g., larger television, absence of other videogames, location of DDR in family and/or living room, and greater DDR participation of others) will demonstrate greater participation in DDR than children with less DDR-specific environmental support.

Methods

Study Population

DANCER was conducted in the homes of 7-8 year old children (n = 60) living in North Carolina. Recruitment of children was based on caregiver consent for their child to participate in DANCER in either the intervention (n = 40) or control (n = 20) condition. The majority of caregivers responded to an email sent through the listserv of UNC Chapel Hill and enrolled children all lived within a 30-mile radius of UNC-CH. Potential participants were screened for the following inclusion criteria, 1) boys and girls between the ages of 7 and 8 years 10 months, 2) any ethnic or racial group, 3) any weight or BMI, 4) guardian willing to give medical release for their child's participation, 5) guardian willing to record-DDR sessions for the child. Exclusion criteria included individuals with significant somatic or mental illness that precluded regular use of DDR (i.e., photosensitive epilepsy, broken bones, exercise-induced asthma, etc.) or individuals with extensive prior experience with DDR, Stepmania, or other forms of Bemani videogames. Extensive experience with DDR was operationalized as any child who had played DDR more than twice prior to enrollment in the DANCER study.

Following a phone screening for inclusion and exclusion criteria as detailed above, one hundred and sixty-six (166) children were screened for participation in the DANCER study and sixty-one (61) children attended a baseline assessment at the UNC Clinical Center for the Study of Development & Learning (CDL), Chapel Hill, NC. Parent(s) provided written informed consent and children gave verbal assent, after which extensive demographic, environmental, and physical data was acquired. The UNC-CH Biomedical Institutional Review Board reviewed and approved this study.

Study Design

Overview

The DANCER study was a 10-week, randomized, wait list delay controlled group comparison of experimental (DDR intervention, n = 40) and control (no DDR, n =20) groups. A second computer generated randomization schedule assigned children in the experimental group to receive either Basic DDR (no coaching) or Enhanced DDR (coaching) The presence of sibling pairs required a slight modification. Sibling pairs were randomized as a single child to avoid confounding influences; however, analysis of results will treat all study participants as individuals. In addition, all statistical analyses controlled for the second randomization by analyzing Basic and Enhanced DDR groups as one experimental group. After a waiting period of 14 weeks, children initially assigned to the control condition were offered DDR equipment and the same initial training as the experimental group.

DDR module

Families were supplied with all equipment necessary to play DDR in the home: the PlayStation2 game console (Sony Corporation of America, New York, NY), DDRMAX2 game (Konami of America, Redwood City, CA), and two padded dance mats. Each child and his/her parent(s) were instructed to designate one dance pad for use only by the child participating in DANCER. These materials were obtained commercially and are available from multiple vendors.

Experimental Group.

Each child in the experimental group and his/her parents were provided with the necessary DDR equipment (as detailed above) during an initial standardized training session (approximately 45-60 minutes) in their home introducing all the necessary machinery to play

DDR and allowing for ample opportunity for the child to assess and navigate the various components of the DDR tutorial and game menus. Each child and their caregivers were "prescribed" 120 minutes per week of DDR, distributed over at least 4 days during each week of the experimental phase, however, children had unlimited access to the game throughout the intervention to participate more frequently or for more extended periods.

Control Group.

During the waiting period of 14 weeks, children and caregivers randomized to the control group were asked to withhold engaging in DDR in any setting, however, they were not given any other prescriptions regarding physical activity or diet. Maloney and colleagues (in press) and Paez and colleagues (unpublished, see Manuscript 1) provide further details on DANCER study methods.

Technical assistance

The DANCER research team set up the majority of the Playstation2 systems to minimize installation problems. After initial installation, families received ongoing technical support via a dedicated pager, email, and telephone. Hardware and software problems were typically resolved within 48 hours. No direct assistance was provided with regard to game play during these visits.

Study Measures

Study measures included demographic information and physical exams consisting of weight, bioelectric impedance body fat percentage, and calculated BMI using the Tanita TBF 310 (Tanita Corporation of America, Arlington Heights, IL) or the Omron 938 (Omron Healthcare, Kyoto, Japan).

Outcome Variables

The primary outcome measures were accelerometer- and DDR-determined physical activity. Accelerometer-determined physical activity was measured as total counts of activity over a seven-day period detected by the MTI/CSA Actigraph® accelerometer (CSA; MTI Health Systems, Ft. Walton Beach, FL) acquired at Baseline (Week 0) and Week 10. The minimum acceptable wearing time was set *a priori* at 80% of waking hours for at least 4 weekdays plus one weekend day during each 7-day monitoring period. The daily DDR log was a self-report tool used in order to obtain a rough estimate of total minutes played each week. General study measures and outcome variables are described in full by Paez and colleagues (unpublished, see Manuscript 1).

Factor Variables

General parental support

The Parent Activity Level and Child Learning Questionnaire was adapted for use in this study to measure caregiver perception on their child's learning abilities, parental participation in physical activities, and general parental support of physical activity. Definitions of physical, moderate, and vigorous activity were used as defined by the National Center for Chronic Disease Prevention and Health Promotion. This questionnaire included items as adapted from the Achenbach's Child Behavior Checklist for Ages 6-18, the CDC's Behavioral Risk Factor Surveillance System 2003, and Trost and colleagues [24]. Caregivers completed this questionnaire at each time point of the study.

Home environment

The Basic Home Environmental Screen captured the conditions under which each participant lived and played as perceived by a member of the research team. Items pertinent to

this pilot included physical impediments (e.g., lack of space), practical barriers (e.g., 2nd floor apartment), and human interference to participation in DDR (e.g., parents, friends, or siblings). This screen also collected information on the location of DDR, size of the television that was being used for DDR, and presence and type of other video games in the home environment. This 11-item scale was administered by a staff team member to the experimental group at week one during the initial DDR training session in each child's home.

Rater Standardization

Staff received extensive training (11-12 sessions, each lasting approximately 45 minutes) comprising all aspects of DANCER. Trainings consisted of detailed explanations, demonstration, and practice of all assessment measures. Staff members were tested on all methods until able to consistently perform as indicated on the protocols. In addition, to further insure uniformity, specific measures were collected by the same staff member at each specific time point (baseline at week 0 and follow-ups at weeks 10 and 26).

Statistical Analysis

Participation in physical activity was based on two outcome variables, CSA data at weeks 0 and 10 and DDR log records at weeks 1 and 10. Factor variables were collected using the Parent Activity Level and Child Learning Questionnaire and Basic Home Environmental Screen at week 0, as well as the DDR log at weeks 1-10. See **Table 3.1**.

CSA Data Reduction

Minute by minute activity counts were used to determine daily total minutes of physical activity and minutes of moderate-to-vigorous physical activity (MVPA) during each 30-minute segment of the seven day monitoring period at weeks 1 and 10. Accelerometer readings were processed using methods similar to those reported by Puyau et al. (2002) which reported data as

means ± SD (activity counts/day). Readings between 1160 to 5200 counts per minute were considered as moderate physical activity, a threshold that corresponds to 3.0 metabolic equivalents (METs) using a calibration equation developed by Treuth and colleagues (2004). Vigorous physical activity was defined as readings greater than 5200 counts/minute, a threshold that corresponds to 6.0 METS. Missing accelerometer data within a 7-day monitoring period were replaced via imputation based on the Expectation Maximization (EM) algorithm (Catellier et al, 2005).

DDR Compliance

Data was reported as means ± SD (minutes/day). A subgroup analysis was used to determine the cutoff point for high versus low exposure to playing DDR. Based on subgroup analysis, the outcome variable of DDR exposure was dichotomized at week 1 and at week 10 as an average of 127.95 and 61.69 minutes, respectively, into high versus low exposure groups for DDR compliance.

Individual Factor Variables

General parental support was assessed based on four questions from the Parent Activity Level and Child Learning Questionnaire to measure weekly frequency with which parents: encouraged child to do physical activity, participated in physical activity with child, watched child participate in physical activity, and drove child to a place where he/she could engage in physical activity. Responses for each question were recorded on a six-point scale (0 days, 1 day, 2 days, 3-4 days, 5-6 days, and everyday). Responses for each question were combined into a summary score, reported as mean ± SD at week 0 (baseline). A sub-analysis was conducted to dichotomize subjects into high versus low general parental support groups. Based on this

analysis, the weekly mean of general parental support was 2.6750, a value which corresponds to 2 days per week.

The following environmental factors from the Basic Home Environmental Screen were collected: size of television (small $\leq$ 13 in, medium 14-18 in, large $\geq$ 19 inches), availability of other videogames in the household (yes/no), and location of DDR (living room/family room, child's room, den/playroom, other). DDR participation of others (i.e., parents, siblings, and peers) was captured on the DDR log and was reported as the number of sessions played with the child at weeks 1 and 10.

Data treatment

Data was analyzed in SPSS v.14.1. Descriptive statistics summarized characteristics of the sample. T-tests were computed between general parental support and participation in physical activity as measured by the CSA accelerometer at baseline (week 0) and follow-up (week 10). Chi-square tests were computed between general parental support and participation in physical activity as measured by the DDR log at baseline (week 1) and follow-up (week 10). Logistic regressions were used to describe associations between DDR-specific environmental support factors (i.e., size of television, availability of other videogames, location of DDR, and DDR participation of others) and participation in physical activity as measured by the DDR log for the experimental group at baseline (week 1) and follow-up (week 10). Post-hoc, the variable for "location of DDR" was eliminated from analysis because there was only 1 case for "child's bedroom" and all other cases corresponded to family rooms or dens, which were determined to serve essentially the same purpose. It was determined that the lack of variation in "location of DDR" would not result in meaningful findings (**Table 3.1**).

Results

Sample Characteristics

One hundred twenty two prospective participants were screened to participate in DANCER, of which 60 participants were enrolled (**Figure 3.1**). As previously reported by Maloney and colleagues (in press, 2007), the experimental and control groups were similar in age, sex, race, physical measurements, and family characteristics (**Table 3.2**).

Descriptive Statistics

One-hundred percent of parents in the experimental group completed the Parent Activity Level and Child Learning Questionnaire at baseline. Weekly mean of general parental support ranged from 0.75 to 4.50; the range of values were indicative of less than 1 day to 6 days per week of parental support for their child's physical activity. Individual determinants of frequency for which parents supported their child's physical activity on a weekly basis are shown in **Table 3.3**.

The Basic Home Environmental Screen was completed for all children in the experimental group (n=40) at baseline. Most children in the experimental group (60%) had a large-sized television, between 19-26 inches, with the remaining children at either end of the spectrum, with a 27-inch or larger (20%) or a 13-inch or smaller (12.5%) set. About half of the children had at least one other videogames in their home, with Playstation (20%) and Nintendo (12.5%) as the most common systems.

Accelerometers were worn by 100% of participants for each 7-week monitoring period. Mean wearing times were 90% and 73% of waking hours at weeks 0 and 10, respectively. DDR participation logs were returned at rates of 75% and 55% at weeks 1 and 10, respectively.

At week 1, parent and peer (i.e., siblings and friends) participation in DDR with the child in the DANCER study ranged from 0-5 and 0-6 sessions and averaged 1.40 $\pm$ 1.516 and 1.58 $\pm$ 1.662 sessions, respectively. At week 10, parent and peer participation in DDR ranged from 0-4 and 0-5 sessions and averaged .53 $\pm$ 1.012 and 1.03 $\pm$ 1.510 sessions, respectively. Throughout the 10 weeks of the intervention, DDR participation of others ranged from 0 to 61 sessions, with a mean of 21.72 $\pm$ 17.133 total sessions. More specifically, throughout the 10 weeks of the DANCER study, parent and peer participation in DDR ranged from 0-29 and 0-43 sessions and averaged 9.18 $\pm$ 8.524 and 13.38 $\pm$ 12.610 sessions, respectively.

Hypothesis Test Results

Independent samples t-tests were conducted to evaluate the hypothesis that children with more general parental support (e.g., participation, enjoyment, encouragement, and transportation) prior to participating in the DANCER study would demonstrate higher levels of participation in moderate and vigorous physical activities than children with less general parental support. At baseline, mean differences between high and low general parental support groups were not significant to explain differences in child participation in physical activity [$t(37)_{mpa} = -.331$, $p = .742$; $t(28.061)_{vpa} = -1.279$, $p = .211$]. Post intervention (week 10), mean differences between high and low general parental support groups were also not significant to explain differences in child's participation in physical activity [$t(18)_{mpa} = -1.000$, $p = .324$; $t(36)_{vpa} = -.758$, $p = .453$].

Chi square tests were conducted to evaluate the hypothesis that children with more general parental support prior to participating in the DANCER study would have greater DDR participation than children with less general parental support. The variables were: DDR minutes (high, low) with general parental support (high, low). At baseline (week 1), DDR participation and general parental support were not statistically significant (X^2 (1, N=40) = 3.558, p =.059).

Post-intervention (week 10), mean differences between high and low general parental support groups were also insignificant for differences in DDR participation (X^2 (1, N=40) = .382, *p* =.536).

Logistic regressions were conducted to determine how well DDR-specific environmental factors predicted participation in physical activity as measured by the DDR log. It was hypothesized that children with greater DDR-specific environmental support (e.g., larger television, absence of other videogames, and greater participation of others) would demonstrate greater participation in DDR than children with less DDR-specific environmental support. Coefficients for each predictor at baseline and follow-up are presented in **Tables 3.4** and **3.5**. Further analyses were conducted post-hoc to differentiate DDR participation of others into parental and peer (i.e., siblings and friends) groups at baseline and follow-up; results for these logistic regressions are in **Tables 3.6** and **3.7**.

Qualitative Findings

Ninety-five percent of parents reported that they liked DDR as a form of physical activity for their child. Additionally, 91% of parents stated that they liked DDR as a form of physical activity for themselves. The majority of parents noted that having DDR in their home was not (49%) or minimally (40%) disruptive. Further, 85% of parents were "very" likely to recommend DDR to other children and their parents.

Discussion

The aims of this study were to examine the association between general parental support and DDR-specific environmental support with participation in moderate and vigorous physical

activity and DDR among a cohort of children age 7-8 years living in North Carolina participating in the DANCER study.

For this cohort, general parental support was most often encouraged (5-6 days per week) as opposed to engaging with, driving, or watching their child participate in physical activity (approximately 2 days per week for each). General parental support, including parental encouragement of physical activities, has been shown to be an important correlate of youth physical activity [24]. Most parents seem to know that physical activity is important for their child. However, translating that knowledge from encouragement to other tangible forms of support does not always occur. Qualitative data from a study among caregiver and daughter dyads reported that overall, there was low parental motivation to engage in physical activities with their child despite knowledge of positive health benefits derived from physical activity [34]. The present study also reports similar findings of low parental participation in physical activities with their child.

General parental support was not associated with youth moderate and vigorous physical activity at baseline or follow-up in this study. However, at week 1, general parental support with DDR participation showed a trend ($p = .059$) that may be related to the construct of "reinforcement" from the Social Cognitive Theory. According to SCT, parental support influences and bolsters children's participation in healthy activities, such as participation in physical activities. Other studies support this trend. Among a cohort of children from elementary schools in a large suburban school district, parental support accounted for 20%, 26%, and 28% of the variance in children's participation in physical activity, attraction to physical activity, and perceptions of competence in physical activities, respectively [35]. Other studies

also consistently reported that parental support influences youth participation in physical activity [19, 21, 22].

The authors attempted to improve the initial scale by Trost and colleagues [24] for measuring general parental support. The adapted version, the Parent Activity Level and Child Learning Questionnaire, reported weekly frequencies of parental support habits on a six-point versus five-point scale with responses combined into a summary score. A limitation of both of these scales is that the construct of "support" was not operationally defined, such that parents were at liberty to interpret the quality and frequency of their actions that constituted as providing "support." Parental perceptions of support likely differed substantially and future studies should thus include operational definitions of verbal and written encouragement, physical participation, observation, and/or actions related to support of child participation in physical activities.
In addition, these questionnaires did not specify a timeframe for parents to consider when responding with their level of support in that parents may have responded based on the support they *used* to or *perceived* to have given versus what they *actually* did. If parents are asked to consider their level of support for the previously mentioned criteria within the past week or another specified timeframe, it is plausible that reliability and validity of this form would increase. These questionnaire limitations may help explain why general parental support was not significant for children's participation in moderate and vigorous physical activity during their participation in this study.

In addition, there are several other limitations in this study that may have confounded statistical findings. The majority of the sample, although randomly drawn, was primarily from the area surrounding Chapel Hill, NC. The educational and economic status of most participating households was higher than societal norms. Further, as previously reported by

Maloney and colleagues (in press, Obesity 2008), baseline sedentary screen time was less than half the national average. Children also had a lower baseline BMI than reported in NC overall. These sample characteristics indicate that the DANCER cohort is not representative on a national level or even North Carolina.

Among the selected DDR-specific environmental supports, absence of other videogames and DDR participation of others (i.e., parents, siblings, and peers) was significant for child participation in DDR. Approximately 50% of the children in this study had other videogames in their home prior to acquiring the Playstation2 as a participant in the DANCER study.
A national study of youth media consumption also reported that 52% of children ages 2-7 years old have a video game box in their home [36]. At ages 8-13, this same study found that the number of households with video game boxes increased to 82%, suggesting that video game usage is an enduring and increasing behavior as children grow older.

At baseline, the absence of other videogames was significant (p = .037) for explaining differences in youth participation in DDR with an odds ratio of 3.97%. This finding suggests that at baseline, children who did not have other video games in their home were more likely to participate in DDR than children who did have other video games in the home. This suggests that other video games in the home may have acted as a conflicting interest for children in this study. This finding holds significant implications from a public health perspective because the trend in pediatric overweight has been associated with increased participation in sedentary activities. Children who have a choice between a passive versus active video games in their home may continue to select the passive video game because the choice to be passive may be a more attractive option than shifting to an active alternative.

At week 10, the absence of other video games was not a significant predictor for youth participation in DDR. It is possible that the novelty of having a video game in the home may have initially motivated children to play DDR. However, the newness of a video game, particularly among children who previously did not have a console in their home, may not have been sufficient to motivate sustained participation in DDR among this cohort as measured at week 10. This current finding parallels the study by Madsen and colleagues [16] which reported that DDR alone was not adequate for sustained play among obese youth.

In addition, seasoned video game players understand the basic underlying principles of video games and are familiar with video game colloquialisms that video game novices have not yet learned. Differences between seasoned and novice video game players are absent at week 10, suggesting that novice video game players quickly learned the culture of DDR. The current finding further implies that although children who had another video game in their home may have benefited from these previous experiences to more easily adopt an active video game such as DDR; however, differences in conventional sedentary video games may not necessarily translate to initial or sustained participation in an active video game. The novelty of DDR may be enough initially to counterbalance the advantage of previous experiences with video games. Yet, this was not directly measured in the current study.

DDR participation of others also influenced children's initial and long term (10 weeks) participation in DDR. At baseline, parents and peers engaged in DDR with the DANCER child for approximately 1-2 sessions. Peers participated more frequently in DDR with the DANCER child, however, it was parental participation in DDR that was directly associated with the DANCER child's participation in DDR (p = .010, odds ratio 3.745). At week 10, both parents and peers participated in DDR less frequently (approximately .5-1 day), yet peers continued to

participate in DDR with the DANCER child at a greater extent that parents. Peer participation in DDR was directly associated with the DANCER child's participation in DDR (p = .015, odds ratio 8.403).

The involvement of "significant others" in physical activities has been shown to be related to more physical activity involvement among children [20, 37] and adolescents [23, 38] and the findings of the present study has implications for future studies and interventions for youth participation in physical activities, either using DDR or another medium, The present findings indicate that at baseline, parents have an imperative role at the onset of a child learning a novel video game. Parental support and encouragement of the child appears to be imperative as the child is gaining knowledge of the intricacies of DDR and becoming skillful and successful players. It is plausible that parental participation and support in a specific medium, DDR or otherwise, acts to create a supportive learning environment and thus, bolsters a child's confidence at this early stage.

However, participation of peers in has a significant role in sustaining a child's participation in DDR and perhaps, other physical activities. The findings from this study indicated that peers played DDR with the child at a much higher frequency per week than parents, suggesting that social interactions with friends and siblings could be more important for creating and sustaining interest in physical activities. Although children appear to need additional support from their parents initially, their level of self-sufficiency at DDR may increase quickly, and the focus may shift from learning to interacting on a social and/or competitive level with peers.

Subjective reports also supported the significance of peer DDR support to increase children's participation in DDR. Social interaction was cited as a contributing factor of child

participation in DDR (i.e., "playing with brother contributed significantly [to child's success]"). Parents also reported greater child attentiveness when playing with peers ("when he played w/friends he was more focused"). However, some parents (31%) felt that playing DDR with a peer did not help their child to be "successful" at DDR. Some parents reported that practicing DDR (i.e., "the repetition made the game a success") and playing new songs ("the game had different levels of achievement which motivated child to keep going and/or do better") contributed to child "success" in DDR. Family competition ("he liked more competition between him and mother and father than friends" and "he loved beating our/ [parents] scores!") also helped children succeed in DDR. These reports suggest that the role of the family, as well as peers, is important to a child's participation in DDR. These subjective and objective findings should be taken into consideration for future study designs promoting participation in physical activity by youth.

It is, however, important to note that participation in DDR does not automatically transfer into "success" in DDR. Qualitative reports indicate that "success" in DDR did indeed occur, yet, "success" in DDR was not directly measured. In addition, the sample size was small, and consequently, only large effects from a statistical standpoint are visible between groups. This limitation is further augmented when considering completion rates for the DDR logs of 75% and 55% at weeks 1 and 10, respectively.

A number of qualitative themes suggest that the majority of parents liked DDR as a form of physical activity for their child and were likely to recommend DDR to other families; the small percentage of families that noted that they would not recommend DDR to other families reported disruptions due to reasons other than DDR itself (**Table 3.8**). Overall, parents also enjoyed DDR as a form of physical activity for themselves. One parent even reported losing 16

pounds during the DANCER study as a result of using DDR with her child, as well as a significant decrease in her cholesterol level from 315 at baseline to 166 at follow-up. Other parents reported that they "liked DDR for myself as exercise" and "[planned] to use DDR for weight loss myself with the kids." A pediatric ten- year randomized treatment study examined behavior family-based treatment and found that 34% of participants (ages 6-12 years) decreased percent overweight by 20% or more, and 30% were not obese at the ten-year follow-up [39]. In another study, treatment of childhood obesity was also more successful when parents were the exclusive agents of change [40].

The current study did not examine the use of DDR as a family-based treatment for child overweight and obesity, however, the qualitative reports indicate that this may be an area for future study. However, some parents appeared to have difficulty learning how to play DDR ("it turned out to be much harder than we thought it would be, and quickly gets too difficult for us 'old folks'"), so DDR as a family-based treatment may not be an option for all families. There were also some temporal limitations noted during the DANCER study that may have impacted participation in DDR. Families reported conflicting interests for other physical and recreational activities, holidays, and school, and thus, seasonal effect may have confounded results.

National health institutes encourage parental modeling and encouragement of physical activity practices to reinforce physical activity patterns in children and adolescents [41, 42]. This also seemed to hold in the case of DDR. The primary finding of this study was that participation of others in DDR was associated with child participation in DDR. However, the use of novel physical activities, such as DDR, to increase physical activity for the entire family was not examined in this study. This study was also only ten weeks in duration and the length of time may not have been adequate to determine short- and long-term effects of the other DDR-specific

environmental supports (e.g., presence of other videogames, size of television, location of DDR) that may have a vital role in sustaining participation in this activity past the duration of this study. Further investigation is needed to understand the role of general parental and DDR-specific factors that may act to influence initial and sustained participation in physical activity and DDR.

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Conflict of Interest

None to report; we were not supported by Sony or Konami.

The opinions and assertions contained in this report are the private views of the authors and are not be construed as reflecting the views of any department of the University of North Carolina.

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Table 3.1. Statistical analysis

	Dependent/Outcome Variables→	**Physical Activity Participation: MTI/CSA Accelerometer**		**Physical Activity Participation: DDR Log**	
	Definitions of Dependent/Outcome variables →	means ± SD (minutes/day) > 1160 counts/minute = MPA > 5200 counts/minute = VPA (continuous variable)		means ± SD (minutes/week) dichotomized from subgroup analysis into high/low exposure groups	
		Pre – (Week 0)	*Post – (Week 10)*	*Pre – (Week 1)*	*Post – (Week 10)*
Independent/Factor Variables ↓	**Definitions of Independent/Factor Variables ↓**				
Parental support habits[1] *Week 0*	mean ± SD (days/week) dichotomized from subgroup analysis into high/low exposure groups	Two sample t-test	Two sample t-test	Chi square	Chi square
DDR-specific environmental support[2] *Week 1*	• Size of television (nominal) • Other videogames in household (dichotomous) • Location of DDR (nominal) • DDR participation of others (continuous variable)			Logistic regression	Logistic regression

[1] As measured on the Parent Activity Level and Child Learning Questionnaire

[2] As measured on the Basic Home Environmental Screen and DDR log

Figure 3.1. Schematic of study design

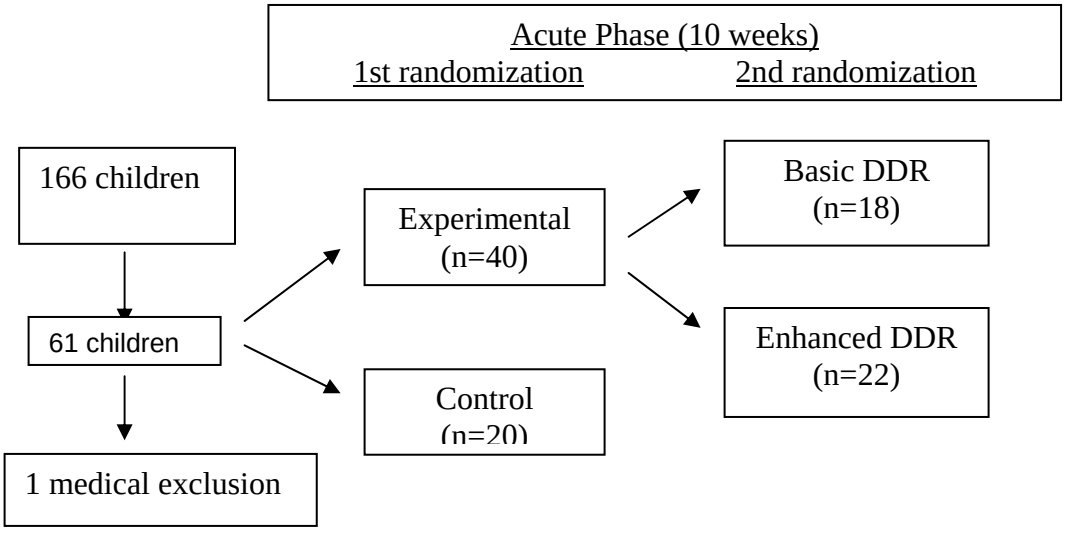

Table3. 2. Sample characteristics (n=60)

Variable	Control (n=20)	Experimental (n=40)
Age, mean years (SD)	7.6 (0.5)	7.5 (0.5)
Female	55%	48%
Non-Caucasian	33%	25%
BMI, mean kg/m^2 (SD)	18.0 (3.3)	17.2 (2.4)
Parent is College Graduate, %	100%	90%
Income > $60,000/yr, %	70%	73%

Table 3.3. Parental support (n=40) at baseline

Parental support item	Mean ± SD	Corresponding number of days of support
How often do you encourage your child to be physically active?	3.95 ± 1.176	5-6 days per week
How often do you do physical activities with your child?	2.18 ± 1.338	2 days per week
How often do you drive your child to a place for physical activity?	2.15 ± 1.350	2 days per week
How often do you watch your child participate in physical activity?	2.43 ± 1.500	2 days per week
Weekly mean of parental support	**2.6750 ± 0.92021**	**2 days per week**

Table 3.4. Logistic regression for DDR-specific environmental support predictors and physical activity as measured by DDR log at baseline (week 1)

	B	Std. Error	Sig.	Exp(B)
TV size (larger)	-.516	.723	.475	.597
Absence of other video games	3.485	1.427	**.015**	**32.622**
Greater participation of others (DDR sessions)	1.200	2.991	**.002**	**3.322**

Table 3.5. Logistic regression for DDR-specific environmental support predictors and physical activity as measured by DDR log at follow-up (week 10)

	B	Std. Error	Sig.	Exp(B)
TV size (larger)	1.292	.921	.161	3.636
Absence of other video games	.484	1.136	.670	1.623
Greater participation of others (DDR sessions)	1.604	.509	**.002**	**4.975**

Table 3.6. Logistic regression for DDR-specific participation of others at baseline (week 1)

	B	Std. Error	Sig.	Exp(B)
TV size (larger)	.420	.776	.588	1.522
Absence of other video games	3.226	1.544	**.037**	**25.179**
Greater participation in DDR – Parents	1.322	.511	**.010**	**3.745**
Greater participation in DDR – Peers	1.033	.549	.060	2.809

Table 3.7. Logistic regression for DDR-specific participation of others at follow-up (week 10)

	B	Std. Error	Sig.	Exp(B)
TV size (larger)	1.234	.903	.172	3.436
Absence of other video games	.565	1.234	.647	1.759
Greater participation in DDR – Parents	1.088	.653	.096	2.967
Greater participation in DDR – Peers	2.131	.873	**.015**	**8.403**

Table 3.8. Qualitative themes on parental support for and against DDR as a form of physical activity for their child

Fun physical activity	"engaging" "fun manner and fun competition" "great way for us to do something together"
Develop coordination skills	"learned a skill" "physically exerting" "foot/eye coordination"
Accessibility	"provides [a] safe environment" "could be done any time [the child} wanted to – regardless of weather" "active [activity] while still being a contained activity"
Geographical barriers	"we just don't have the floor space to play without moving furniture" "we live in apartment complex and we have a neighbor downstairs"
Competition with siblings	"disruptive when the competitiveness of my kids led to arguments" "all 3 children wanted to play at once"
Schedule conflicts	"difficult to make time for it in our busy schedule" "transferring between homes was disruptive"

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CHAPTER IV

MANUSCRIPT THREE: DESIGN AND IMPLICATIONS OF MOTOR LEARNING-BASED COACHING FOR CHILDREN PARTICIPATING IN AN ACTIVE DANCE VIDEOGAME

Abstract

Purpose: Motor learning-based coaching was examined as a potential enabling factor for participation in moderate and vigorous physical activity and use of a dance simulation video game, Dance Dance Revolution (DDR), among a cohort of 7-8 year old children participating in the DANCER study

Method: Sixty children (7.5 ± 0.5 years) were randomized in a 2:1 ratio to receive DDR or to a wait-list control group (10 week delay). The children in the DDR group were randomized a second time in a 1:1 ratio to an Enhanced (received motor-learning based DDR coaching) or Basic (no coaching) group. The Basic group received one initial DDR training session with instructions on accessing and navigating DDR. Children in the Enhanced group received the same Basic training session plus four individualized standardized coaching sessions. The coaching protocol applied principles from Schmidt's Schema Theory and Fitts and Posner's Stages of Motor Learning to DDR participation. Coaches were physical therapy graduate students at the University of North Carolina at Chapel Hill. Physical activity was measured objectively with accelerometry (at baseline and week 10) and DDR participation logs signed by parent(s) (weeks 1 through 10), as well as subjectively with satisfaction surveys (at week 10).

Results: Accelerometer measurements of moderate and vigorous physical activity did not show significant statistical differences between the Basic and Enhanced DDR groups at baseline or week 10, although there was an increase in vigorous physical activity in both groups. Physical activity specific to DDR ranged from 0-660 minutes per week over the 10 weeks of the DANCER study. The Enhanced group had greater DDR participation than the Basic group through the end of coaching at week five, but there were no observed statistical differences in DDR participation between the two groups at week five or at week 10. Post-intervention (at

week 10), 20% of the Enhanced group parent(s) and 50% of the Basic group parent(s) felt that their child got frustrated learning DDR and “quit” or slowed down their participation. Qualitative findings further suggest that motor learning-based coaching may have increased competence for children in the Enhanced group in gross motor components specific to DDR, such as timing and eye-foot coordination. **Conclusions**: This pilot study suggests that DDR is inherently motivating for children to self-initiate participation in physical activity and may be one way to increase physical activity among youth. Motor learning-based coaching may minimize frustrations with initial skill acquisition by structuring the learning process. However, it is unclear if motor-learning based coaching directly affects DDR performance or participation in physical activities. This study supports the role of coaches to instruct children in learning novel gross motor tasks by applying motor-learning principles to the specific task. Further study is required to evaluate the most effective and cost efficient dosage of coaching needed to determine the effectiveness of strategy to promote participation in the innovative physical activity programs for children.

Key phrases: physical activity, Dance Dance Revolution, motor learning, coaching

Introduction

Obesity has been labeled an endocrine, nutritional and metabolic disease [1], a chronic physical illness or condition of excessive fat in the body [2], and a behavioral or psychiatric problem stemming from the chronic inability to control how much one eats [3]. This condition is complex in nature and has been rapidly multiplying on a global scale, with some of the latest worldwide projections indicating that at least 20 million children under the age of 5 are overweight [4].

In one of the largest comprehensive studies following obese youth into adulthood, Whitaker and colleagues [5] reported that children who were obese by age six had a 50% risk of remaining obese into adulthood. Further, if childhood obesity continued into adolescence (ages 10-14) and the child lived with at least one obese parent, the risk of becoming an obese adult increased to 80%. Additionally, a number of other studies further report that adiposity and body mass index (BMI) are accurate predictors of future obesity for children and adolescents [6, 7].

Childhood obesity is associated with negative medical and economic costs that track into adulthood. A review of child and adolescent obesity over the past ten years found that medical outcomes include but are not limited to non-insulin dependent diabetes, sleep apnea, asthma, cancer, depression, and hypertension [2]. Further, annual hospital costs for childhood obesity have tripled over the past 20 years to $127 million during the period of 1997-1999 [7]. Further, annual hospital costs for childhood obesity have tripled over the past 20 years to $127 million during the period of 1997-1999 [8].

National health agendas have recognized that prevention and treatment of childhood obesity is key to reversing this epidemic. Healthy People 2010 [9] has established a nationwide goal to reduce the proportion of overweight and obese children and adolescents to 5%. Toward

this end, HP 2010 has established national standards for increasing physical activity levels among youth and adolescents. Yet, only 36% of youth and adolescents currently report meeting the recommended minimum of 60 minutes of physical activity on five or more days per week [10].

The majority of obesity prevention interventions have been conducted in school settings and have included such strategies as nutritional education, physical activity, behavior modification, and parent involvement; these have resulted in few significant and sustained changes in body mass index or percent body fat observed among participants [11]. Some of the more successful efforts have included attempts to decrease sedentary behaviors while simultaneously increasing physical activities in both the school [12-14] and home environment [15, 16].

Dance Dance Revolution (DDR), an active dance videogame that can be adapted for school, home or arcade use, has shown promise as a medium to increase physical activity and to displace sedentary behaviors. Today's youth is the first generation immersed in a rich multi-media and digital environment [17]. A national study of youth media consumption found that 100% of children ages 2-7 years old have at least one television in their home and 52% have a video game box [18]. At ages 8-13, this same study found that the number of households with video game boxes increased to 82%, suggesting that video game usage is an enduring and increasing behavior as children grow older. Because youth have been shown to be early adopters and avid consumers of new media technologies, it is likely that DDR will be easily espoused and accepted.

DDR uses a game console that links to dance pad sensors to measure whether each individual player is dancing the correct steps in the correct sequence with proper timing. The

resultant DDR feedback reports the accuracy of the dance steps, encouraging the individual to earn points by sustaining footwork precision. The machine provides auditory ("Boo!, "Great!") and visual feedback, tracks scores and total time on the machine. Dance Dance Revolution has gained broad appeal among youth and among some, has lead to significant weight loss, as evidenced thorough in non-peer reviewed testimonials at www.getupmove.com.

DANCER, a ten-week intervention investigating the feasibility of DDR to increase physical activity among 7-8 year old children in North Carolina, was one of eight pilot studies which aimed to develop and evaluate strategies to prevent childhood obesity through promotion of physical activity. A recent study conducted with 8-12 year old children substantiated that DDR increased energy expenditure by 172 $\pm$ 68% compared to sedentary screen time [18]. A study among a teen cohort found that playing DDR had comparable energy expenditure rates to playing tennis [19]. A study among a teen cohort found that playing DDR had comparable energy expenditure rates to playing tennis [20], suggesting that children and adolescents may need additional external motivators.

DDR participants learn dance step sequences that promote a multitude of sensory and motor experiences, including kinesthetic, proprioceptive, and tactile exploration resulting in visual-perceptual learning experiences. Challenging conditions inherent to DDR, such as interactive visual and auditory feedback, may suggest certain skill requirements in order to master and advance to more difficult levels of play.

Schmidt's theory of motor learning defines a set of rules, concepts or relationships formed on the basis of excellence that describe a class of movement [21]. Motor learning, an internal process comprised of neuronal and behavioral responses, leads to *relatively* permanent changes in the execution of a motor task [22, 23]. Schmidt's rules, similar to memory storage,

are called schema. Schema explains a class of movement through parameters describing the initial conditions, response specification, sensory consequences, and response outcomes. This theory supports motor learning as a result of practicing a variety of movements, thus creating an expanded set of schema [21, 23]. Further, this theory also supports the concept that providing learners with variability or contextual interference in several factors, such as context, time, speed, terrain, etc., during an activity will promote enhanced motor learning [21].

In the context of Schmidt's Schema Theory, it was surmised that coaching is one potential strategy for addressing the challenges of acquiring the necessary skills for children to be successful at DDR. Several studies have demonstrated that a coach may be a critical component towards motivating athletes in their sports [24, 25] including instructing and teaching athletes what to do, how to do it, and how to succeed [26]. Moreover, coaching has been instrumental for identifying key areas of improvement for athletes [27]. However, to date, DDR as a medium for increasing physical activity and the role of a coach in helping children acquire DDR-specific motor skills has not been studied.

This study aims to describe motor learning-based Dance Dance Revolution (DDR) coaching and determine the strength of association between participation in DDR with children that received coaching versus children that did not receive coaching for a cohort of North Carolinian 7-8 year old children. It was hypothesized that the association will be stronger between participation in DDR for children that received coaching than for children that did not receive coaching. It was also hypothesized that motor learning-based coaching may effect participation in moderate and vigorous physical activity based on related motivational aspects of having a coach for DDR [24, 25] and that the association will be stronger for children that received coaching than for children that did not receive coaching.

Methods

Study Population

DANCER was conducted in the homes of 7-8 year old children (n = 60) living in North Carolina. Recruitment of children was based on caregiver consent for their child to participate in DANCER in either the intervention (n = 40) or control (n = 20) condition. The majority of caregivers responded to an email sent through the listserv of UNC Chapel Hill and enrolled children all lived within a 30-mile radius of UNC-CH. Potential participants were screened for the following inclusion criteria, 1) boys and girls between the ages of 7 and 8 years 10 months, 2) any ethnic or racial group, 3) any weight or BMI, 4) guardian willing to give medical release for their child's participation, 5) guardian willing to record-DDR sessions for the child. Exclusion criteria included individuals with significant somatic or mental illness that precluded regular use of DDR (i.e., photosensitive epilepsy, broken bones, exercise-induced asthma, etc.) or individuals with extensive prior experience with DDR, Stepmania, or other forms of Bemani videogames. Extensive experience with DDR was operationalized as any child who had played DDR more than twice prior to enrollment in the DANCER study.

Following a phone screening for inclusion and exclusion criteria as detailed above, one hundred and sixty-six (166) children were screened for participation in the DANCER study and sixty-one (61) children attended a baseline assessment at the UNC Clinical Center for the Study of Development & Learning (CDL), Chapel Hill, NC. Parent(s) provided written informed consent and children gave verbal assent, after which extensive demographic, environmental, and physical data was acquired. The UNC-CH Biomedical Institutional Review Board reviewed and approved this study.

Study Design

Overview

The DANCER study was a 10-week, randomized, wait list delay controlled group comparison of experimental (DDR intervention, n = 40) and control (no DDR, n =20) groups (**Figure 1**). A second computer generated randomization schedule assigned children in the experimental group to receive either Basic DDR (no coaching, n = 18) or Enhanced DDR (coaching, n = 22). The presence of sibling pairs required a slight modification. Sibling pairs were randomized as a single child to avoid confounding influences; however, analysis of results will treat all study participants as individuals. After a waiting period of 14 weeks, children initially assigned to the control condition were offered DDR equipment and the same initial training as the experimental (Basic DDR).

DDR module

Families were supplied with all equipment necessary to play DDR in the home: the PlayStation2 game console (Sony Corporation of America, New York, NY), DDRMAX2 game (Konami of America, Redwood City, CA), and two padded dance mats. Each child and his/her parent(s) were instructed to designate one dance pad for use only by the child participating in DANCER. These materials were obtained commercially and are available from multiple vendors.

Basic DDR

Each child in the experimental group and his/her parents were provided with the necessary DDR equipment (as detailed above) during an initial standardized training session (approximately 45-60 minutes) in their home. During this session, participants were introduced to all the necessary machinery to play DDR allowing for ample opportunity for the child to

assess and navigate the various components of the DDR tutorial and game menus. Each child and their caregivers were "prescribed" 120 minutes per week of DDR, distributed over at least 4 days during each week of the experimental phase, however, children had unlimited access to the game throughout the intervention to participate more frequently or for more extended periods.

Enhanced DDR

The children in the Enhanced DDR group received the same initial training and prescription for activity as the children in the Basic DDR group. In addition, each child in the Enhanced DDR group had four individualized "coaching sessions" during the 10-week intervention period that were structured to last approximately 45 minutes. Each coaching session utilized a standardized format based on motor learning principles (detailed below).

Control Group

During the waiting period of 14 weeks, children and caregivers randomized to the control group were asked to withhold engaging in DDR in any setting, however, they were not given any other prescriptions regarding physical activity or diet. Maloney and colleagues (in press, Obesity 2008) and Paez and colleagues (unpublished, see Manuscript 1) provide further details on general DANCER study methods.

Technical assistance

The DANCER research team set up the majority of the Playstation2 systems to minimize installation problems. After initial installation, families received ongoing technical support via a dedicated pager, email, and telephone. Hardware and software problems were typically resolved within 48 hours. No direct assistance was provided with regard to game play during these visits.

The DANCER Study

Motor Learning-based Coaching and Dance Dance Revolution

Based upon the framework of Schmidt's Schema Theory, the DANCER coaching protocol was organized using Fitts and Posner's Stages of Motor Learning [28]. Fitts and Posner describe the process of motor learning as occurring in three distinct stages – cognitive, associative, and autonomous – which illustrates a progression from a high level of cognitive processing to a refinement of the motor program through repetition to a largely automatic performance of the motor skill [23] (see **Table 4.1**).

Based upon Fitts and Posner's first, or cognitive, stage of motor learning [28], the initial coaching session focused on increasing body-foot awareness and rhythm to help each child develop an overall understanding and organization of the motor learning skills necessary for playing DDR. Cognitive strategies included having the child clap and bounce their body to the rhythm of the song, call out the directions of the arrows out loud, and visualize marshmallows on the dance pad to step lightly and quickly. Knowledge of results (KR) [23] is inherent to DDR and occurs in conjunction with play through audiovisual confirmation of step accuracy. In contrast, coaching focused on providing feedback related to movement, or knowledge of performance (KP) [23]. KP related to the movement pattern each child used to achieve the outcome of stepping on each arrow with precise timing and accuracy when playing DDR. Knowledge of performance was given frequently and concurrently with the child playing the tutorials and game.

The second coaching session, designed around Fitts and Posner's second, or associative, stage of motor learning [28], was focused on the provision of proprioceptive cues to facilitate a child's spatial and temporal organization of DDR. Coaches directed children on timing and

mastery of step combinations through various methods, such as having the child tap the beat of a step combination on his/her legs, verbalize the step combination into a word pattern (e.g., ta ta tan, tan tan), and practice the dance sequence on the floor to minimize distractions from the dance pad. KP was given as a summary at the end of each tutorial and game to decrease feedback dependency.

The third coaching session concentrated on the progression of each child toward "automatic" dancing according to Fitts and Posner's last, or autonomous, stage of motor learning [28]. Each child was advanced to a song of greater difficulty through various strategies, including practicing on the training mode of DDR and reading the song's "notes" on a step chart. Training mode allows the child to choose additional assistance for each song track, such as using a metronome and/or handclap, slowing down the speed of the music, or selecting only certain parameter to practice, such as the first 20 bars of the song. The child used training mode to practice the more advanced song introduced at this section in a simpler form up to four times. The step chart shows each step of the song in its entirety, allowing one to practice off the dance pad to learn the arrow patterns prior to performing with the music. Coaches also used this session to show each child a video of another child successfully playing a difficult DDR song, as well as a personal demonstration of how to play the selected song for this session. Performance feedback was given on a faded schedule (throughout the session at 75%, 50%, and 25%) to further avoid feedback dependency.

The fourth and last coaching session aimed to reinforce the previous lessons. Each child was instructed to invite a friend or family member that had not yet played DDR to participate in the session. The goal of this lesson was to empower each child to coach his/her friend or family member to learn how to play DDR. Each child was to explain the concept of DDR, demonstrate

playing DDR, progress their friend or family member through the first tutorial, describe the DDR game menu, and select an appropriate song for their friend or family member to play. The coach acted in a supportive role to the child during this session, providing assistance only when specifically asked by the child. At the conclusion of this coaching lesson, each child was presented with a certificate of accomplishment in special DDR training.

Rater Standardization

Staff received extensive training (11-12 sessions, each lasting approximately 45 minutes) comprising all aspects of DANCER. Trainings consisted of detailed explanations, demonstration, and practice of all assessment measures. Staff members were tested on all methods until able to consistently perform as indicated on the protocols. In addition, to further insure uniformity, specific measures were collected by the same staff member at each specific time point (baseline at week 0 and follow-ups at weeks 10 and 26).

Coaches were assigned 2-3 children to train in the Enhanced group. Each coach was observed by the primary author (SP) interacting with a selected child and their parent(s) during the intervention period to ensure compliance and uniformity with protocol.

Study Measures

Study measures included demographic information and physical exams consisting of weight, bioelectric impedance body fat percentage, and calculated BMI using the Tanita TBF 310 (Tanita Corporation of America, Arlington Heights, IL) or the Omron 938 (Omron Healthcare, Kyoto, Japan).

Outcome Variables

The primary outcome measures were accelerometer- and DDR-determined physical activity. Accelerometer-determined physical activity was measured as total counts of activity

over a seven-day period detected by the MTI/CSA Actigraph® accelerometer (CSA; MTI Health Systems, Ft. Walton Beach, FL) acquired at Baseline (Week 0) and Week 10. The minimum acceptable wearing time was set *a priori* at 80% of waking hours for at least 4 weekdays plus one weekend day during each 7-day monitoring period. The daily DDR log was a self-report tool used in order to obtain a rough estimate of total minutes played each week. General study measures and outcome variables are described in full by Paez and colleagues (unpublished, see Manuscript 1).

Individual Factor Variables

The coaching variable was dichotomized as either "Basic" or "Enhanced" group membership. Environmental conditions for children in the Basic and Enhanced groups were recorded on the Basic Home Environmental Screen and the Enhanced Intervention Home Visitations Record. The Basic Home Environmental Screen (BHES) captured the conditions under which children live and play as perceived by a member of the research team. Items pertinent to this pilot include physical impediments (e.g., lack of space), practical barriers (e.g., 2nd floor apartment), and human interference to participation in DDR (e.g., parent(s), friends, or siblings). This 11-item scale was administered by a staff team member to both Basic and Enhanced groups at week one during the initial DDR training session in each child's home.

In addition to the description provided by the BHES, home environment details for the Enhanced group were recorded during each of the in-home training visits on the Enhanced Intervention Home Visitations Record (EIHVR). The EIHVR provided additional detail about the in-home training experience with elements common to the BHES, as well as novel items such as duration of training, type of instruction provided by trainer, and child improvement during the

session. This record was administered by the coaches and was used primarily to note any deviations from the protocol and to further assess any specific motivators and barriers to DDR.

Qualitative data from satisfaction surveys administered to parent(s) and children included responses to inquiries regarding the amount of coaching provided and consequent response (i.e., frustration, difficulty of DDR) of children. Parent(s) and children also described how the instruction helped or could have been improved.

Statistical Analysis

Participation in physical activity was based on two outcome variables, CSA data at weeks 0 and 10, and DDR log records at weeks 1 and 10. The factor variable of coaching was based on whether the child was randomized to the Basic (no coaching) or Enhanced (coaching) group. See **Table 4.2**.

CSA Data Reduction

Minute by minute activity counts were used to determine daily total minutes of physical activity and minutes of moderate-to-vigorous physical activity (MVPA) during each 30-minute segment of the seven day monitoring period at weeks 1 and 10. Accelerometer readings were processed using methods similar to those reported by Puyau et al. (2002) which reported data as means $\pm$ SD (activity counts/day). Readings between 1160 to 5200 counts per minute were considered as moderate physical activity, a threshold that corresponds to 3.0 metabolic equivalents (METs) using a calibration equation developed by Treuth and colleagues (2004). Vigorous physical activity was defined as readings above 5200 counts/minute, a threshold that corresponds to 6.0 METS. Missing accelerometer data within a 7-day monitoring period were replaced via imputation based on the Expectation Maximization (EM) algorithm (Catellier et al, 2005).

DDR Compliance

Data was reported as means ± SD (minutes/day). A subgroup analysis was used to determine the cutoff point for high versus low exposure to playing DDR. Based on subgroup analysis, the outcome variable of DDR exposure was dichotomized at week 1 and at week 10 as an average of 127.95 and 61.69 minutes, respectively, into high versus low exposure groups for DDR compliance.

Data treatment

Data was compiled in an Access database for subsequent analysis in SPSS v.14.1 Descriptive statistics summarized characteristics of the sample. A subgroup analysis was conducted to determine the cutoff point for high versus low exposure of DDR participation. This variable was then use to dichotomized subjects in the experimental group to maximize differences in further analyses. Independent-samples t-tests and chi-square tests were computed between the coaching variable and participation in physical activity as measured by the MTI/CSA accelerometer and the DDR logs, respectively.

Results

Sample Characteristics

One hundred twenty two prospective participants were screened to participate in DANCER, of which 60 participants were enrolled (see **Figure 4.1**). The groups were similar in age, sex, race, physical measurements, and family characteristics (see **Table 4.3**).

Descriptive Statistics

Accelerometers were worn by 100% of participants in the experimental group for each 7-week monitoring period. Mean wearing times were 90% and 73% of waking hours at weeks 0

and 10, respectively. Moderate physical activity (mpa) and vigorous physical activity (vpa) as measured by an accelerometer at baseline (week 0) and post-intervention (week 10) are reported in **Table 4.4**. Group differences in mpa and vpa were not statistically significant.

The Basic group completed 67% and 72% of DDR logs at weeks 1 and 10, respectively. The Enhanced group completed 82% and 41% of DDR logs at weeks 1 and 10, respectively. Physical activity as self-reported on the DDR logs ranged from 0-660 minutes per week,; mean use across Basic and Enhanced groups at baseline (week 1) was 141 minutes per week and at post-intervention (week 10) was 64 minutes per week. The Enhanced group had numerically, but statistically non-significant, greater DDR use than the Basic group through the end of week 5. **Figure 4.2** compares minutes of DDR use in Basic and Enhanced groups over the ten weeks.

Hypothesis Test Results

Independent-samples t-tests were conducted to evaluate the hypotheses that children receiving motor learning-based coaching would demonstrate higher levels of participation in moderate and vigorous physical activity than children that did not receive coaching. At baseline, mean differences between Enhanced and Basic groups were not significant, $t_{mpa}(35.533) = 1.403$, $p=.169$, $t_{vpa}(34.244) = 1.992$, $p=.054$. There were also no significant differences between groups post-intervention (week 10), $t_{mpa}(20) = 1.000$, $p=.329$, $t_{vpa}(33.784) = -.066$, $p=.948$.

Pearson's chi square tests were conducted to evaluate whether participation in DDR differed based on coaching. The two variables were DDR exposure minutes with two levels (high, low) and presence of coaching with two levels (Enhanced, Basic). At baseline, DDR exposure and coaching were found to be statistically insignificant, Pearson $X^2(1, N=40) = .082$, $p = .775$. Similarly, there were no significant differences post-intervention, Pearson $X^2(1, N=40) = .852$, $p=.356$.

Qualitative Findings

Forty-two percent of Enhanced children and 18% of Basic children responded that at the start, it was "too hard" to play DDR. Some parent(s) (19% Enhanced, 22% Basic) also seemed to agree that DDR was initially too difficult for their child. Post-intervention (at week 10), 35% of Enhanced children and 24% of Basic children got frustrated "a lot" playing DDR. According to parent(s), at post-intervention, 20% of Enhanced and 50% of Basic felt that their child got frustrated learning DDR and "quit" or slowed down their participation.

The majority of parent(s) (95%) reported that the DANCER staff provided enough instruction to get their child started playing DDR. Enhanced group parent(s) additionally cited that coaching was beneficial; some of the comments were that "coaching helped him get started," "helped [him/her] with hearing the beat and placement of feet," "taught her how to move on the dance pad so she was not frustrated," and "helped focus him." Comments from the Basic group parent(s) suggested that one home visit was adequate (e.g., "enough to give my child an idea of how to perform but still allowed him to learn on his own and figure some things out"), however, 11% of Basic group parent(s) thought that one home visit was not sufficient.

Discussion

The present investigation used a randomized wait list control study design to explore the association between motor learning-based coaching and no coaching with participation in moderate and vigorous physical activity and Dance Dance Revolution (DDR) among 7-8 year old North Carolinian children participating in the DANCER study. A major finding of the present study was that motor learning-based coaching did not have any statistical implications associated with children's participation in moderate and vigorous physical activity and DDR.

Maloney and colleagues (in press, Obesity 2008) reported that *vigorous* physical activity increased significantly in the DDR group (Enhanced and Basic) compared to the control group during the 10-week DANCER intervention, however, the current findings were that differences in *vigorous* physical activity between the DDR cohort – Enhanced versus Basic – were not significant. During the first five weeks of the DANCER intervention, children in the Enhanced group appeared to participate in DDR to a greater extent; however, both groups showed an overall trend of decreasing minutes of participation in DDR. After the conclusion of coaching at week five, minutes of participation in DDR for the Enhanced group continued to subsequently decline for each of the remaining weeks of the intervention. Conversely, the Basic group demonstrated a steady amount of participation for the remainder of the intervention, although at a lesser extent than during the first few weeks.

These global patterns of declining DDR participation in the Enhanced and Basic groups are consistent with the limited literature on DDR and may indicate that the novelty of DDR is initially sufficient to increase levels of physical activity, but that in and of itself, is not adequate for sustained participation. Madsen and colleagues [20] reported that among overweight children and adolescents, only 40% continued to participate in DDR at least twice a week throughout the initial 3-month period, and further, only 2 children continued to participate from months 3 to 6. Forty-three percent of the subjects reported boredom with DDR within 4 weeks.

In this study, monotony with the "easy" songs may have also led some children to discontinue their participation. Subjective reports by parents in the Basic group indicated that these children had more frustrations and a tendency to slow down or quit participation in DDR than children in the Enhanced group, particularly post-intervention. These parents cited explanations for their child's frustration and decreased level of playing DDR that included their

child experiencing difficulty with coordinating the timing of steps, tracking the arrows on the television screen, and synchronizing their eye and foot movements. Conversely, less children in the Basic group reported difficulty with DDR at the onset and termination of the DANCER study, particularly at week 1. Although children were randomly allocated to Basic or Enhanced groups, there may have been some differences between children in the groups that were not measured in this study.

In the Enhanced group, a potential explanation for the waning of DDR participation may be that cited in Magueu and Vallerand's [24] coach-athlete motivation model. Magueu and Vallerand [24] suggest that extrinsically motivated athletes may engage in their activity as a result of feelings of imposition or coerciveness by an external force, such as a coach. In the DANCER study, children in the Enhanced group may have participated in DDR at a greater extent during the first five weeks of the intervention (i.e., the coaching period) due to the presence of a DANCER coach and perceived pressure to participate in DDR. After the coaching sessions ended, children may not have felt the same obligation to participate in DDR.

Among studies of elite athletes, the role of a coach is imperative in creating the climate of learning, one that has been described as ideally supportive and caring [25-27]. Given the individuality of coaches, children and families, this atmosphere is difficult to control from a research standpoint, however, the motor-learning protocol attempted to control for these individualities by standardizing each coaching session. As a result, although coaches were able to interject their own personality and allow for extra time during each coaching session, coaches were required to complete the DDR lesson in its entirety whether or not a child was ready to progress. This study did not allow each coach the flexibility to adapt or modify the protocol beyond additional time as based on the child's personal needs as would typically be done in a

real world setting. Thus, although coaches may have had every intention to create an environment conducive to learning, the individual learning styles of the child and the coach's adherence to the set protocol may not have allowed for establishing a perceived "supportive and caring" environment.

Differences between parent and child perception of DDR difficulty are important to note. Parents of children in the Enhanced group reported that their child has *less* difficulty with DDR, yet children in the Enhanced group reported *more* difficulty with DDR. Parent and child perceptions of difficulties with DDR were reversed in the Basic group. It is plausible that parents of children in the Enhanced group perceived the additional instruction with coaching as helpful and advantageous for their child to gain additional skills; parents may have perceived that coaches *did* create a "supportive and caring" environment. Yet, children in the Enhanced group may have perceived coaching entirely different.

The strict adherence to the protocol may have actually acted as a barrier to fostering a sustained interest in DDR beyond the five weeks of coaching. Coaching may have been perceived as a burden to children in the Enhanced group. By remaining consistent to the motor-learning based DDR protocol, coaches may have inadvertently set a level of expectation that the child was not yet ready to achieve. Accordingly, coaches may have acted to further complicate a situation that was already confusing and difficult for the child. If the child was struggling with learning the previous lesson's DDR skills, coaches may have acted to exacerbate frustrations levels and cause additional stress by imposing further expectations on the child. Moreover, coaching may have been a hindrance to children in the Enhanced group.

In addition, a further detriment of the coaching protocol is that it may have introduced a dependency among children on their coach. It is plausible that the natural curiosity that children

may have for exploring and self-regulating learning DDR may have stifled. Children no longer had control of his or her own experience with DDR and may actually have learned to depend on the coach to guide his or her learning. DDR may have become a chore or a nuisance to the child receiving coaching in that the "fun" of DDR may have been removed by setting up a forced learning schedule.

. Coaches were not able to set individualized goals or adapt their coaching style for each child. In addition, the coaching relationship was abbreviated to five weeks. Thus, the role of the coach in the DANCER study was different than the role of a coach in a real world setting which typically varies from athlete to athlete and is typically longer in duration. For some individuals, it is important for the coach to directly guide the athlete; for others, they appreciate more freedom as they continue to master skills for their particular sport [25]. Coaches were not able to set goals based on each child's level of skill or adapt lessons as needed to advance the child to the appropriate skill level. Because of this, the role of a coach in building confidence and/or self-efficacy was limited.

The family's role in creating the ideal climate for learning gross motor tasks has been illustrated as "a function of a shared environment with other family members" with individual behavior and personal characteristics functioning within this larger environment [as cited in 33, 34]. In a shared environment, [33]parental and familial encouragement for physical activity has been shown to predict participation in physical activity [35-37] and to correlate to the level of physical activity [38-42] among children and adolescents. In the presence of child frustration, parent(s) conveyed using a specific tactic during the intervention: "we worked at it as a family," "encouraged [him/her] to keep going," and "reminded [him/her] it was for fun." These additional findings suggest that family encouragement may have created a supportive and

fostering environment, perhaps acting to supplant the role of a coach as a confidence builder.

Other strategies to increase DDR use have included competitions, group participation, and social support from family members and peers [20]. Children in the DANCER study also suggested several approaches to help other children enjoy DDR: “do the lessons a lot”, provide incentives such as “give [them] a prize every week”, “written reminders”, “practice,” “try your best,” and “talk to my coach.” Several children in the Basic cohort cited that “[having coaches go] to their house to help them,” having “more home visits,” and “[learning] with a teacher” could also help other children sustain and improve their DDR play.

The current findings suggest that coaching should be complementary to family support and that the effects of parents *and* coaching may be additive. Future public health initiatives may want to employ joint interventions involving parents *and* coaching. Children in this study reported enjoying a relationship with their coaches, yet, from a skill level, perceived undue burden. It is thus plausible that the presence of a coach was perceived as cooperative or competitive or both and that *this* relationship was the motivating factor for DDR. These findings suggest that future interventions should consider adopting strategies that involve a “coach” visiting the child and his/her family to participate in DDR with the child. The mere presence of a coach may be enough to sustain participation in DDR or another physical activity due to the relational aspect. This model may allow for the child to explore DDR freely and to ask for help when needed, rather than assistance being imposed upon the child. Coaches should therefore determine whether cooperation, competition, or a combination of both, acts as the primary motivator for the child in the relationship and structure the “coaching” accordingly.

This pilot study has several limitations. Interpretation of the data may be possibly confounded by seasonal effects; children and parent(s) in both groups reported conflicting

interests with other seasonal physical activities (e.g., basketball, soccer), as well as with school and holiday schedules. Generalizability of the data is also limited primarily due to recruitment methods that may have introduced a selection bias. The sample size was largely Caucasian with educational and economic status higher than the national or state averages. Conversely, baseline BMI was lower in both groups than the overall BMI in NC for this age cohort. These limitations are further augmented when considering the sample size and the completion rates for the DDR logs. As a result of these limitations, only large effects are visible between groups and it is feasible that differences between Enhanced and Basic groups may statistical power was too low to find significance.

Our findings suggest that inherent components of DDR (e.g., such as the tutorial sections or the innate "fun") are sufficient for children to begin playing. Motor learning-based coaching did not prove to be significance in terms of minutes of DDR participation; however individual reports suggest that the presence or absence of coaching did have an impact. The presence of a coach may have acted to mediate frustration by guiding the learning process of a novel gross motor task, however, this was not explicitly measured. Based on this study, it remains equivocal whether motor learning-based coaching for DDR had any effects on DDR performance, transfer of learning to other analogous motor tasks, or participation in physical activities. These findings merit additional study of the association between motor-learning based coaching and participation in a dance simulation videogame.

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Conflict of Interest

None to report; we were not supported by Sony or Konami.

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Table 4.1. Motor learning-based protocol for DANCER

Coaching Visit	Focus	Specific Strategies
First	Theory: Fitts and Posner's (CITE) Cognitive Stage, "what to do" DDR: Body-foot awareness and rhythm (Foundation Building)	1. Pick up the beat – listen to the rhythm cue for arrows flashing and character bouncing to the beat; have child clap hands and bounce body to the beat 2. Step lightly – (visual – marshmallows) – to move feet faster. 3. Stay on the arrows – alternate feet Concurrent Knowledge of Performance (KP) feedback
Second	Theory: Fitts and Posner's Association Stage, "how to do" DDR: Scoring (Continuation of Foundation Building)	1. Learning complex step patterns – having the child tap the beat and/or pattern on his/her legs, verbalizing the step combo into a word pattern (e.g., tat a tan, tan tan), practicing the sequence on the floor to minimize distractions 2. Keep the combo's going – accuracy of steps – proprioceptive cues to facilitate spatial and temporal organization of DDR Summary KP feedback
Third	Theory: Fitts and Posner's Autonomous Stage, "how to succeed" DDR: Progressing towards "automatic" dancing (Challenging the Foundation)	1. Demonstration of "automatic" dancing: video of DDR players at competitive levels, www.ddrfreak.com website, coach demonstrated dancing a difficult DDR song 2. Instruction on simplifying a difficult song: DDR step charts, training mode Faded KP feedback
Fourth	Theory: Social support and Social Cognitive theories DDR: Parent/Peer involvement (Motivational and Empowerment to Succeed)	1. Reinforcement of previous lessons – child taught a parent and/or peer how to play DDR using a specific protocol (explaining DDR concept and menus, child demo of a difficult song, leading parent and/or peer through tutorial and game sections) 2. Presentation of Certificate of Accomplishment in Special DDR Training to Dancer (child's name) Coach acted in a supportive role providing assistance only when specifically requested by the child

Table 4.2. Statistical analysis

	Dependent/Outcome Variables→	**Physical Activity Participation: MTI/CSA Accelerometer**		**Physical Activity Participation: DDR Log**	
	Definitions of Dependent/Outcome variables →	means ± SD (minutes/day) > 1160 but <5200 counts/minute = MPA > 5200 counts/minute = VPA (continuous variable)		means ± SD (minutes/week) dichotomized from subgroup analysis into high/low exposure groups	
		Pre – (Week 0)	*Post – (Week 10)*	*Pre – (Week 1)*	*Post – (Week 10)*
Independent/Factor Variables ↓	**Definitions of Independent/Factor Variables ↓**				
Coaching *Week 1*	Enhanced/Basic (dichotomous variable)	Independent-samples t-test	Independent-samples t-test	Chi-square test	Chi-square test

Figure 4.1. Schematic of study design

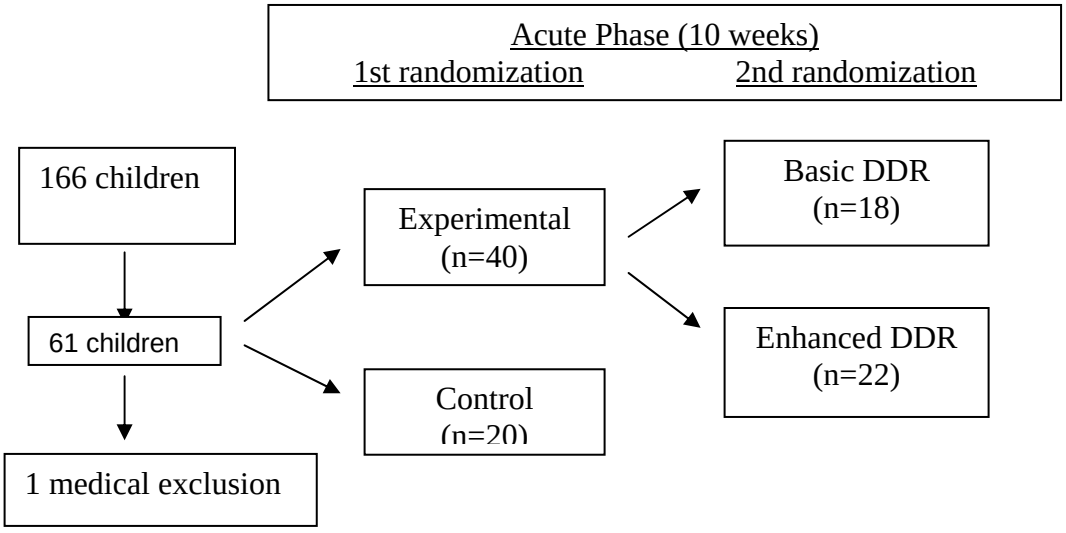


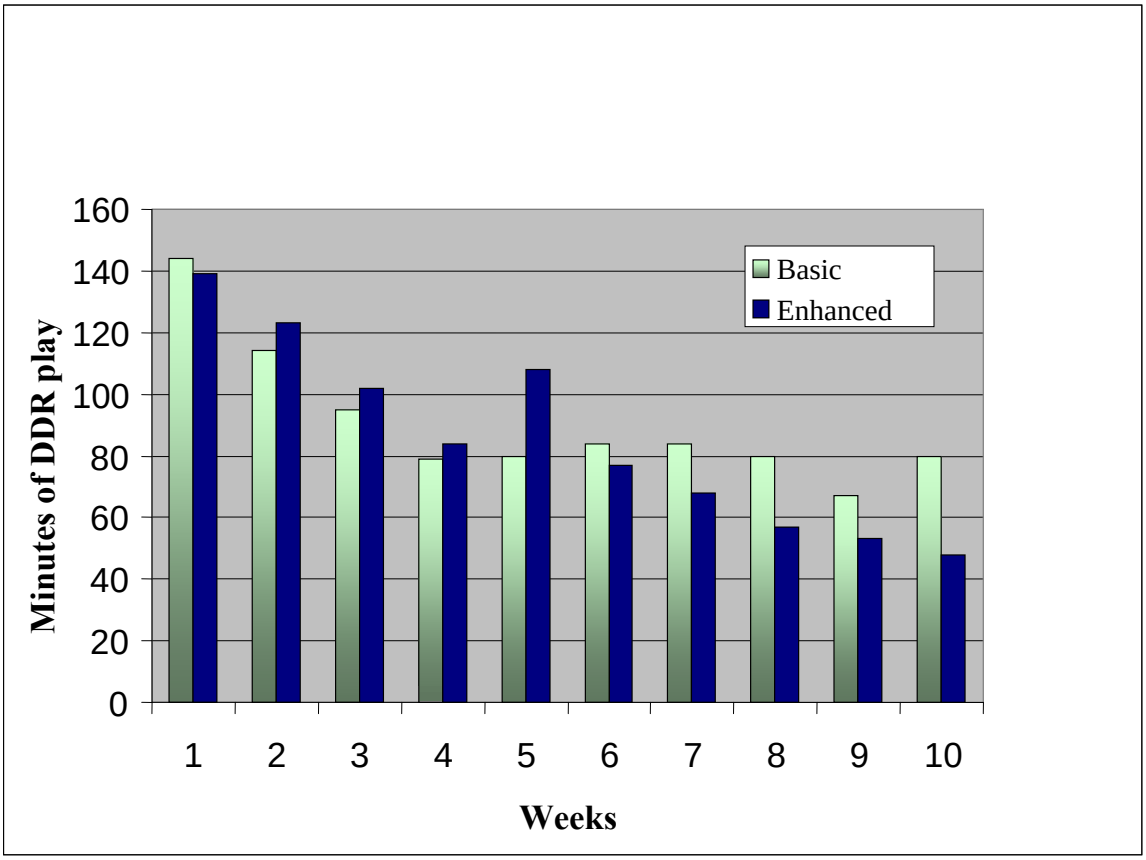
Table 4.3. Sample characteristics (n=60)

Variable	Control (n=20)	Basic (n=18)	Enhanced (n=22)
Age, mean years (SD)	7.6 (0.5)	7.4 (0.5)	7.5 (0.5)
Female	55%	40%	55%
Non-Caucasian	33.3%	28.6%	37.5%
BMI, mean kg/m^2 (SD)	18.0 (3.3)	17.6 (2.6)	16.7 (2.1)
Parent is College Graduate, %	100%	89%	91%
Income > $60,000/yr, %	70%	78%	68%

Table 4.4. Average daily minutes of physical activity

	Baseline (week 0)		Post-intervention (week 10)	
	MPA (mean ± SD)	VPA (mean ± SD)	MPA (mean ± SD)	VPA (mean ± SD)
Basic (n=18)	140.49 ± 23.84	7.49 ± 4.99	146.40 ± 37.86	16.37 ± 12.26
Enhanced (n=22)	154.57 ± 38.49	11.94 ± 8.85	148.13 ± 30.19	16.11 ± 11.80

Figure 4.2. Comparison of DDR minutes per week



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CHAPTER V

SYNTHESIS

The purpose of this dissertation was to review the predisposing, reinforcing and enabling factors that influenced participation in moderate and vigorous physical activity and Dance Dance Revolution for North Carolinian 7-8 year old children participating in the DANCER study. The dissertation was presented in three inter-related manuscripts, each addressing individual aims.

Summary of Major Findings

Manuscript one: Associations between previous physical activity exposure and self-perception of physical competence with physical activity among children participating in an active dance videogame

Aim 1: To describe predisposing factors (e.g., previous physical activity exposure and self-perception in physical competence) for children participating in the DANCER study
Findings: Previous physical activity exposure varied significantly for the DANCER cohort, both in physical activity exposure and in frequency of participation over the year preceding the start of the DANCER study. M-GAQ previous physical activity summary scores ranged from 0 to 53, indicating a range of no exposure to participation in four physical activities at a frequency of at least 2x's per week for at least 30 minutes per session for each reported physical activity. Physical competence subscale means for the DANCER cohort aligned closely to reported psychometrics for the Self-Perception Profile for Children [1] and the Pictorial Scale of Perceived Competence and Social

Acceptance for Young Children [2]. Seven-year old children had higher self-perception in physical competence than 8-year old children overall.

Aim 2: To identify the strength of association between these predisposing factors (e.g., previous physical activity exposure and self-perception in physical competence) with participation in moderate and vigorous physical activities and DDR at 1st and 10th week of the DANCER study.

Findings: Previous physical activity exposure explained differences for participation in vigorous physical activity at follow-up, but not for participation in moderate physical activity or DDR at follow up or for differences in participation in moderate and vigorous physical activity or DDR at baseline. Self-perception in physical competence was insignificant for differences in participation in moderate and vigorous physical activity or DDR at baseline or follow-up. Ninety-five percent of children reported that they liked DDR and 71% of children that they reached "advanced" or "expert" levels of proficiency playing DDR. Roughly 91% and 66% of children and parents, respectively, stated that they felt the child participating in DANCER became more active during the period of the study.

Manuscript two: Parental and environmental factors associated with physical activity among children participating in an active dance videogame

Aim 1: To describe the reinforcing factors (e.g., direct parental support and DDR-specific environmental support) for children participating in the DANCER study

Findings: Weekly general parental support habits ranged from 1 to 6 days, with *encouragement* of physical activity occurring most often (mean of almost 5 days per week). The majority of children played DDR in the living room or den/additional playroom (95%) on a large-sized television between 19-26 inches (60%). Roughly half of the children had at least one other videogames in their home, with Playstation (20%) and Nintendo (12.5%) as the most common systems. DDR participation of others ranged from 0-61 sessions over the ten weeks of the intervention. At week 1, parent and peer (i.e., siblings and friends) participation in DDR with the child in the DANCER study ranged from 0-5 and 0-6 sessions, respectively. At week 10, parent and peer participation in DDR ranged from 0-4 and 0-5 sessions, respectively.

Aim 2: To identify the strength of association between reinforcing factors (e.g., direct parental support and DDR-specific environmental support) with participation in moderate and vigorous physical activities and DDR at 1st and 10th week of intervention of the DANCER study

Findings: General parental support was insignificant for children's participation in moderate and vigorous physical activity or DDR at baseline or follow-up. At week 1, presence of other videogames was inversely associated with child participation in DDR; in addition, DDR participation of parents was directly associated with child participation in DDR at week 1. At week 10, participation of peers (i.e., sibling and friends) was directly associated with child participation in DDR. The majority of families reported that they liked DDR as a form of physical activity both for their child and themselves;

additionally, the majority of parents reported that having DDR in the home was minimally or not disruptive and that they would recommend DDR to other families.

Manuscript three: Design and implications of motor learning-based coaching for children participating in an active dance videogame

Aim 1: To describe the development of a motor learning-based DDR coaching protocol for children participating in the DANCER study.

Findings: The coaching protocol applied principles from Schmidt's Schema Theory and Fitts and Posner's Stages of Motor Learning to DDR

Aim 2: To identify the strength of association between the enabling factor of coaching with participation in moderate and vigorous physical activities and DDR at 1st and 10th week of the DANCER study

Findings: Physical activity specific to DDR ranged from 0-660 minutes per week over the 10 weeks of the DANCER study. The Enhanced group had greater DDR participation than the Basic group through the end of week five, but there were no observed statistical differences in DDR participation between the two groups. Accelerometer measurements of moderate and vigorous physical activity did not show significant statistical differences between the Basic (no coaching) and Enhanced (coaching) DDR groups at baseline or week 10, although there was a numerical increase in vigorous physical activity in both groups. Post-intervention (at week 10), 20% of the

Enhanced group parent(s) and 50% of the Basic group parent(s) felt that their child got frustrated learning DDR and "quit" or slowed down their participation.

Significance of Findings

National health agendas, prevention goals, and targeted studies underscore the urgent need for knowledge of and access to sustainable, life-long recreational physical activities that will prevent and treat child and adolescent overweight and obesity. Moreover, prevention of youth overweight and obesity is particularly imperative because of the increasing number of people affected, the difficulty, cost and low yield of therapeutic approaches, and the complexity in treating established obesity [3].

DDR is an attractive option to increase lifespan participation in physical activity within the home environment; however, evidence-based research on its effectiveness is limited. This dissertation applied principles from SCT, Schmidt's Schema Theory, and Fitts and Posner's Stages of Motor Learning to the DANCER study to explore the link between participation in moderate and vigorous physical activity and DDR with several behavioral and environmental factors.

The results of this dissertation provide evidence that social interactions were associated with increased participation in DDR within the home environment. In particular, participation of parents is critical to children's initial participation in DDR (at week 1) and participation of peers (e.g., friends and siblings) is important for children's sustained participation in DDR (at week 10). Additionally, the presence of other video games competes with participation in DDR and is therefore, not conducive to increasing participation in physical activity using this medium. Qualitative reports provide further

support that DDR is not only an attractive mode of physical activity, but also, that children and families perceived becoming more physically active via use of an active video game. The effects of coaching are vague in that subjective reports indicated that families of children's without coaching had increased levels of frustration and would have liked to have had additional coaching sessions or these families adjusted and provided their child with instruction and motivation similar to that of a coach.

Previous exposure and self-perception in physical competence were not associated with participation in DDR; however, subjective accounts indicate that these factors may have been instrumental for a child's perceptions of acquired proficiency at playing DDR after a 10-week usage. Further, previous physical activity exposure was associated with participation in vigorous physical activity at follow-up as measured by accelerometer. This finding parallels other inferences from the literature of previous physical activity being related to future physical activity; however, interpretation of this finding is limited because of the condensed duration of this study.

Strengths and Weaknesses

Strengths

1. Theory-based (e.g., motor learning and public health) research questions
2. Novel physical activity intervention
3. Subjective support for DDR reported by subjects and families
4. Motor learning-based coaching protocol
5. Identification of need for future research

Weaknesses (Limitations)

1. Small sample from a statistical perspective so that only large effects were detectable between groups
2. Probable selection bias from recruiting methods and therefore, a nonrepresentative sample
3. Conflicting interest of seasonal effects; as well as school and holiday schedules
4. Limited length of intervention and follow-up
5. Limited validity and reliability for previous physical activity exposure and general parental support measures
6. Low to moderate completion rates for DDR participation logs

Future Research

This dissertation adds supportive evidence to the currently limited body of literature exploring the effectiveness of providing active alternatives to increase physical activity. It also provides evidence for use of an active dance video game, such as DDR, that can be promoted as play and utilized within the community or home environment. The current findings suggest that initial and sustained participation in DDR can be influenced by external factors other than the participants themselves. In addition, these findings suggest that other factors, including personal characteristics, may be relevant, however, given statistical limitations, did not prove themselves to be significant in this study.

Additional research is needed to explore the effects of predisposing, reinforcing, and enabling factors on initiating and sustaining participation in physical activities and

DDR. Children seem to participate in physical activities as a natural, even habitual, part of their daily lives; however,, as they mature, children gradually become more inactive and maintain a sedentary lifestyle [4]. Several studies [5, 6] suggest that children's physical activity habits do not necessarily translate into adulthood. Further, individuals with disability and chronic illnesses are even less likely to participate in physical activity [6]. Future research can include exploration of DDR as a mode of physical activity into adolescence and adulthood. It would also be beneficial to investigate the use of DDR as a medium to promote physical activity among children with special health care needs to address the concern of overweight and obesity in this population.

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Appendix A: Literature Review

The 2001-2002 National Health and Nutrition Examination Survey (NHANES), a data source that monitors the prevalence of overweight and obesity in the United States [1], indicated that 31% and 16% of children aged 6-19 years were overweight and obese, respectively. Decreased participation in physical activities and increased participation in sedentary activities are primary contributors to the child and adolescent overweight endemic. National health agendas and prevention goals recommend 60 minutes of daily participation in physical activities for children and adolescents both for general wellness and for prevention of overweight and obesity [2]. Despite these guidelines, North Carolina recently received a grade of "D" for participation in physical activity [3].

A matrix of factors, including biological, psychological, social, cultural, and environmental, can influence the involvement, sustained effort, and continued interest in physical activity among youth [4]. There is currently no evidence-based literature examining the influence of these factors for children participating in Dance Dance Revolution (DDR), a dance simulation video game. This dissertation will focus upon the prospective role of several prominent factors to promote participation in DDR as a means to increase physical activity among a cohort of North Carolinian children participating in the DANCER study.

The DANCER study

DANCER was one of eight pilot projects funded under the Linking Interventions for Children (LINC) project at the University of North Carolina at Chapel Hill (UNC-CH). LINC is a series of childhood obesity prevention pilot projects funded by Get Kids in Action, a four-year,

$4 million partnership initiated in 2001 between UNC-CH and the Gatorade Corporation. The purpose of this partnership was to develop and evaluate strategies to prevent childhood obesity through promotion of physical activity and healthy diet using education, outreach, and research, ultimately linking primary care and family-based interventions.

The broad objective of the DANCER study was to evaluate the efficacy of a dance simulation videogame, Dance Dance Revolution (DDR), to increase physical activity and decrease sedentary activity in children 7-8 years old living in North Carolina. DDR uses a game console, which communicates with a dance pad that senses when one is dancing the correct steps in the correct sequence with proper timing. It measures the accuracy of the dance steps and encourages the individual to earn points and sustain combinations of footwork.

Using an adaptation of the Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation (PRECEDE) planning model [5] this dissertation will more specifically focus upon the potential role of predisposing, reinforcing and enabling constructs to promote participation in DDR for North Carolinian children in the DANCER study. (See **Appendix B** for theoretical model).

An overview of PRECEDE

The Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation planning model (PRECEDE) uses systematic participatory planning and ecological approaches to influence environmental and lifestyle changes affecting health and quality of life [5]. PRECEDE centers on the standard that health behavior change is best sustained when the basis is voluntary [6]. This planning model, consisting of five phases[1], has been used extensively to develop evidence-based interventions across multiple levels of influence tailored

[1] Note: This dissertation only adapted the first four phases of PRECEDE.

to the needs and interests of a target population, including menopause counseling in a managed care setting in North Carolina [7] and diabetes prevention and control in a Canadian Aboriginal community [8]. PRECEDE was primarily used to discriminate among and organize the multitude of potential precursors for youth participation in DDR into an evidence-based select framework of predisposing, enabling, and reinforcing determinants.

Phases one and two: Social and epidemiological assessments of pediatric overweight and obesity

PRECEDE begins with Phase 1, a *social assessment*, to describe the reciprocal relationship between health and indicators of quality of life [5]. Phase 2, the *epidemiological assessment*, prioritizes the health goals or problems for a target population that present the greatest obstacle to quality of life. Phases 1 and 2 are often intimately related, as frequently denoted by the "five D's" of health problems – death, disease, dysfunction, discomfort, and dissatisfaction – that extend into the quality of life issue. This dissertation aligns closely with the familiar intermingling between Phases 1 and 2. The prevalence of pediatric overweight and obesity has been repeatedly shown to correlate with numerous medical and psychosocial co-morbidities, many of them encompassing the "five D's", as well as additional significant financial detriments.

Etiology of overweight and obesity

The etiology of overweight and obesity is complex, stemming from genetic, metabolic, behavioral, environmental, physiological, social, cultural, and socioeconomic factors that result in an energy imbalance [9]. Obesity-promoting environmental factors are now collectively

termed the “obesogenic” environment [4] and among children and adolescents, an “obesogenic” environment leads to an increased risk of overweight and obesity [9-11].

Prevalence of pediatric overweight and obesity

Over the past three decades, this “obesogenic” environment has contributed to a prevalence of overweight that has more than doubled from 5% to 11% for adolescents ages 12 to 19 and nearly tripled from 4% to 11% for children ages 6 to 11 years [12]. Further, there is a disproportionate increase in overweight among non-Hispanic black and Mexican-American adolescents [12] and in Southern states [13]. This trend in pediatric overweight and obesity is associated with numerous medical, psychosocial and economical costs.

Medical, psychosocial, and economic implications

Health consequences associated with youth overweight and obesity include but are not limited to diabetes mellitus, functional ovarian hyperandrogenism, asthma, sleep apnea, pseudotumor cerebri, flat feet, slipped capital femoral epiphysis, hypertension, dyslipidemia, hepatic steatosis, cholelithiasis, menstrual abnormalities, impaired balance, and orthopedic problems [14-16].

Emotional and social consequences begin as early as 5 years of age [17] and are associated with social marginalization [18], depression [19], teasing, discrimination and victimization [20]. Further, overweight youth report having a more negative body image than their peers, as well as lower self-esteem, self-concept [21-23] and reports of health-related quality of life [24-26].

Pediatric overweight and obesity also has high economical costs. In North Carolina, 35% of preventable deaths are attributed to poor nutrition and physical inactivity, with physical inactivity costing $6.2 billion per year [3]. In addition, the costs of overweight in children track into adulthood [27], with estimates of more than 50% of obese six-year old children remaining so through adulthood [28]. As the prevalence of pediatric overweight and obesity continues to escalate, so does the cost, making prevention of the utmost importance.

Phase three: Behavioral and environmental assessments of pediatric overweight and obesity

Phase 3 of PRECEDE, *behavioral and environmental assessment*, inventories and prioritizes individual and collective actions that are allied to the health and quality of life goals or problems identified in Phases 1 and 2 [5]. Behavioral and environmental factors are appraised according to relative importance and changeability on a more/less scale to determine which factors are most important and most changeable. The behavioral assessment describes characteristics of individuals, or risk factors that increase the probability of developing a health problem; for this dissertation, the primary risk factor identified is decreased participation in physical activities. The environmental assessment includes risk conditions, a class of factors that are more distal in time, place, or scope from personal control, which are known to be associated with the health problem. This dissertation highlights the decreased availability to fun, economical, safe and easily accessible modes of physical activity as the primary risk condition for youth that is associated with an increased prevalence of overweight and obesity.

Decreased participation in physical activity

There are numerous benefits to participating in regular physical activity, such as enhanced overall health, improved strength, self esteem, and body image [29] and improved bone formation [30]. Further, regular participation in physical activity can lower cardiovascular disease risk factors related to body fatness [31] and increased insulin sensitivity [32]. Despite these benefits, the majority of children and adolescents are not meeting minimum recommendations to benefit from regular participation in physical activity.

Developmental patterns of physical activity indicate that participation begins to decline from childhood [33, 34] and continues to consistently erode from adolescence into adulthood, from ages 12 through 21 [35-39]. Less than 50% of children participate in regular physical activity and less than 36% of schools offer physical education classes [40].

These decreases in consistent physical activity are inversely associated with changes in BMI and adiposity [36] and are thought to be one of the root causes of the overweight and obesity epidemic [41, 42]. Decreased participation in physical activity is one of the more important and most changeable behavioral and environmental factors contributing to the epidemic in pediatric overweight and obesity.

Obesity prevention programs

A number of reviews examining obesity prevention programs for children described multifactorial approaches, including nutrition education, behavior modification, parent involvement, and changes to the school food service [43-45]. However, short- and long-term programs targeting an increase in participation in physical activities appear to be the most effective [44]. Pediatric healthcare providers also endorse youth involvement in unstructured

physical activity or free play [46], particularly if they are fun, enjoyable, entertaining, and positive experiences for youth [32, 47].

National and state healthcare initiatives and proposals also advocate healthy activity habits to maintain a healthy weight [48, 49]. Results from the National Longitudinal Study of Adolescent Health found that the odds of overweight decreased with high levels of moderate to vigorous physical activities among Hispanic boys and girls, as well as white boys and non-Hispanic black boys [50]. Other studies show similar results [51-55].

However, opportunities for fun, economical and easily accessed modes of physical activities are limited, particularly for disadvantaged youth. One study illustrated that underserved children who have inside-home environments may have little stimulation from physical activity [56]. In contrast, findings from a qualitative and quantitative study on children's perceptions of their home and neighborhood environments found that shared social space within the family home is important and often acts as a safe haven for children [57], suggesting a potential avenue for increased physical activity. These studies suggest that the home environment is an untapped opportunity to increase participation in physical activity among youth.

New initiatives: Dance Dance Revolution

Dance Dance Revolution (DDR) is one dance stimulation video game that involves players who dance a series of steps as presented on a screen by stepping on a dance pad. In addition to the arcade version of DDR, several home versions exist, including the PC, Playstation® or the Dancing Carpet. The machines provide auditory ("Boo!, "Great!") and visual feedback based on accuracy of timing and sustained combinations of footwork. DDR has

gained broad appeal among youth and among some, has lead to significant weight loss, as evidenced through non-peer reviewed testimonials at www.getupmove.com. In addition to entertainment, there are several ostensible benefits to dance stimulation games. China is currently using the Dancing Carpet as a health-care product, while a Korean hospital is using DDR in an obesity facility [58]. However, despite the abundance of anecdotal evidence, there are only three evidence-based DDR studies.

Tan, Aziz, Chua and Teh [58] studied the intensity and energy cost of the arcade version of DDR among a volunteer cohort of adolescents. After two weeks of a familiarization phase, subjects accumulated 201 hours of dance time, with no reported injuries. During testing phases, playing DDR had comparable energy expenditure rates to playing tennis. More specifically, the authors reported that the arcade version of DDR met the recommendations set by the American College of Sports Medicine (ACSM) for exercise intensity. However, the authors observed that individuals playing in the arcade version of DDR rarely exceeded the minimal guidelines set by ACSM for exercise duration (20 minutes). Thus, the authors strongly recommend a home version of DDR to encourage longer playing times.

A study of 8-12 year old children substantiated that DDR increased energy expenditure by 172 $\pm$ 68% compared to sedentary screen time [59]. This study also differentiated the rates of energy expenditure between lean and overweight children. In absolute terms, the overweight children expended significantly greater amounts of energy then lean children; when the data was corrected for body weight, lean and overweight children had similar rates of energy expenditure.

A recent six-month study using DDR as a weight management intervention for obese children and adolescents (aged 9-18 years with BMI > 95th percentile) reported that isolated use of DDR was not sufficiently motivating to yield sustained use over three months [60]. In this

study, use of DDR declined significantly over time and was not associated with change in BMI. Qualitative findings suggested that peer or family support, competitions, a greater variety of music, and group participation may increase use of DDR, suggesting that children and adolescents may need additional external motivators to sustain participation in dance stimulation video games.

Numerous websites, in particular the US-based www.DDRfreak.com, attest to the popularity of DDR, "karaoke for the feet" [61]. Supplementary, objective studies have demonstrated that DDR holds potential for increasing physical activity within the home environment based on the ready availability and relatively low cost of the equipment, the "fun" factor, and the ability of players to participate solo or with others. However, this evidence is quite limited and more research is needed to determine how to most effectively use DDR to increase physical activity within the home environment.

Phase four: Educational and organizational assessments of pediatric overweight and obesity

Phase 4, *educational and organizational assessment*, identifies predisposing, enabling, and reinforcing factors that require change in order to initiate and sustain the behavioral and environmental changes prioritized in Phase 3 [5]. Each set of factors is then prioritized according to importance based on the prevalence or frequency, the immediacy or urgency of the factor, and necessity or consideration that although a factor may occur at a low prevalence, it is still necessary for behavioral or environmental change to occur. Predisposing, enabling, and reinforcing factors are also prioritized according to changeability, assessed by reviewing the results of previous programs. Prior exposure to physical activity and self-perception in physical

competence were examined as predisposing factors, general parental support and DDR-specific environmental support as reinforcing factors, and motor learning-based coaching as an enabling factor.

Predisposing factors

Predisposing factors are defined as any characteristic of a person or population that motivates behavior prior to the occurrence of the behavior [5].

Prior exposure to physical activity

Various studies indicate that previous patterns of physical activity and participation in community sports have been consistently associated with children and adolescents future physical activity levels [38, 39, 62]. More specifically, movement science and motor learning theories and principles support the transfer of motor skills from one activity to another. An abundance of motor skills are learned from childhood to old age [63]. Skills from one learning situation can be transferred to another learning situation [63, 64] through transfer of learning, a gain or a loss in the capability for performance of one task as a result of practice on another task [65]. Thus, previous motor experiences can have a direct influence on the acquisition of new skills. This influence can be general and affect a wide range of skills or specific and affect only particular skills [66].

In the case of DDR, prior exposure to other gross motor activities, such as basketball, soccer, dance, martial arts, and gymnastics, may facilitate learning of this novel activity due to commonality in basic components such as strength, balance, coordination and motor control**.** Green and Kreuter [5] assert that cognitive learning of new skills occurs through the

accumulation of experiences. It is thus hypothesized that children who have a greater amount of exposure to physical activities prior to participating in DANCER may have an inherent gross motor skill set that predisposes them to better learn the new skill set required for DDR, thus increasing their participation in DDR.

Self-perception of physical competence

According to Harter [67], self-perception of physical competence is defined as global belief in one's ability to perform physical abilities, including sports and outdoor games. In general, self-perceptions have been shown to be important indicators of motivation and psychological well-being [68]. More specifically, physical self-perceptions are related to performance, self-confidence and involvement with physical activity [69, 70].

In a study of 7th and 8th grade children, physical self-perception of body, sport competence, physical conditioning and general physical self-worth were all related to several field indicators of anaerobic, aerobic, and muscular strength [71]. Physical self-perceptions, followed by sport, were also established as the best predictors between active and inactive Russian children [72]. A study of Estonian school children and adolescents showed that perceived sport/athletic competence, physical self-worth, and perceived strength competence were the preeminent discriminators of moderate to vigorous physical activity and physical fitness [73].

Researchers have also found that sex-related differences exist between physical self-perceptions and physical activity. Among British children, strength and sport were the best discriminators for girls, sport and conditioning for boys [72]. Findings have also shown that boys were more physically active [73-75] and had more positive perceptions of strength, sport

skills, and physical self-worth [73, 76, 77] than girls. Yet, there is still some discrepancy between the sexes for specific domains – body attractiveness, sport aptitude, physical condition and strength competence – of physical self-perceptions and physical activity in youth.

Overall, these studies suggest that physical self-perception is an important indicator of current and future participation in physical activities. Self-perception in physical competence may thus act as a potential benefit or barrier and may be an important aspect of which children participate in novel physical activities, such as DDR.

Reinforcing factors

Reinforcing factors are defined as any reward or punishment following or anticipated as a consequence of a behavior serving to strengthen the motivation for or against the behavior [5]. Although there is no one theory explaining the association between social relationships and health, there are several conceptual models and theories that provide scaffolding for clinical, research, and community settings [78]. Social Cognitive Theory (SCT) suggests that interactions with the environment, including people, are one of the most powerful influences, acting to modify or augment an individual's health-related behavior [79]. Other social support models further substantiate the roles of physical and environmental systems as imperative towards the adoption and maintenance of behavior change in an individual [78, 79]. This dissertation specifically proposes that parental support and the provision of specific reinforcements for DDR may shape an individual's participation in DDR.

Parental support

Parents have significant influence on their children's physical activity by promoting certain values and attitudes, by rewarding certain behaviors and by serving as role models. For this dissertation, parental support will focus specifically on 1) parental participation, 2) parental encouragement, and 3) parental enjoyment of physical activities.

The tenet of "observational learning" in the Social Cognitive Theory (SCT) supports the role of parents as social reinforcements. Children are influenced and prompted by the "significant others" in their life [11]. "Observational learning," the acquisition of a specific behavior secondary to watching the actions and outcomes of another's behavior, [80], will most likely occur for children as a result of watching their "significant others," their parents. Parental involvement and modeling in physical activities has been consistently demonstrated to predict youth physical activity [81-86] and further, modeling behaviors by parents has also been correlated to greater mean reduction in percent overweight [87].

Health behavior and health education also supports the role of social support in social networks as a commanding influence in an individual's behavior, acting to enhance feelings of well-being, coping resources, and a sense of personal control [78]. Social networks, "a person-centered web of social relationships," [78] are characterized by an exchange of resources and support, an offering of many functions, including emotional closeness and networking opportunities, and demographic and geographic similarity. Parents often provide "emotional" support, or "expressions of empathy, love, trust, and caring" and "instrumental" support, or "tangible aid and service" to their child [78].

The daily interactions between parents and children, as well as family beliefs regarding physical activity and body image, help to explain the pattern of physical activity that children

adopt [88]. Parental enjoyment of physical activity is an additional value that has been linked to a child's physical activity [85]. Further, parents act as household policy makers and "gatekeepers," fostering and reinforcing familial attitudes by making daily decisions on the availability of recreational opportunities [16, 89, 90].

These studies suggest that parental participation, encouragement, and enjoyment of physical activities are eminent influences on a child's initiation and continued participation in physical activities. The Social Cognitive theory and models of social network and social support corroborate the recurrent promotion of physical activity by parents, particularly for novel physical activities such as DDR.

DDR-specific environmental support

Environment and situation are two concepts of the Social Cognitive Theory (SCT) that provide a theoretical background for the role of DDR-specific entities. According to SCT, "environment" includes objective factors that are physically external to the person, including both social and physical settings [80]. "Situation" refers to the person's perception or their cognitive representation of the environment, and comprises real, distorted, or imagined factors of "place, time, physical features, activity, participants, and his or her own role" [80]. Collectively, environment and situation provide an ecological framework for understanding behavior, acting to either encourage or dissuade health behavior changes [91].

In general, supportive "environments" and "situations" lead to greater participation in physical activities by children and adolescents [92]. National and international health organizations have even developed recommendations for environmental changes despite limited research on the role between environment and health behaviors [91]. Explicit to DDR, there is

limited subjective and objective data supporting the role of specific factors to increase participation. However, the available data warrants further investigation and the following parameters specific to DDR will be examined in this dissertation: 1) size of television, 2) other videogames in home, 3) location of DDR, and 4) DDR participation by others.

The debut of DDR occurred in October 1998 in Japan, followed by the US unveiling a few years later; in both cases, DDR emerged as an arcade game [61]. Shortly after, a home version of DDR was developed, adding variability in screen size that is not available in the arcade version. It stands to reason that for home use of DDR, a larger screen, such as those used for the arcade version, would facilitate learning, perhaps mediated through increased visual pursuit of the moving arrows or the character on the screen.

Another consideration is personal experiences with other videogames, which may act to foster a mindset that facilitates learning and playing a new videogame. A report by Kaiser Family Foundation [93] examining media in the lives of 8-18 years old, reported that for the majority of youth, the game experience on computers or various game consoles (i.e., X-box, GameCube, Playstation, etc) is highly similar. However, it is hypothesized that the presence of other videogames in the home may operate in direct competition with DDR, and will therefore be considered a hindrance to participation in DDR.

The location of DDR might also be important in emphasizing socialization and participation of others, such as parents, siblings and friends. Shared or social space within the family home [57] and support for physical activity from parents, siblings and peers [62, 94] are strong correlates and predictors for youth involvement in physical activity, suggesting that placing DDR in a common area instead of a secluded area, such as a child's bedroom, provides an important opportunity for cooperative involvement. Further, several internet articles from

DDR Freak [95, 96] suggest that observing and learning from other DDR players may improve an individual's DDR play.

"The space outside the person" [91] is an important stimulus that helps to explain an individual's behavior. Understand this "space" as it relates to participation in DDR may help to encourage a positive behavior change for children participating in DANCER.

Enabling factors

Enabling factors are skills, resources or programs required to attain specific behavior [5]. These factors act to facilitate performance, and include the availability, accessibility, and affordability of resources, conditions of living that may act as a barrier to action. These factors also include new skills that are needed to execute a behavior change. Movement science theories support coaching as one potential strategy for addressing the challenges of acquiring the necessary skills for children to be successful at DDR. This dissertation proposal considered motor-learning based coaching as an enabling factor for children in the DANCER study.

Movement science explores how children learn important developmental skills that are needed for physical activities. Through DDR participants can explore and learn dance step sequences that promote a multitude of sensory and motor experiences, including kinesthetic, proprioceptive, and tactile exploration resulting in visual-perceptual learning experiences. In the case of DDR, challenging conditions inherent to the activity, such as interactive visual and auditory feedback, require certain skills in order to master and advance to more difficult levels of play.

Motor learning theories and mechanisms, such as Schmidt's schema theory [97] and Fitts and Posner's stages of motor learning [98] respectively, provide underpinnings to understand the

acquisition of novel motor skills. Schema is defined as a set of rules, concepts or relationships formed on the basis of excellence [97]. Similar to memory storage, schema includes initial conditions, relationships between movement parameters, environmental outcomes and sensory consequences. These rules can then be used to select a new set of parameters for a movement situation, even a novel variation, that involves the same motor program [65]. This theory supports learning and improved performance as a result of practicing a variety of movements, thus creating an expanding set of schema.

Fitts and Posner [98] describe the process of motor learning as occurring in three stages, similar to the role of a coach as an instructor as described by Hodges and Franks [99]. Fitts and Posner's stages of motor learning outline three distinct stages as a framework to describe how individuals learn novel gross motor tasks: cognitive, associative, and autonomous. Training strategies, including practice schedule, structure of environment, and selection of appropriate feedback, are organized by stage to most effectively systematize a child's learning as they progress from a high level of cognitive processing to a largely automatic performance of the motor skill [100]

Additionally, various studies emphasize the importance of the coach-athlete relationship as a key aspect of influencing an athlete's motivation towards his or her sport [101, 102]. "Observational learning", another SCT concept, was previously described in terms of parental support; however, this concept also supports the use of coaches as role models for the targeted behavior of participation in DDR. Coaches can be instructors, teaching the athlete 1) what to do, 2) how to do it, and 3) how to succeed [99]. The construct of "behavioral capability" in Social Cognitive Theory (SCT) also holds that both knowledge of the behavior and the skill to perform the behavior are necessary; in other words, performing the behavior is indicative of having

learned the behavior [80]. This concept indicates that skills training are necessary in order to promote an individual's mastery of a new behavior. Coaches typically watch their performers on a weekly basis to identify key areas of improvement [103] and may serve as a "reinforcement" for repetition of a targeted behavior by providing tangible stimuli to children in the forms of informational or appraisal support [78].

Movement science theories support the use of coaches as one possible approach to assist children as they learn novel motor tasks. Coaching may be that "reinforcement" – that reward or motivation – that leads some children to participate in DDR.

Conclusion

The costs of pediatric overweight and obesity combined with the complex etiology and implications of the longevity of this condition point to the absolute need of finding contemporary and innovative approaches to reverse this trend. The PRECEDE planning model provided the framework to better understand the predisposing, reinforcing and enabling factors that may affect the initiation and sustainment of participation in DDR for children participating in the DANCER study. Discernment of these factors may provide the necessary evidence to recommend this medium through both personal and healthcare avenues. Further, evidence-based research on DDR may provide crucial insight for future investigations, particularly for ability of DDR to be used in a public health setting. Guidelines are needed to determine the most cost-effective method to carry out a DDR intervention and to provide information on the factors that are most critical to success.

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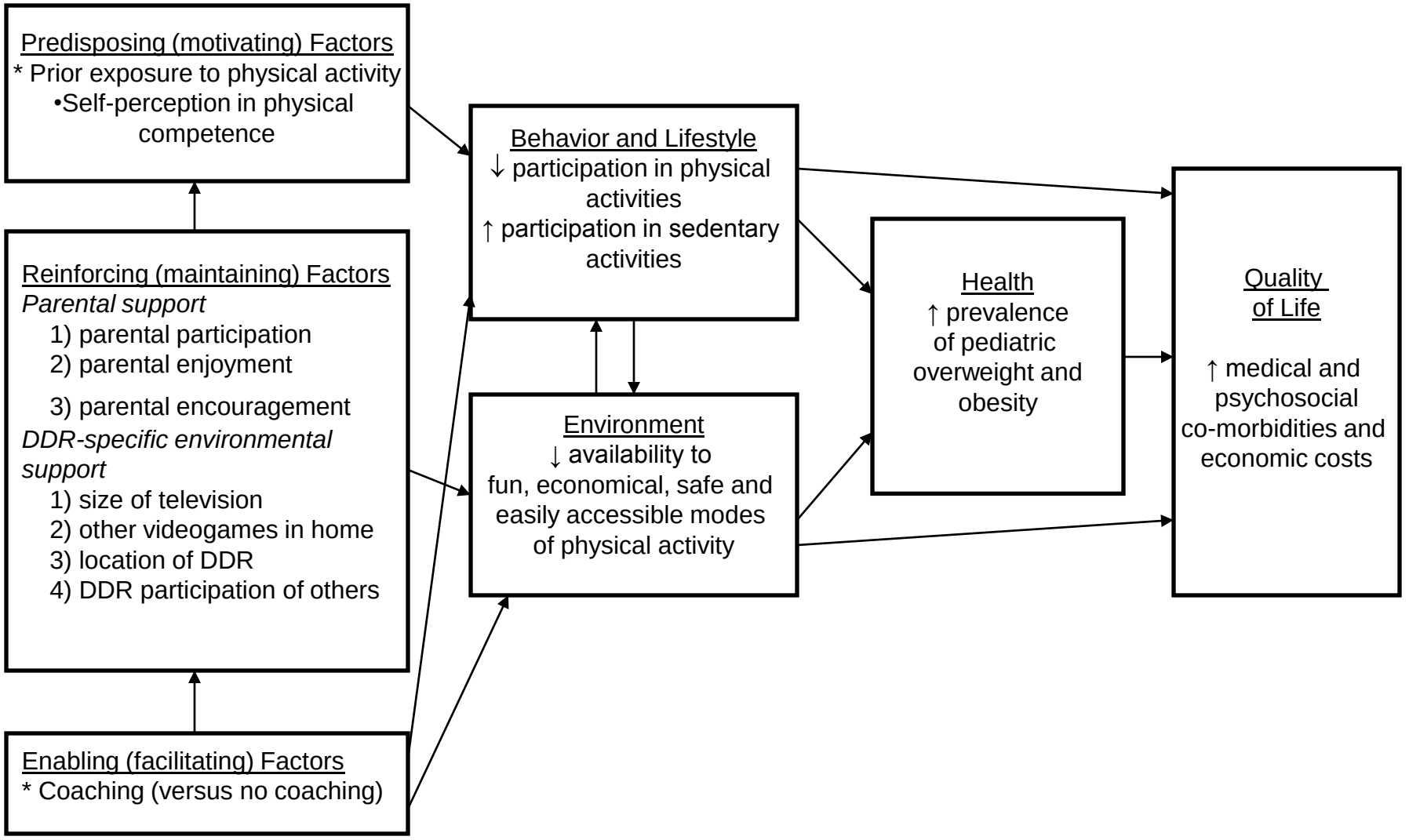
Appendix B: Theoretical Framework (Adapted from PRECEDE model, Green & Kreuter, 1999)

Phase 4 Educational & Epidemiological Assessments	**Phase 3** Behavioral & Environmental Assessments	**Phase 2** Epidemiological Assessment	**Phase 1** Social Assessment



Appendix C: Enhanced Activity Questionnaire

We **would like to know some more information about a few specific activities that your child may participate in. Please answer the following questions about each activity below.**

Has your child participated in this activity?	Does your child participate in this activity as part of an organized team?	When was the last time your child participated in this activity regularly (at least once per week?)	When your child is participating in this activity, about how often do they participate?	About how much time does your child spend in this activity each time they participate?
Basketball ❑ Yes ❑ No *If yes, please answer questions across → →* *If no, skip to next activity*	❑ Yes ❑ No	❑ Within past 3 months ❑ Within past 6 months ❑ Within past year ❑ Over a year ago	❑ 1x per week ❑ 2x per week ❑ 3x per week ❑ More than 3x per week	❑ A little: 30 minutes per practice ❑ Average: 31-60 min per practice ❑ A lot: Over 60 min per practice
Soccer ❑ Yes ❑ No *If yes, please answer questions across → →* *If no, skip to next activity*	❑ Yes ❑ No	❑ Within past 3 months ❑ Within past 6 months ❑ Within past year ❑ Over a year ago	❑ 1x per week ❑ 2x per week ❑ 3x per week ❑ More than 3x per week	❑ A little: 30 minutes per practice ❑ Average: 31-60 min per practice ❑ A lot: Over 60 min per practice

Has your child participated in this activity?	Does your child participate in this activity as part of an organized team?	When was the last time your child participated in this activity regularly (at least once per week?)	When your child is participating in this activity, about how often do they participate?	About how much time does your child spend in this activity each time they participate?
Dance ❑ Yes ❑ No *If yes, please answer questions across → →* *If no, skip to next activity*	❑ Yes ❑ No	❑ Within past 3 months ❑ Within past 6 months ❑ Within past year ❑ Over a year ago	❑ 1x per week ❑ 2x per week ❑ 3x per week ❑ More than 3x per week	❑ A little: 30 minutes per practice ❑ Average: 31-60 min per practice ❑ A lot: Over 60 min per practice
Gymnastics ❑ Yes ❑ No *If yes, please answer questions across → →* *If no, skip to next activity*	❑ Yes ❑ No	❑ Within past 3 months ❑ Within past 6 months ❑ Within past year ❑ Over a year ago	❑ 1x per week ❑ 2x per week ❑ 3x per week ❑ More than 3x per week	❑ A little: 30 minutes per practice ❑ Average: 31-60 min per practice ❑ A lot: Over 60 min per practice
Martial Arts ❑ Yes ❑ No *If yes, please answer questions across → →* *If no, skip to next activity*	❑ Yes ❑ No	❑ Within past 3 months ❑ Within past 6 months ❑ Within past year ❑ Over a year ago	❑ 1x per week ❑ 2x per week ❑ 3x per week ❑ More than 3x per week	❑ A little: 30 minutes per practice ❑ Average: 31-60 min per practice ❑ A lot: Over 60 min per practice

If your child participates in any other activities or sports regularly, please tell us about them here…

Has your child participated in this activity?	Does your child participate in this activity as part of an organized team?	When was the last time your child participated in this activity regularly (at least once per week?)	When your child is participating in this activity, about how often do they participate?	About how much time does your child spend in this activity each time they participate?
Please write the name of the activity _____	❑ Yes ❑ No	❑ Within past 3 months ❑ Within past 6 months ❑ Within past year ❑ Over a year ago	❑ 1x per week ❑ 2x per week ❑ 3x per week ❑ More than 3x per week	❑ A little: 30 minutes per practice ❑ Average: 31-60 min per practice ❑ A lot: Over 60 min per practice
Please write the name of the activity _____	❑ Yes ❑ No	❑ Within past 3 months ❑ Within past 6 months ❑ Within past year ❑ Over a year ago	❑ 1x per week ❑ 2x per week ❑ 3x per week ❑ More than 3x per week	❑ A little: 30 minutes per practice ❑ Average: 31-60 min per practice ❑ A lot: Over 60 min per practice

Appendix D: Parent Activity Level and Child Learning

The following survey will be asking you different questions about you and your child. There is no right or wrong answer. Please try to answer each question as honestly as possible.

Please use the following definitions when answering the questions[1]:
Physical activities*:* any activity that involves moving your body that you do during exercise, recreation, or anytime other than when you are doing your regular job

Moderate activities: examples are walking quickly, mowing the lawn, dancing, swimming, or bicycling on level ground. You should be able to carry on a conversation comfortably during the activity.

Vigorous activities: examples are jogging, mowing the lawn with a nonmotorized pushmower, chopping wood, doing high-impact aerobic dancing, swimming continuous laps, or bicycling uphill. You should be breathing hard and sweating a lot.

These questions are about your child.

1. How do you feel your child best learns to perform a new sport or physical game?

a) Visual (e.g. watches the coach or a friend, imitation of movement)
b) Auditory (e.g. listens to instructions)
c) Touch (e.g. physical assistance to perform movement)
d) All of the above

2. What type of directions do you feel are best suited for your child's learning?

a) Step by step instruction – tell them what to do
b) Demonstration of the entire task – show them what to do
c) Combination of both – both show and tell them what to do

[1] Definitions adapted from the National Center for Chronic Disease Prevention and Health Promotion http://www.cdc.gov/nccdphp/dnpa/physical/terms/index.htm

3. Compared to other children of the same age, about how much time do you feel your child spends doing physical activity?

a) Below average.
b) Average.
c) Above average.

4. Compared to others of the same age, about how well do you feel your child performs in physical activities?

a) Below average.
b) Average.
c) Above average.

These questions are about you, the parent, and your feelings. Please answer for a typical week.

5. Other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise during the past month?

a) Yes
b) No

6. Are you trying to lose weight?

a) Yes
b) No

7. Are you using physical activity or exercise to try and lose weight?

a) Yes
b) No

8. When you are at work, which of the following best describes what you do?

a) Currently not working
b) Mostly sitting or standing
c) Mostly walking
d) Mostly heavy labor or physically demanding work

9. How many days per week do you do moderate activities (for example: walking briskly, mowing the lawn, dancing, swimming, or bicycling on level terrain) for at least 10 minutes a day?

a) 0 days (skip to question #11)
b) 1 day per week
c) 2 days per week
d) 3-4 days per week
e) 5-6 days per week
f) Everyday

10. On days when you do moderate activities for at least 10 minutes at a time, how much total time per day do you spend doing these activities?

a) 10-20 minutes per day
b) 21-30 minutes per day
c) 31-60 minutes per day
d) 1-2 hours per day
e) More than 2 hours per day

11. How many days per week do you do vigorous activities (for example: jogging, mowing the lawn with a nonmotorized pushmower, chopping wood, participating in high-impact aerobic dancing, swimming continuous laps, or bicycling uphill) for at least 10 minutes at a time?

a) 0 days (skip to question #13)
b) 1 day per week
c) 2 days per week
d) 3-4 days per week
e) 5-6 days per week
f) Everyday

12. On days when you do vigorous activities for at least 10 minutes at a time, how much total time per day do you spend doing these activities?

a) 10-20 minutes per day
b) 21-30 minutes per day
c) 31-60 minutes per day
d) 1-2 hours per day
e) More than 2 hours per day

13. How much do you enjoy or not enjoy physical activity or exercise?

a) Very enjoyable
b) Somewhat enjoyable
c) Neutral
d) Somewhat unenjoyable
e) Very unenjoyable

14. How often do you encourage your child to do physical activities?

a) 0 days per week
b) 1 day per week
c) 2 days per week
d) 3-4 days per week
e) 5-6 days per week
f) Everyday

15. How often do you do physical activities with your child?

g) 0 days per week
h) 1 day per week
i) 2 days per week
j) 3-4 days per week
k) 5-6 days per week
l) Everyday

16. How often do you drive your child to a place where he or she can do physical activity?

a) 0 days per week
b) 1 day per week
c) 2 days per week
d) 3-4 days per week
e) 5-6 days per week
f) Everyday

17. How often do you watch your child participate in physical activity?

a) 0 days per week
b) 1 day per week
c) 2 days per week
d) 3-4 days per week
e) 5-6 days per week
f) Everyday

18. How important or unimportant do you feel physical activity is for your child's health?

a) Very important
b) Somewhat important
c) Neutral
d) Somewhat unimportant
e) Very unimportant

19. How important or unimportant is it for your child to participate in physical activities?

a) Very important
b) Somewhat important
c) Neutral
e) Somewhat unimportant
f) Very unimportant

20. What were the factors that you thought were important enough to be in this study? (circle **all** that apply)

1. Free Playstation2
2. Child being paid for exercising
3. Really want child to be less of a “couch potato”
4. Weight issues run in the family, we want to prevent this
5. Child is a good dancer
6. Looking for social games that are active for my child
7. To help researchers find answers to pediatric obesity prevention
8. I saw in an arcade/TC, it looks fun
9. Other_____

Appendix E: Basic Home Environmental Screen

1. Type of Housing:
   a) Apartment/Condo (specify the floor: _____)
   b) Private Residence/House (specify floor where DDR is setup: _____)
   c) Mobile Home
   d) Other: _____

2. Location of DDR:
   a) Living Room/Family Room
   b) Child's Bedroom
   c) Den/Additional Room/Playroom
   d) Other: _____

3. Is there an 8 feet wide and 4 feet long area available for DDR pad (please answer for how the space is with the DDR assembled and not how you originally found the room)?
   a) Yes
   b) No: please approximate the amount of feet available: _____ feet

4. What type of flooring is the DDR pad on?
   a) Carpet
   b) Wood/Laminate
   c) Tile
   d) Linoleum
   e) Other: _____

5. Please approximate the size of the television that DDR will be played on?
   a) Small: 13 inches or smaller
   b) Medium: 14 - 18 inches
   c) Large: 19-27 inches
   d) Nice: greater than 27 inches

6. Do you foresee a problem with the child being able to perform DDR due to the location of DDR?
   a) Yes: _____
   b) No.

7. Is the child wearing prescription glasses when playing DDR?
   a) Yes.
   b) No.

8. Does the child have any other videogame system in the home? (e.g. Nintendo, X-box, Gameboy, other portable videogame, etc.)

a) Yes.
b) No.

If yes, please list: _____
_____

9. Did child have fun during the session[1]?

a) Yes (e.g. child is smiling, giggling/laughing, active participant in session)
b) No (e.g. child appears frustrated)

10. Did parent participate in today's session?

a) Yes.
b) No.

11. Did you encounter any difficulties or unusual circumstances on this visit? If yes, please check appropriate responses below:

Noise distractions:

- ❑ Additional television/radio in close proximity to location of DDR
- ❑ Family/friends speaking (this category would include any verbal distractions **not** related to DDR – e.g. babies crying)
- ❑ Family Pet (e.g. excessive barking, excessive chirping, etc)
- ❑ Neighborhood noises (e.g. car alarms, neighbors)
- ❑ Other: _____

Visual distractions:

- ❑ General clutter in the room
- ❑ Television or computer screen (e.g. child watching, flickering images, interfering glare, etc)
- ❑ Poor lighting (e.g. flickering, low/inadequate amount, too much lighting)
- ❑ Sunlight glare on television
- ❑ Other: _____

Spatial/Physical distractions:

- ❑ Pets/Animals (e.g. running across the pad)
- ❑ Sibling/friend (e.g. stepping on child's pad, waving hand/body in front of tv screen)
- ❑ Other: _____

Parental input:

- ❑ Parents/sibling voicing opinions/comments to child playing DDR
- ❑ Parent/sibling voicing opinions/comments to DDR coach
- ❑ Other: _____

Miscellaneous:

- ❑ Other: _____
- ❑ Other: _____
- ❑ Other:_____

[1] Operational definitions adapted from Merriam-Webster Online, http://www.m-w.com/

Appendix F: Enhanced Intervention Home Visitations Record[1]

Visit #: _____ Total time: _____

1. Did child's score improve by the end of the session?
   a) Yes.
   b) No.

If a specific song was used to determine improvement, please name: _____

2. Did child have fun during the session?
   a) Yes (e.g. child is smiling, giggling/laughing, active participant in session)
   b) No (e.g. child appears frustrated)

3. Where there any other children or adults present during the session?
   a) Yes.
   b) No.

Please state their relationship to the child: _____
_____

If yes, did they provide any instruction/comments to the child? Briefly explain the nature of the comments: _____
_____
_____

4. What type of instruction was provided to the child? *(Circle all that apply.)*
   a) Verbal cues (e.g. spoken instructions relating to child's performance)
   b) Demonstration (e.g. modeling specific instructions)
   c) Tactile Cues (e.g. "of or relating to the sense of touch")
   d) Educational (e.g. having the child physically "get closer" to the game to learn – using hands to "stomp" the beat on the arrows or using his/her fingers on the television to trail the arrows).
   e) Other: _____

5. Did the child ask any specific questions?
   a) Yes.
   b) No.

Please note the nature of the questions: _____
_____
_____

[1] Operational definitions adapted from Merriam-Webster Online, http://www.m-w.com/

6. Did the parent ask any specific questions of you, the coach?

a) Yes.
b) No.

Please note the nature of the questions: _____
_____
_____

7. Did you encounter any difficulties or unusual circumstances on this visit? If yes, please check appropriate responses below:

Noise distractions:

- ❑ Additional television/radio in close proximity to location of DDR
- ❑ Family/friends speaking (this category would include any verbal distractions **not** related to DDR – e.g. babies crying)
- ❑ Family Pet (e.g. excessive barking, excessive chirping, etc)
- ❑ Neighborhood noises (e.g. car alarms, neighbors)
- ❑ Other: _____

Visual distractions:

- ❑ General clutter in the room
- ❑ Television or computer screen (e.g. child watching, flickering images, interfering glare, etc)
- ❑ Poor lighting (e.g. flickering, low/inadequate amount, too much lighting)
- ❑ Sunlight glare on television
- ❑ Other: _____

Spatial/Physical distractions:

- ❑ Pets/Animals (e.g. running across the pad)
- ❑ Sibling/friend (e.g. stepping on child's pad, waving hand/body in front of TV screen)
- ❑ Other: _____

Parental input:

- ❑ Parents/sibling voicing opinions/comments to child playing DDR
- ❑ Parent/sibling voicing opinions/comments to DDR coach
- ❑ Other: _____

Miscellaneous:

- ❑ Other: _____
- ❑ Other: _____
- ❑ Other:_____

8. If you deviated from the protocol for this session, please specify the reason for deviating and what was done with the child: _____
_____
_____
_____
_____
_____

Appendix G: Basic DDR Training Module

Mr/Mrs. "X", it would be great if you could join us and watch as I teach "child" how to start and play DDR. If "child" has any questions then you will hopefully be able to help him/her. Please let me know if you have any questions along the way.

Introduction to Playstation 2 Console: *(remember to dance with socks!!)*
1. Point to Playstation 2 Console: "This is the videogame machine. It is called Playstation-2. This button (point to it) is **how you turn the game on and off**. When the light is "red" it means that the machine is turned off. When the light is "green" it means the machine is on and you can play Dance Dance Revolution. If the game is not starting, you can also press this button to start the game over (**restarting**)."

- Have child practice turning Playstation 2 on and off. Have child practice resetting the game.

2. "This is how you **connect the Dance pads to the game**. See how this **arrow is pointing towards the ceiling. Make sure you put your pad in the first slot here** – this is your space only. The other pad is connected here for someone else to play."

- Have child practice inserting and removing the dance pad.

*This is your **memory card**. Do not take it out – it will record how you do at playing DDR. (Enhanced will have the BLUE cards; basic will have the RED cards).*

"Do you have any questions so far?"
(Set up DDR in its entirety prior to proceeding with tutorial.)

Explanation of DDR:
3. (Explain this as the game is setting up; you should have a screen of a character dancing with arrows pointing out the steps) "Before we practice, let me **explain how Dance Dance Revolution is played.** Dance Dance Revolution is sometimes called DDR. DDR is a game you play with your feet. This is the dance pad. You will be dancing by using the arrows on this pad. There is an up arrow, a down arrow, a left arrow, and a right arrow. (Stand on the pad and tap your foot on the appropriate arrow as you speak)."

- Have child hit each arrow when you call it out.

4. "Good. The games uses a dance pad on the floor that you dance on while following the steps on the TV screen and listening to the music. The purpose of the game is to match the steps on the screen as close as possible – then you can gain more points and move up to more difficult songs and dance routines." (Should have the "Days go By" demonstration screen playing – you can hit the arrows to demonstrate at this point. Show concept of DDR by only using one arrow (e.g. up))

a) Like playing the piano with your feet
b) Like puzzle pieces
c) Like trying to push a block into its hole

"Do you have any questions so far?"

Getting to Tutorial:
5. "Once the game turns on, **press this button (start**). You will **get to this main menu**. We will start with the tutorial. **Use the up or down arrows to choose "Lesson Mode**."

- Have child navigate menu to "Lesson Mode."
- "Good. Can you **pick "Lesson #1"** now? We will be doing several of the sections. **First, there will be a dancer demonstrating the steps. Then we will practice the same steps. We will get to practice each section twice.** Can you pick "Section #1" now? Good. Watch the dancer."
- "Now it's our turn."(**Call out the directions of the arrow as they near the top to help the child with timing**).

- (After that section is over and you are back to the "Section" menu). "**Did you notice how the game would tell us how well we hit the arrows? It will say "perfect, great, or good" depending on how well we hit the arrow. (Note: Go through each section once, regardless of whether the child passes…this visit is for the purpose of the child learning how to navigate the game and basic understanding…they will need time to improve at DDR!)**
- "Good. Now can you pick "Section #2? Use the up and down arrows to get to that section, then press start." (repeat for sections 3-8; repeat directions if necessary – "we will watch the dancer, then we get to practice twice")
    - **Section #2: Verbalize the steps (e.g. up, up, up, up; right, right, right, right).**
    - **Section #3: Switching feet side to side (e.g. left, right, left, right)**
    - **Section #4: Up and down (e.g. right foot only for first trail; then left foot only)**
    - **Section #5: Alternating feet up and down**
    - **Section #6: Turn sideways to hit up/down arrows – similar to hitting left/right arrows when facing the front**
    - **Section #7: Hitting the up/side/down arrows with one foot, then switching to the other foot**
    - **Section #8: Putting it all together (there is no demo – start immediately)**

Playing DDR:
"Now that we have practiced some of the steps, I will teach you how to play the game."

6. "**Press the button above select to go back to the previous menu; keep pressing this button until you get to that main menu we saw before**."

7. "At the main menu, **choose "Game Mode**.' Then press start."
Have child select game mode.

8. "You will get to a screen that asks about how many people are going to play DDR. (**Select the style**) If only you are playing, chose 'single'; you can also tell which version is single because there is only one person standing on the pad. (Point to the tv screen). If there are two people playing, press the right arrow to go to 'versus; you can also tell which version is versus because you will see two people standing on two pads. Once you pick how many people are playing, press the 'start' button."
- Have child select style mode.

9. "Next, you will be choosing the level of difficulty for DDR, or how hard it will be to play the game. **(Select difficulty)** Choose 'beginner' mode and then press 'start.' Continue to pick 'beginner' mode until you get really good at this level, and then you can make it harder by going to the next level, 'light.'"
- Have the child select beginner mode.

You will get a screen that has a **freeze screen. Explain that when you see this arrow, it means you have to hold your foot down on the arrow**. Can demonstrate on the floor. "Press start to continue to the songs."

10. "You will then get to **a song selection menu**. (Select music). You can **use the left and right arrows to pick different songs**. Can you try picking different songs?"
- Have child scroll through songs.

11. "The difficulty of the songs are shown here. The **Groove Radar** tells you about how hard a song is; the bigger this area is, the harder the song will be to play. **BPM (beats per minute)**: this part of the screen will also tell you how fast a song is – see this number? This song is "x" beats per minute. Can you use your right arrow and pick a different song? How fast is this song? Good. (If child gets the wrong answer, explain concept and have child try with a different song). Can

you **find this song: "Keep on Lifting**". Good. When you press 'start' this song will start playing and you and I will play using the arrows. Are you ready? Press start." (Focus more on the child then your actual playing).
(**Continue coaching child with verbal cues about the direction of the arrow – up, right, right, left, down, etc**)

12. "That was great! After you finish a song, this game will tell you how well each person did. It will give you a **letter grade**. It will **also tell you how many perfects, greats, goods, and almosts you got on each song – you got "x" perfects**! This is a brand new game to you – you will get better as you continue to practice! You can use these numbers to see how much better you are getting each time you play."

13. "Let's **try that song again**. Are you ready? Press start."

14. "You did great! [**Point out (hopefully) improvement in perfects/greats**.]
This game also tells you how many perfect and great arrows you hit in a row. This is called a **combo** (explain). You hit "x" arrows in a row! You can also use this to see how much better you are doing each time you practice. I would like you to keep practicing this song until you get really good at this song and then you can pick another song. The sheet I am giving you has some good songs you can try – as you get better, I encourage you to try other songs. The **tip sheet** has some ideas of songs you can try – it tells you about the increase in difficulty. Start by picking the songs that have the smallest increase in difficulty between beginner and light mode.

We would like for you to **dance at least 4 times a week for 30 minutes each time**. Here's a camera for you to **take two pictures each week**. What I want you to do is to take a picture of any score that you are proud of and want others to know about – I will **take the first picture today** of you and your score since I think you did great for your first time playing DDR." (Take picture).

"Now we will **have your mom/dad help us fill out this form**. This form will help us know how well you are doing and how much you are playing DDR. Since we played today, we will put a sticker here. And since we took a picture today, we will put a sticker here." (Continue explaining form for the parent).

15. "Do you have any questions about how to do the lessons or how to pick a song? This sheet (DDR Tipsheet) has all the steps for you in case you forget. It's been fun to meet you – good luck playing DDR."

If enhanced – remind/verify appointment for next week. Let child know that they can practice Lesson #1 as many times as they want, but to please not do Lesson #2 or Lesson #3 because you will be doing some of those with them at your next visit.

Appendix H

DDR Tip Sheet

- Red light = off
- Green light = on
- Make sure your pad is connected in the first slot!!
- Play in socks – you'll slide better on the mat.
- Play DDR at least 30 minutes, 4 times a week – don't forget to record each time you play!! ☺

Groove Radar

- Stream = overall density
- Chaos = degree of complexity in step patterns
- Freeze = the number of freeze steps in patterns
- Air = the number of jumps
- Voltage = degree of max density in dance step patterns

Arrow ratings: based on accuracy of steps

- Perfect = hit exactly on beat
- Great = slightly before or after beat (keeps combo going)
- Good = slightly off beat

<u>Lessons:</u>

1. From main menu, choose "Lesson Mode." Press "start."
2. Use the "up" and "down" arrows to pick "Lesson Mode." Press "start"
3. Use the "up" and "down" arrows to pick Lesson #1. Then pick "Section #1." Press "start." Continue playing the remaining sections in Lesson #1.
4. When finished, press the button above select to go back to the main menu.

Playing DDR:

1. From main menu, choose “Game Mode.” Press “start.”
2. “Select the style”
   - Select “single” mode if only one person is playing.
   - Select “versus” mode if two people are playing on two pads..
3. “Select difficulty.”
   - Select “beginner mode.” Press “start” to continue.
4. “Select music.”
   - Use “right” and “left” arrows to scroll through songs.
   - Use a double-tap on the “up” or “down” arrows to increase or decrease the difficulty (look at the “Groove Radar” to see the changes).
   - Keep practicing *“Keep on Lifting”* until you learn the pattern – this will help you learn the basic steps. There are some songs listed below you may want to try next – they are listed by the amount of increase in difficulty.

1-Beginner ---> 2-Light
Spin the disc
Secret Rendezvous
Long Train Running
Let's Groove
Destiny
Drifting Away

1-Beginner ---> 3-Light
Keep on Lifting
Try 2 Luv (needs 5pts to unlock)
Get Down Tonight
Put your Faith in Me (needs 10pts to unlock)
Whistle Song
Twilight Zone
Conga Feeling
D2R

1-Beginner----> 4-Light
Radical Faith (slow song -114bpm- but big jump in difficulty)
A little bit of ecstasy (variable beat)
Days Go By
Dream a Dream
In the Navy

Don’t forget: take 2 pictures each week of any score you are proud of and want others to know about!! ☺

Appendix I: Enhanced Intervention Protocol

Purpose of Protocol: standardization for reproducibility of results and development of specific training guidelines for development of public health programs and investigations of future studies.

Aim #2: whether personal coaching sessions for DDR increase PA among the intervention group when compared to the control group without these sessions

Motivation:
"According to the Social Cognitive Theory, children are motivated to exercise if they believe that the targeted behavior will benefit them (outcome expectancy) and if they believe that the intended behavior is attainable (self-efficacy)." (McWhorter et al 2003).

End each visit with success – make sure the child recognizes some aspect of his/her improvement as a result of the coaching session and his/her participation in PA!!!

Guidelines for Motivating Children in Exercise Participation Data from Faigenbaum, 1998, and Parker and Bar-Or, 1991 (McWhorter et al 2003)	
Do's:	***Don'ts:***
• Educate children and parents in the importance of fitness.	• Avoid being critical or overly demanding.
• Allow children to participate in exercise goal formulation.	• Avoid categorical comparisons with physically fit children (for the obese child).
• Give frequent positive verbal feedback to the extroverted child.	• Winning and competition should be de-emphasized.
• Direct goals towards self-improvement.	• Extrinsic rewards should be de-emphasized.
• Make the activity fun.	• Be careful not to give the introverted child excessive verbal feedback.
• Begin with low-intensity activities.	• Avoid progressing to high-intensity activities too quickly.

Visit #1: *Basic DDR Training and Set Up*

Forty (40) children within intervention group will receive this first home visit. See "First Home Visitation Checklist and Protocol."

Supporting Documents:

1. Dance Dance Revolution Organization (S. Paez, last edited April 7, 2004)
2. DDR – The Basics by Pakwan Kenobi: for some suggested beginner songs
3. FAQ/Songlist of DDR Max 2
4. Basic Home Environmental Screen

Competencies:

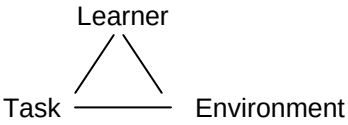
- Maneuvering DDR: navigating through the menus
- Setting up DDR: technical expertise
- DDR Language: familiarizing yourself with the terminology

DDR Intervention. *The subject and his/her caregivers will be provided with necessary DDR equipment and an instructional manual at a training meeting in their home. Home instruction will include a detailed, personalized tutorial on how to connect/maintain DDR equipment. We will help the children with the "Lesson Mode" and with navigation of game menus, demonstration of the game, and ample time for further questions. Subjects and their caregivers will be instructed to participate in at least 120 minutes per week of DDR activity, distributed over at least 4 days, during each week of the 12 weeks. Participants may use any games or songs they wish and may use it in a solitary fashion or a social fashion with another player. We will stress that many caregivers enjoy doing the activity with their children and suggest the caregiver try the activity. Each subject will also be asked to take a photograph of game scores they are particularly proud of each week. Subjects will have free access to the game throughout the intervention and will be told that they can participate more frequently or for more extended periods if they wish. During the first week, study staff will call and visit to make sure the subject and their caregivers have mastered use of the game and hardware. In addition, study staff will be available by pager to resolve any technologic difficulties that develop with the DDR software or hardware.*

Enhanced DDR. *The subjects in the enhanced DDR subgroup will receive the same initial training and prescription for activity as the subjects in the basic DDR subgroup. In addition, the participants will be visited up to 5 times during the first few weeks period by a personal coach. These 1:1 "coaching sessions" are expected to last up to 40 minutes and will follow a standardized format. The sessions will provide feedback related to the child's DDR performance since the last session and personalized suggestions for strategies to enhance the child's enjoyment of and success with DDR. For instance, if a child is frustrated by low scores on a mid-game, the coach might suggest trying a less demanding game or might suggest initially focusing on a subset of the steps or seeking ways to enhance his/her awareness of the song's rhythm. If a child is having a difficult time making time to participate in DDR, the trainer might explore ways to manipulate the child's schedule so there is sufficient time (i.e. setting up a schedule to do 30 min of homework and then 30 minutes of DDR) or inviting a friend to play with the participant rather than watching television with the friend.*

Enhanced Home Visits – Motor Learning Applications

Classic Model of Motor Learning – Cognitive, Associative, and Autonomous Stages
(Fitts and Posner, 1967)



Movement occurs through the interaction of the learner, task, and the environment – these three factors determine how learning occurs.

- *Task* – actual skill performed
- *Environment* – physical (actual), social and psychological (i.e. support system), and feedback
- *Learner* – age, cognition, motor and neurological development, preferred learning style

Practice

- In general, increased practice leads to increased learning (and thus, increased/improved performance – learning is inferred through improvements in performance as a result of practice – cannot measure learning directly!!

Variability

- In general, the protocol introduces variability gradually. Variability is used to teach the learner how to generalize a skill and to enhance adaptability (however, note that too much variability can dilute skill set)

Extrinsic feedback – external information provided to the learner; typically not provided in the task

- DDR gives *Knowledge of Results* (KR) – the outcome or result of the movement (i.e. perfect, great…boo) – redundant!!!
- *Knowledge of Performance* (KP) – information about the quality of movement during the skill; can be detrimental to the new learner if excessive
  - Focus on quality of movements, not results of movements (e.g. letter grade, amount of perfect's, etc)

Visit #2: **Classic Model of Motor Learning – Cognitive Stage ("what to do")**
DDR Specific: *Body-Foot Awareness and Rhythm (Foundation Building)*

Supporting Documents:
1. How to be a Dance Dance Revolutionary: Part 1, section by Radien
2. Tips and Techniques – Beginners by PitterPanda
3. FAQ: Beginners Tips/Improvement Methods by Eckostyle

Competencies:
- ❑ Key techniques for beginning DDR players
- ❑ Appropriate motivational techniques by child's dominant personality type

"The extroverted child relies more on what his peers and adults think. The introverted child relies more on self-reflection." (McWhorter et al 2003)

Cognitive Stage:
- o Pertains to developing of overall understanding and organization of the skill
- o Trail-and-error utilized to determine which strategies approximate the desired task outcome

Feedback Schedule*: Concurrent* – given during the performance of a task
- o Novice – benefits from frequent feedback initially to learn the correct procedure (however, too much can foster feedback dependence)

Protocol:
1. Ask about the past week – how has it gone? Have they tried Lesson #1 again? Any difficulties navigating menu? (If so, go through training with child again – troubleshoot).
2. Warm-up:
   - Have child get his/her water.
   - Warm-Up: on floor, 10 of each
     - Marching: narrow, then wide
     - Jumping jacks
     - Scissor jumps
3. Specific coaching: *body-foot awareness and rhythm*
   a) Pick up the beat – listen to the rhythm.
      - Arrows (and character in beginner level) flash (and bounce) to the beat.
      - Have child clap to beat. Have child bounce to the beat.
   b) Step lightly: (visual – marshmallows). You'll be able to move your feet faster.
   c) Stay on the arrows. Alternate your feet.

Lesson #2:
Child: during demo, have child clap rhythm, bounce to rhythm, or call out directions aloud
Coach: cue child on stepping lightly (not stomping) and staying on arrows (not returning to middle)
Section #1: Step on the left and right arrows consecutively (not returning feet to the middle)
Section #2: An arrangement of section #1 (further practice on concept)
Section #3: Do the basic steps
Section #4: Try stepping with both steps at once (jumps)
Section #5: Jump to the rhythm
Section #6: Develop your own way of moving your feet
Section #7: Move sideways and step
Section #8: Practice of sections #1-#7
Song: "Keep on Lifting" (beginner mode – note improvements!) Then play another song of the child's choosing. Play each song through twice – continue cueing child!

Visit #3: **Classic Model of Motor Learning – Association Stage ("how to do")**
DDR Specific*: Scoring (Continuation of Foundation Building)*

Supporting Documents:
1. The Physiology of DDR by SweetPinoy85
2. Tips and Techniques – Scoring by EnoOn

Competencies:
- Key techniques for scoring through a focus on timing and mastery of combos

Association Stage:
- Hones the motor program through practice
- Performance improves (i.e. greater consistency, decreased errors) as a coordinated pattern of the motor program develops (spatial and temporal aspects)
- Proprioceptive cues – "feel of the movement" (use for section #6 of Lesson #3)

Feedback Schedule*: Summary* – given at the completion of a task
- Better suited for retention and retrieval

Protocol:
1. Ask about the past week – how has it gone? Have they tried Lesson #2 again?
2. Warm-up:
   - Have child get his/her water.
   - On floor: 10 of each
     - Marching: narrow, then wide
     - Jumping jacks
     - Scissor jumps
3. Specific coaching: *scoring*
   a) Learning complex step patterns
   b) Keep the combo going – accuracy of steps (perfect and great's)

Lesson #3: to practice complex patterns
Section #1: 1/8th arrows (have child clap rhythm with demo/example)
Section #2: Basic consecutive step (have child call out directions)
Section #3: Dance cool to the rhythm (similar to section #2)
Section #4: Move your center of mass and dance (cue if needed – keep feet on arrows, step lightly)
Section #5: Arrangement of the 1/8th beat step (have child clap rhythm with demo/example)
Section #6: Practice a difficult step
- Tap beat on your legs with your hands – have child imitate
- Demo step to child on floor – verbally state "ta ta tan, tan tan" (instructions given by game)
- Have child practice steps and calling out "ta ta tan, tan tan"
- Practice section

Section #7: Fun steps (doing "turns" while dancing)
Section #8: Practice of sections #1-#7

Song: *Super Star* – do in beginner mode twice. Tell child to continue practicing "Super Star" in beginner mode and "Lesson #3 throughout the week – tell him/her you are going to show him/her something really cool next week. Then play another song of the child's choosing, repeat song twice – focus on improving combo score.

Visit #4: **Classic Model of Motor Learning: Autonomous Stage ("how to succeed")**
DDR Specific: *Progressing towards "automatic" dancing (Challenging the Foundation)*

Supporting Documents:
1. General Motor Learning Principles
2. Specific Motor Learning Principles Applicable to DDR

Competencies:
- *Correlating physical with cognition*: introduction of schema theory as it relates to DDR and cognition (e.g. changing appearance of arrows to "sudden")

Autonomous Stage:
- Evident when motor performance is largely automatic
- Learner can now perform equally well in predictable or changing environments
- Movements are highly organized and relatively error-free

Feedback Schedule*: Faded* – slowly decreased in frequency as the child progresses
- Avoidance of feedback dependence

Specific coaching – facilitating steady, individualized goal attainment through continual challenge to learn
1. Schema theory: supports learning and improved performance as a result of practicing a variety of movements to expand schema (Schmidt); contextual interference introduces variability in factors (e.g. context, time, speed, etc): teaching to generalize skill (vs strict pattern memorization)
2. Adaptive Training: breaking down the steps within serial tasks (predictable but non-repeating order) into components
3. Cognitive Strategies:
   - Step chart
   - Training mode

Protocol:
1. Ask about the past week – how has it gone? Have they tried Lesson #3 again? What about "Super Star"?
2. Warm-up:
   - Have child get his/her water.
   - On floor: 10 of each
     - Marching: narrow, then wide
     - Jumping jacks
     - Scissor jumps
3. Specific coaching: (remember I said I was going to show you something cool this week?)
   a) Video of DDR players
   b) www.ddrfreak.com (tell child about how they even have DDR competitions)
   c) Super Star – light mode step chart
      - Coach: will demo "Super Star" at regular speed in light mode
      - Have child practice "Super Star" first in training mode: breaking down complexity into simpler pattern for child to learn (tell child they can use this method to learn other songs)
        - Level: choose light
        - Player mode: choose single
        - Assist: choose "6" (all elements – track, metronome, and handclap)
        - Music Speed: choose "1" for the slowest
        - First, Last Bars: practice the first 20 bars of the song

    - Select start to play song
    - When you are finished playing the song, choose “check” to see accuracy of steps
    - If child does well, increase speed level; if not, chose “again” to repeat song
    - Continue practicing – two more times with this song, in it’s entirety.
- End by playing a song of the child’s choosing (twice) – praise improvements! Have child continue practicing “Super Star” throughout week. Also have child think about teaching his/her friend next week – try to remember what you, the coach, did on the first visit.

Tip Sheet – Training Mode

- Select “Training Mode” from the main menu
- Left/Right arrows to select song you want to practice.
- Press “up” arrow to pick the song.

1. Use up/down arrows to go through options
2. Use left/right arrows to modify the option
3. Level: choose beginner, light, standard, or heavy
4. Player mode: choose single, versus, or double
5. Assist:
   - Off: music only
   - 1: metronome only
   - 2: track and metronome
   - 3: handclap only
   - 4: track and handclap
   - 5: metronome and handclap
   - 6: all elements
6. Music Speed
   - 1: slowest
   - 5: regular
7. First, Last Bars: select which part of the song to practice
8. Select “start” to play song

- When you are finished playing the song, gives three options:
  - Again: to repeat song with same settings
  - Check: to view accuracy per arrows (color coded)
    - Menu: to modify training mode on song or quit

Visit #5: **Cognitive Rehearsal**

DDR Specific*: Parent/Peer Involvement (Motivational and Empowerment to Succeed)*

Reassess noise/interference level from other activities or from DDR to family environment, time factor, location of DDR, etc (environmental factors): brainstorm with family if necessary

Literature:

- The literature clearly supports the involvement of parents/guardians as being influential to children's PA levels.
- "Children are easily influenced by 'significant others' in all aspects of their lives. Although parents exert a strong influence over their children and may be the key to motivating them to exercise and be more active, most parents are unaware of the importance of helping their children develop early beneficial exercise habits." (McWhorter et al 2003).
- "Involving parents is also an opportunity to educate them so that they can modify their behaviors and become good role models for their children, positively reinforce their children's attempts to be PA and adopt healthy eating habits, and provide an environment conducive to PA and healthy eating." (Pate et al 2000)

Competencies:

- ❑ Use of age-appropriate language to communicate to both parent and child
- ❑ Review correlating physical with cognition – training mode.

Protocol:

1. Ask about the past week – how has it gone? Have they tried Lesson Mode again?
2. Warm-up:
   - Have child get his/her water.
   - On floor: 10 of each
     - Marching: narrow, then wide
     - Jumping jacks
     - Scissor jumps
3. Specific coaching: *parent/peer involvement*
   - Child will be teaching their friend how to play DDR – you are there to help if needed. The goal is to empower the child and reinforce the learning from the past couple of weeks.
     1. Child will explain concept of DDR to friend
     2. Child will demo DDR by playing "Super Star" on light mode (or other song of child's choosing if more appropriate for skill level) – coach will comment on how practice leads to improvement ☺
     3. Child will take friend through Lesson #1, sections #1-#8
     4. Child will explain game mode and song selection screen (e.g. groove radar, bpm)
     5. Child will select appropriate song for friend to play/practice steps. (Keep on Lifting or other appropriate song)
   - Once the new friend has grasped the concept, alternate playing songs with child, friend, and the parent (minimum of two songs each person).

Present child with Certificate of Accomplishment in Special DDR Training

Tip Sheet – Endless Mode

1. Select “Endless Mode” from main menu.
2. Choose modifications:

Regulation

- On – play by the rules
- Off – no rules

Player

- Single – one player, one pad
- Versus – two players, two pads
- Double – one player, two pads

Level: beginner, light, standard, heavy, challenge, random

Arrow Options

- *Speedback*: 6 speed levels; selection does not affect playback speed of music – 1(normal), 1.5, 2, 3, 5, 8 (fastest)
- *Boost*: dance steps gradually accelerate to designated speed – on, off
- *Appearance*
  - Visible
  - Hidden: vanish unexpectedly
  - Sudden: appear unexpectedly
  - Stealth: not displayed
- *Turn*
  - Off
  - Mirror: rotate 180 degrees
  - Left: rotates 90 degrees to left
  - Right: rotates 90 degrees to right
  - Shuffle
- *Other*
  - Little: simplifies; useful in trying to learn
  - Flat: same color
  - Solo: colors based upon beat unit
  - Help arrow: special arrow increases dance gauge when hit properly
- *Scroll*
  - Standard: arrows go from bottom to top
  - Reverse
- *Freeze*