TEST-RETEST RELIABILITY OF ACTIVITY MEASUREMENT IN PRESCHOOLERS WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

UNIVERSITY OF FLORIDA

2009

ACKNOWLEDGMENTS

I thank Sheila Eyberg, Ph.D., my supervisory committee chair and research advisor, for her mentorship, encouragement, and editorial support as I worked on this thesis. I would like to thank Stephen Boggs, Ph.D. and Regina Bussing, M.D. for their guidance. I would also like to thank David Janicke, Ph.D., Deidre Pereira, Ph.D., and Catherine Price, Ph.D., members of my master's thesis committee, for the time and energy they have devoted to providing thoughtful feedback, and to the Child Study Laboratory for their efforts in data collection and encouragement as I worked on this thesis. Finally, I would like to acknowledge the National Institute of Mental Health (R01-MH-072780) for funding the project from which these data were collected.

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of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Science

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May 2009

Chair: Sheila Eyberg
Major: Psychology

Attention Deficit Hyperactivity Disorder (ADHD) is a pervasive and chronic disorder characterized by inattention, impulsivity, and hyperactivity. Young children often come to clinical attention because parents have concerns about hyperactive behavior, but accurate assessment of the degree of hyperactivity is difficult. Assessors commonly rely on parent and teacher reports of child behavior. Alternatively, child activity rates can be measured directly through technological instruments. One of the newest devices, the Actical Accelerometer, provides objective measurement of physical activity level. Studies evaluating objective measures of activity in children with ADHD have found that children with ADHD show consistently higher rates of activity than do normal controls and that levels of child activity may vary depending on the situation. Previous studies have included long observation periods, and researchers know very little about the variability of children's activity levels within shorter observation periods. This study examined 1-week test-retest reliability of physical activity levels using the Actical Accelerometer during structured parent-child interaction situations, which are a standard part of the Dyadic Parent-Child Interaction Coding System (DPICS), a measure of the quality of parent-child interaction often used as a treatment outcome measure.

During pre-treatment assessment, activity levels of 25 children were measured on two occasions, one week apart, during the three standard 5-min parent-child interaction situations of the DPICS: Child Led Play, Parent Led Play, and Clean Up. Children were between the ages of 4 and 6 years old, met DSM-IV-R criteria for ADHD, had no cognitive or developmental delays, and were not receiving any medication or behavioral therapy for ADHD symptoms. Children wore the Actical Accelerometer at both assessment visits, and data were collected during each standard situation. Pearson correlations were used to measure 1-week test-retest reliability of the activity measurement, and paired-samples *t* tests were used to examine whether activity measurements evidenced systematic change with repeated administration. Repeated Measures ANOVA examined the relationship of child activity within the three DPICS situations.

Activity level measurements during the 15-min observation period at Week 1 and Week 2 were moderately correlated: $r(23) = .40$, $p < .05$, and showed no systematic increase or decrease across administrations. Comparisons of the individual 5-min situations revealed significant correlations only for Child Led Play, $r(23) = .52$, $p < .009$. The Repeated Measures ANOVA found a main effect for situation. For Visit 1, child activity in CU was greater than child activity in CLP or PLP respectively: $F(1, 24) = -152.64$ $p < .001$, $F(1, 24) = -188.24$, $p < .001$. The same relationship between the situations was found for Visit 2: $F(1, 24) = -195.04$ $p < .001$, $F(1, 24) = -238.4$, $p < .001$. There was no significant difference between child activity in CLP or PLP for either visit.

Activity level in children with ADHD cannot be measured reliably in a brief, structured child-led play situation to a clinically significant level. The moderate test-retest correlation of activity level during the Child Led Play situation does not demonstrate reliable measurement within a 5-minute period of laboratory observation, as the correlation is too low as to be

interpretable . Variability introduced by parent and situational factors in a very short observation period may account for the non-significant results in the PLP and CU situations. Child activity measurements were able to differentiate between the CLP and CU situations, demonstrating a difference in child activity depending on the situations.

CHAPTER 1
INTRODUCTION

ADHD in Preschoolers

Attention Deficit Hyperactivity Disorder (ADHD) is a pervasive and chronic disorder characterized by inattention, impulsivity, and hyperactivity. The prevalence of this disorder has been estimated by the National Institutes of Health as affecting 3 to 5% of the childhood population (NIH, 2000). A child with ADHD experiences significant problems in many areas of his or her life: at home, at school, and with peers. The diagnosis of ADHD requires the identification of specific behaviors described in the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition, revised, (American Psychiatric Association, 2000). This manual identifies three types of ADHD, of which the most-often diagnosed is the combined inattentive, hyperactive, and impulsive type, which is diagnosed in about 80% of children with ADHD (Rappley, 2005).

Hyperactivity

Hyperactivity, especially when combined with impulsivity and attention problems, often causes children to come to clinical attention. In 4- to 6-year-old children, who are often too young to be in challenging scholastic settings that make inattentive symptoms overtly problematic, behaviors that stem from hyperactivity interfere most with children's functioning at home and school. Past research has suggested that preschoolers with high activity may need more adaptations in school than older children with ADHD (Stormont & Zentall, 1999). Because the symptoms of hyperactivity present specific challenges for the families and schools of preschoolers with ADHD, and because these symptoms are often the reason the disorder is brought to clinical attention, it is important to evaluate the symptoms of hyperactivity apart from the other components of the disorder.

"Hyperactivity" has been poorly defined and operationalized, both in the literature and by clinicians (Poggio & Salkind, 1979). Currently, parents and teachers are asked to identify whether their child is more active than "normal," without a clear definition of what activity level is healthy and developmentally appropriate for young children. By objectively measuring a child's activity level, it may be possible to tease apart normal child "energy" from truly maladaptive hyperactivity. However, it is first necessary to determine if activity level can be reliably and validly measured at any point on the continuum from "normal" to maladaptive.

Objective Measures of Physical Activity and ADHD

Fortunately, activity rates, unlike less observable components of ADHD such as "inattention" or "impulsivity," can be measured objectively. Activity is physically measurable in natural science units, creating a natural science perspective for a behavioral characteristic (Tryon, 1991). If activity can be measured in physical units, then the data can be understood and used in myriad ways. However, activity has not been measured in common, scientific units when evaluating children for ADHD clinically. Instead, the concept of hyperactivity has been understood only as reported by parents and teachers. In his critique of commonly-used measures of ADHD, Sandoval (1977) argued that the diagnosis of hyperactivity is often made on the basis of reports that contain many leading questions and not on analysis of hard evidence. Sandoval's assertion was supported by a study by Tryon and Pinto (1994), in which researchers found that teacher ratings of hyperactivity did not always demonstrate convergent validity with the pedometer, an objective measure of hyperactivity, in "mildly hyperactive" children. In this study, fifteen of twenty-two (68 percent) children rated by teachers as hyperactive were equally or less active than the most active "normal" child as previously assessed. These average children were actually more active than some children with an ADHD label, suggesting that teacher report alone could over-diagnose some children as having ADHD (Tryon & Pinto, 1994).

Evidence suggests that rating scales can be influenced by many factors, and that few child rating scales have shown convergent validity with objective measures of child activity (Rapport et al., 2006). These researchers also stated that rating scales are limited by imprecise measurement, poor construct validity, and a dearth of research demonstrating their diagnostic utility. Past research has clearly indicated that behavior rating scales alone fail to fully capture and define the concept of hyperactivity and its presentation in young children.

In the early 1960's and 1970's, psychologists recognized the limitations of observer report and began to invent and test different tools that could provide objective measures of activity. Some objective measures were simple observations of the number of times a child in a room crossed the grid on the floor during a specific time interval (Partington, Lang, & Campbell, 1971). Other, more technological, tools for measuring activity included the Actometer (Johnson,1971), pedometers, step counters, tilt counters, accelerometers, heart rate, oxygen consumption, integrated EMG, stabilimeters, photoelectric cells, and ultrasound (Handen, et al., 1998; Haynes & Yoskioka, 2007; Tryon, 1991).

Although the early instruments were unreliable, expensive, and obtrusive in nature (Sandoval, 1977), due to recent advances in technology, the field of actigraphy has revolutionized the tools available for activity measurement. Teicher et al. (1996) described the advantages of actigraphs in terms of their "portability and their capacity to provide data on patients in their natural settings." Other researchers have praised them for their ability to provide "highly accurate information concerning activity level" and to "document even minor motor movements between body parts 24 hours a day for several week" (Rapport et al., 2006, p. 129-131) There are a variety of actigraphs on the market that are relatively inexpensive, reliable, and

very easy to wear. They are known for their established reliability and precision of measurement (Tryon, 2005; Rapport et al., 2006).

Actigraphs

One of the newest actigraphs, the Actical accelerometer, is a valid tool for measuring physical activity in young children (Pfeiffer et al., 2006). It can be worn as a light-weight waterproof wristwatch that monitors the occurrence and degree of motion and the intensity of physical activity and produces a voltage output signal whose magnitude and duration depend on the amount of motion. The voltage output (measured in Hertz) is stored as Activity Counts. The Actical Accelerometer accurately reports intensity and range of motion in all planes, which allows for greater sensitivity than devices (such as pedometers) that only measure up/down motion. The data collected can be uploaded from the device into a simple computer program, which displays physical activity intensity scores in epoch lengths of 15 seconds.

In a study comparing three of the most commonly used accelerometer models in a mechanical laboratory setup, the Actical Accelerometer demonstrated superior intra- and interinstrument reliability, as compared to the Actigraph and RT3 (Eslinger & Tremblay, 2006). The three accelerometers were placed on a hydraulic shaker plate and simultaneously accelerated and decelerated with varying frequencies. Three experiments were performed, the first of which evaluated 5 Acticals, and the second and third of which evaluated 39 Actical accelerometers for 7-min test periods. The results indicated impressive intraclass correlations for the Actical for both the first (0.985) and second experiment(1.00), while the reported coefficients of variation demonstrated better reliability for the Actical across all experiments, and particularly in experiments 2 and 3 (CVintra = 0.5%, CVinter = 5.4%) (Eslinger & Tremblay, 2006).

Additional research indicated validity of the Actical with physical activity in preschoolers. In a study by Pfeiffer et al. (2006), preschool children wore the Actical at rest, while performing

three structured physical activities, and during 40 minutes of indoor and outdoor activities in preschool. Respiratory gases and oxygen consumption were also measured in these situations. This study provided calibration and cross-validation data for the Actical as a measure of physical activity using a metabolic criterion measure in 3-5-year-olds, indicating that the Actical accelerometer can be used as a measure of physical activity in young children. (Pfeiffer et al., 2006). McIver et al. (2004) published a similar study with preschoolers that also evaluated placement of accelerometers on the body during exercise. The results of their analysis also suggested that the Actical accelerometer appears to be a valid device for measuring physical activity in young children.

Actigraphs and other objective measures of activity have been previously used in ADHD research to evaluate whether children diagnosed with ADHD were actually more physically active than children without the diagnosis. One study compared the activity of 12 middle-school hyperactive boys to 12 controls over a week's period using pedometers, and found that hyperactive children were generally more active than control children in all situations, including sleep (Porrino et al., 1983). Another study compared the activity of 18 boys with ADHD to normal controls using infrared motion analysis during administration of the Continuous Performance Test. They also concluded that children with diagnosed ADHD were more physically active than normal controls, and they were able to describe more clearly the specific activity patterns demonstrated by children with ADHD (Teicher et al., 1996). Finally, ADHD children were found to show motor excess in both structured and unstructured situations compared to normal controls (Pinto & Tryon, 1996). These findings indicate that levels of child activity may vary depending upon the situation.

Actigraphy has even been used an as a treatment for ADHD (Tryon et al., 2006). In research evaluating this treatment, nine boys aged 8 to 9 years diagnosed with combined type ADHD wore the Buzzbee© feedback actigraph during school, and they were notified every time they exceeded a certain activity level. The boys were reinforced for activity level reductions, and they significantly reduced their activity during the study (Tryon et al, 2006).

Specific Aims

Although activity level in children has been examined using actigraphs, past observations took place over weeks, days, or periods of several hours. Long periods of observation have allowed researchers to learn more about general activity patterns exhibited by children with ADHD, but researchers still know very little about the variability of children's activity levels in shorter observation periods. How reliable (or unreliable) is the physical activity level of children with ADHD across highly similar situations? Does a snap-shot of child activity provide a true picture of how that child is likely to behave in the future? Additionally, does a child's physical activity vary depending upon the demands of a situation? The purpose of this study was to examine the 1-week test-retest reliability in physical activity of children with diagnosed ADHD during three 5-min structured parent-child interactions as measured by the Actical Accelerometer. It was hypothesized that the Actical would show significant 1-week test-retest reliability for measuring physical activity level of young children with ADHD for each of the three 5-min structured interactions with a correlation between Visit 1 and Visit 2 greater than 0.7.

Past research suggests that children's physical activity can vary depending upon the situation (Pinto & Tryon, 1996). It stands to reason that in certain play situations, particularly those with high demands for action, children may be more physically active than in other, less-demanding situations. In this study, children were observed in structured parent-child play situations that are

a standard part of the Dyadic Parent-Child Interaction Coding System (DPICS), a measure of the quality of parent-child interaction often used as a treatment outcome measure (Eyberg et al, 2005). These play situations include specific directions instructing a parent to follow specific "rules" for each of the 5-minute play situations. In the Child Led Play situation (CLP), parents are told simply to allow the child to "lead the play" and to "follow the child's lead." In the Parent Led Play (PLP) situation, parents are told that it is their turn to lead the play and to "get the child to play along" with them. Both of these situations allow for significant interpretation from the parent as to what it means to play with their child or to "lead the play."

However, the Clean Up (CU situation) differs from the other situations in that it instructs the parent to "have the child pick up all the toys by him or herself" and provides details for how the child is expected to clean up the play room. The demands of the situation are such that the child is expected to move around the entire room, physically picking up all of the toys and putting them in boxes. In this situation, a child is typically either actively complying or trying to avoid complying. For this reason, it was hypothesized that child activity in the CU situation would be significantly higher than activity in either the CLP or PLP situations.

CHAPTER 2
METHOD

Participants

Twenty-five children were observed in standardized play situations with their mothers. Children in the study were mostly boys (76%), with a mean age of 4 years, 11 months (*SD* = .67). Racial-ethnic composition was 75% Caucasian, 12% African American, 4% biracial, and 8% Hispanic. Composition of mothers' education level was as follows: 44% completed some college or technical school, 28% graduated college, 12% completed some graduate education, 12% graduated high school, and 4% had less than 7 years of formal education. Inclusion criteria for this study were as follows: (a) The child was between 4 and 6 years of age; (b) The child met both DSM-IV-R and Jensen criteria for ADHD; (c) The child had no developmental delays (d) The child was enrolled in a structured daycare or school program; and (e) The child was not receiving medication or other psychosocial treatment for ADHD symptoms. The mothers obtained scores of at least 75 on a cognitive screening measure and were required to attend both assessment sessions with their child.

Measures for Jensen Criteria for ADHD Diagnosis

The Jensen criteria (Jensen et al., 2001) were used for ADHD diagnosis, which required a parent-report measure, a teacher-report measure, and a DSM-IV-R structured diagnostic interview all indicating presence of the diagnosis.

Young Child Diagnostic Interview Schedule for Children (YC-DISC; Lucas, Fisher, & Luby, 2000) is a structured diagnostic interview for administration to parents of preschool-aged children. Individual modules of interest (ADHD, Oppositional Defiant Disorder, Conduct Disorder, Separation Anxiety [SAD] and Major Depressive Disorder [MDD]) can be administered separately.

The Child Behavior Checklist (CBCL); (Achenbach & Rescorla, 2000; Achenbach & Rescorla, 2001) A measure comprised of two measures administered to children in different age ranges (1.5-5 years; 6-18 yrs). Both measures were used because some children enrolled in the study were age 5 or younger and others were age 6. Standardized scores from the DSM-Oriented scales on the CBCL measures were used as one index in determining child diagnoses.

Conners Teacher Rating Scale-Revised: Long Version (CTRS-R: L; Conners et al., 1998) A 59-item teacher rating scale that measures ADHD and common comorbid disorders in children age 3 to 17 years. We required a score in the clinical range ($T \geq 60$) on the CTRS-R:L DSM-IV: Hyperactive/Impulsive for DSM-IV: Inattention scales in addition to a DISC-IV-P diagnosis of ADHD and a score in the clinical range on the corresponding DSM-Oriented Scale of the CBCL to confirm the diagnosis of ADHD for study inclusion.

Other Screening Measures

Demographic and Background Questionnaire. A parent questionnaire provided descriptive information about the child and family. This information included sex, age, race/ethnicity, occupation, education level, and medical history.

Peabody Picture Vocabulary Test-Third Edition (PPVT-III; Dunn & Dunn, 1998). The PPVT-III is a well-standardized measure of receptive language in individuals age 2.6 years and older. Raw scores are converted into standard scores (M = 100, SD = 15). Split-half reliability coefficients for children range from .86 to .97, with a median of .94. Test–retest reliabilities range from .91 to .94. The PPVT-III was used as the cognitive screening measure for children.

Wonderlic Personnel Test (WPT); (Dodrill, 1981). The WPT is a 50-item test designed as a screening scale of adults' intellectual abilities. In a sample of 120 normal adults, the

Wonderlic estimate of intelligence correlated .93 with the WAIS Full Scale IQ score, and the Wonderlic score was within 10 points of the WAIS IQ score for 90% of the sample (Dodrill, 1981). The WPT Full Scale IQ estimate was used as the cognitive screening measure for parents.

Activity Measure

Actiwatch ® Accelerometer; (MiniMitter Company, Inc., Bend, OR). The Actical accelerometer is a valid measure of physical activity in preschool children (Pfeiffer, 2006). The device measures the occurrence and frequency of motion and is worn as a light-weight wrist watch. The activity can be time-stamped by pressing the button on the center of the device, allowing activity levels to be measured within a specified time-frame. The information from the Actical is downloaded into a computer.

Procedure

Activity levels of the 25 children were measured on two occasions, one week apart, during three standard 5-minute parent-child interaction situations: Child Led Play, Parent Led Play, and Clean-Up. Three observations could not be used due to errors in administration, such as the child removing the Actical during Cleanup, one case of missing Actical data in which the data were never entered into the computer, and one case in which an assessor did not record the real times that the Actical was activated. Children wore the Actical accelerometer at both assessment visits on the non-dominant wrist. During each visit, the child and the child's mother were observed in three DPICS situations in a playroom with age-appropriate toys. The mother was verbally instructed to let the child lead the play. After 5 minutes of warm-up, the mother was instructed to push the button on the Actical device and to continue letting the child lead the play. Play continued for an additional 5 minutes. The mother was then given a verbal instruction to lead the play herself, and after another 5 minutes of warm-up, was instructed to push the button on the Actical and continue leading the play. After 5 minutes, the mother was given a verbal

instruction to have the child clean up all of the toys and to push the button on the Actical. The clean up situation was recorded for 5 minutes. This same procedure with the same playroom set-up was repeated at the second visit a week later.

Data from the Actical were uploaded onto a computer and transformed into Excel documents. Activity level, measured in Hertz, was recorded for every 15 second period of the each 5 minute DPICS situation.

CHAPTER 3
RESULTS

Preliminary Analysis

Paired-samples *t* tests were used to examine whether activity measurements evidenced systematic change with repeated administration. Activity level showed no systematic increase or decrease across administrations, demonstrating no significant change in activity level from Visit 1 to Visit 2 (Table 3-1).

Analysis of Test-Retest Reliability

Pearson correlations were used to measure 1-week test-retest reliability of the activity measurement across each play situation and across the combined three play situations. The average scores for measurement during the three play situations were added and observation scores from Visit 1 were moderately correlated with observation scores from Visit 2: $r(23) = .40$, $p < .05$. Analysis of the individual 5-min situations revealed significant reliability only for Child Led Play, $r(23) = .52$, $p < .009$, which was the first play situation following a warm-up of five minutes. There was no significant correlation between Visits 1 and 2 for either Parent Led Play or Clean Up situations across the two visits (Table 3-2).

Analysis of Play Situation

A Repeated Measures ANOVA was conducted to examine the relationship of child activity within the three standardized play situations (Child Led Play, Parent Led Play, and Clean Up.) Analysis of the 5-min situations revealed a significant main effect for situation. For Visit 1, the results indicated that child activity in CU was significantly greater than child activity in CLP or PLP, respectively: $F(1, 24) = -152.64$ $p < .001$, $F(1, 24) = -188.24$, $p < .001$. For Visit 2, the results also indicated that child activity in CU was significantly greater than child activity in CLP

or PLP, respectively: $F(1, 24) = -195.04$ $p < .001$, $F(1, 24) = -238.4$, $p < .001$. There was no significant difference between child activity in CLP or PLP for either visit (Figure 3-1).

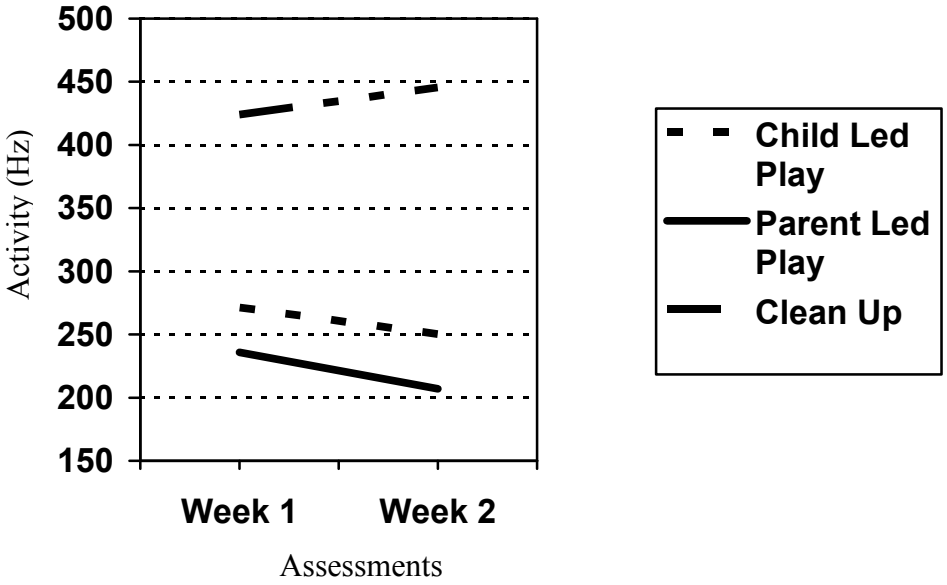
3-1. Paired Samples *t* test for Activity Level Across Assessment (N=25)

Play Situation	Assessment	Mean (Hz)	*t*	*p*
Child Led Play	Visit 1	271.36	.82	.421
	Visit 2	250.40		
Parent Led Play	Visit 1	235.76	1.24	.226
	Visit 2	207.04		
Clean Up	Visit 1	424.00	.36	.526
	Visit 2	445.44		

3-2. Descriptive Statistics and Pearson Correlations for Activity Level Across Observations (*N*=25)

Play Situation	Assessment	Range (Hz)	Mean (Hz)	*SD*	*r*
Child Led Play	Visit 1	42-659	271.36	144.05	.514*
	Visit 2	105-468	250.40	107.35	
Parent Led Play	Visit 1	96-476	235.76	92.59	.260
	Visit 2	41-451	207.04	97.27	
Clean Up	Visit 1	105-468	424.00	149.09	.359
	Visit 2	164-721	445.44	145.00	

*$p < 0.05$ level (2-tailed).



3-1. Play Situation Physical Activity by Assessment

CHAPTER 4
DISCUSSION

Reliability of Child Physical Activity in the Play Situations

This study found that activity level in children with Attention Deficit Hyperactivity Disorder is moderately correlated from one visit to the next in short structured play situations as measured by the Actical Accelerometer. The research confirmed the Actical's reputation as a portable and inexpensive tool for examining child physical activity (Teicher et al.,1996). However, child physical activity did not show adequate test-retest reliability for any of the DPICS situation as was originally hypothesized. Additionally, data across the three situations combined (15 minute period of coded observation) also produced a correlation coefficient that was too low to indicate stable measurement across the one week time interval between observations.

As predicted, children were significantly more active in the Clean Up situation than in either Child or Parent Led Play. The effect of situation may be related to the increased demands placed on a child to do an active task in Clean Up: cleaning up the playroom. In this situation, the child is either actively complying or trying to avoid the task. Although the Parent Led Play situation has the potential to demand high levels of child activity, the instructions given to the parents are open to parental interpretation and do not require child activity. More directive parents could interpret these directions as permission to give the child many commands, while more passive parents could decide not to interfere in the child's play. Child Led Play is different than both Parent Led Play and Clean Up because parents are explicitly told to "play along" with their child and "follow the child's lead." In CLP, parents are essentially instructed to be as undemanding as possible. The relationship of demandingness in the DPICS situations and child physical activity should be examined in future research.

Limitations, Strengths, and Future Directions

Some limitations of this research should be noted. The child activity scores for measurement from Visit 1 were not sufficiently correlated with observation scores from Visit 2 in the CLP situation to give evidence of the reliability of the measure. Moderate correlations are not strong enough to allow any interpretations to be drawn about child physical activity from only one observation. Only reliability with a magnitude greater than 0.7 was hypothesized as being interpretable. It could be argued that child physical activity in Visit 1 is not a true snap-shot of child physical activity in that play situation and that low reliability scores are the product of inconsistent child physical activity over time.

It is possible that the structure of the DPICS situations decreased the reliability of child activity by providing too many opportunities for variability in child play. In the DPICS situations, children were provided with five different toys and no set instructions on how to use the toys. Some games that children played may have been inherently more active (for example, racing wooden cars around the floor) than others (sitting at the table to build a castle out of foam blocks). If a child played with one toy during the first observation and a completely different toy in the second observation, the differences in their physical activity may have resulted from their toy choice. The number of toys in the room may have created an environment where children were not actually being observed in similar situations across time. Future studies should observe the child with only one toy available to decrease toy-produced variability.

Parent variables and behavior may contribute to the variability of child physical activity in the parent-child interaction. In the situations, parents may adapt or alter their behavior in the interaction depending on the child's behavior. For example, if a child protested in PLP during the first visit, the parent might change her approach to the play at the second visit. Similarly, if a

child was unruly during CLP in the first visit, the parent might become more directive in the second visit. In the CU situation, the high demands of this situation may increase parent inconsistency. A parent might help the child clean up the second week to avoid the tantrum that occurred in the first week. Parental behavior in all of these situations may affect the child's reaction to the parent and cause the child's behavior to be more variable as well. Even in CLP, where the parent was instructed to allow the child to "lead the play," parent behavior could still have had a strong influence on child behavior. Observing children playing alone would eliminate this possible confound and provide a clearer picture of uninfluenced child activity

It is possible that higher reliability correlations would have been obtained in any or all of these situations if the children were observed for longer than 5 minutes. In past research, children were observed for days and weeks before patterns in their behavior were seen. Future research should use 10-minute observations to determine if a slightly longer time period would improve reliability in all situations.

Only mother-child dyads were used to assess reliability. However, mothers are typically the primary caregivers who accompany children to doctor visits. It is possible that children may behave differently and show different levels of activity if evaluated with their father or a different caregiver. Data also represent primarily male Caucasian children. Although the gender ratio is consistent with the rates of ADHD diagnosis in the general population, children from different cultural backgrounds are underrepresented in this study. Future research should be conducted to improve the generalizability of these research findings.

The moderate correlation of child activity across two 5-minute observation periods suggests potential for clinical use of Actical activity measurements for preschoolers. The finding that the highest correlation occurs in Child Led Play situation, within the first 10 minutes of

assessment, highlights the potential clinical use of this measure for evaluating the activity of hyperactive children. Theoretically, any pediatrician or psychologist could conduct a 10-minute evaluation without incurring expenses greater than the cost of the Actical technology. The evaluation requires no more than a room containing several interactive toys, the Actical technology, and the participation of a parent. The potentially valuable information of an objective rating of child activity could be well worth the ten minutes of observation.

To make such an evaluation clinically informative, future research obtaining correlations higher than 0.7 across two child observations would be necessary. If this finding were supported, further research examining the discriminative validity between preschoolers with ADHD and normal controls would be particularly valuable. If objectively-measured activity in Child Led Play differentiates children with ADHD from children without ADHD, then mental health professions could use Actical measurements to help determine whether a child's over-activity reaches a level of clinical significance. This information could be particularly helpful to pediatricians, who are asked to diagnose ADHD with limited time. In mental health clinics, the information could provide additional data to confirm or call into question a parent's report that her child is overly active. Normative data would need to be established for non-ADHD populations before the potential clinical uses could be realized.

LIST OF REFERENCES

Achenbach, T.M. and L.A. Rescorla. (2000) *Manual for ASEBA preschool forms & profiles.* University of Vermont, Research Center for Children, Youth, & Families.: Burlington, VT.

Achenbach, T.M. and L.A. Rescorla. (2001). *Manual for ASEBA school-age forms & profiles. University* of Vermont, Research Center for Children, Youth, & Families.: Burlington, VT.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders: DSM-IV-TR.* Washington, DC: Author.

Conners, K. C., Sitarenios, G., Parker, J., & Epstein, J. (1998) Revision and restandardization of the Conners Teacher Rating Scale (CTRS-R): factor structure, reliability, and criterion validity. *Journal of Abnormal Psychology, 26,* 279-291

Dodrill, C.B. (1981). An economical method for the evaluation of general intelligence in adults. *Journal of Consulting & Clinical Psychology*, *49*, p. 668-673.

Dunn, L.M. and L.M. Dunn, *Examiner's manual for the PPVT-3: Peabody Picture Vocabulary Test Third Edition.* 1997, American Guidance Services: Circle Pines MN.

Eyberg, S.M., Nelson, M.,M., Duke, M., & Boggs, S.R. (2005). Manual for the Dyadic Parent-Child Interaction Coding System (3rd edition)

Eslinger, D. W., & Tremblay, M. S. (2006). Technical reliability assessment of three accelerometer models in a mechanical setup. *Medicine and Science in Sports and Exercise, 38*, 2173-2181.

Handen, B. L., McAuiliffe, S., Janosky, J., Feldman, H., Breaux, A. M. (1998).A playroom observation procedure to assess children with mental retardation and ADHD. *Journal of Abnormal Psychology, 26,* 269-277

Haynes, S. N., & Yoskioka, D. T. (2007). Clinical assessment applications of ambulatory biosensors. *Psychological Assessment, 19,* 44-57

Jensen, P.S., & Members of the MTA Cooperative Group. (2002). ADHD comorbidity findings from the MTA Study: New diagnostic subtypes and their optimal treatments. In J.E. Helzer, & J.J. Hudziak (Eds.), *Defining psychopathology in the 21st century: DSM-V and beyond. American Psychopathological Association series* (pp. 169-192). Washington, DC: American Psychiatric Publishing, Inc.

Jensen, P.S., Watanabe, H.K., Richters, J.E., Roper, M., Hibbs, E.D., Salzberg, A.D. & Liu, S. (1996). Scales, diagnoses, and child psychopathology: II. Comparing the CBCL and the DISC against external validators. *Journal of Abnormal Child Psychology, 24,* 151-168.

Johnson, C.F. (1971). Hyperactivity and the machine, the actometer. *Child Development, 42,* 2105-2110.

McIver, K., Pfeiffer, K., Almeida, J., Dowda, M., & Pate, R. (2004). Validity of the actigraph and actical accelerometers in 3-5-year-old children. *North American Society for Pediatric Exercise Medicine.*

National Institutes of Health [NIH]. (2000). National Institutes of Health consensus development conference statement: Diagnosis and treatment of Attention Deficit/Hyperactivity Disorder (ADHD). *Journal of the American Academy of Child and Adolescent Psychiatry*, *39*, 182–193.

Partington, M. W., Lang, E., & Campbell, D. (1971). Motor activity in early life. I. Fries's congenital activity types. *Biology of the Neonate, 18*, 94-107

Pfeiffer, K. A., McIver, K.L., Dowda, M., Almeida, M. J. C. A., & Pate, R. (2006). Validation and calibration of the actical accelerometer in preschool children. *Medicine & Science in Sports & Exercise*, 152-157.Pinto, L.& Tryon, W.(1996). Activity measurements support dimensional assessment. *Behavior Modification, 20*, 247-258

Poggio, J. P. & Salkind, N. J. (1979). A review and appraisal of instruments assessing hyperactivity in children. *Learning Disability Quarterly, 2,* 9-22.

Rapport, M. D., Kofler. M. J., & Himmerich, C. (2006). Activity measurement. In M. Hersen (Eds.) *Clinician's Handbook of Child Behavior Assessment* (pp. 125-157). Burlington, MA: Elsevier Academic Press.

Rappley, M. (2005). Attention-deficit hyperactivity disorder. *New England Journal of Medicine, 352,* 166-173

Sandoval, J. (1977). The measurement of the hyperactive syndrome in children. *Review of Educational Research, 47,* 293-318.

Shaffer, D., Fisher, P., Lucas, C. P., Dulcan, M. K., & Schwab-Stone, M. E. (2000). NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): Description, differences from previous versions, and reliability of some common diagnoses. *Journal of the American Academy of Child and Adolescent Psychiatry, 39,* 28-38

Stormont, M., & Zentall, S.S. (1999). Assessment of setting in the behavioral ratings of preschoolers with and without high levels of activity. *Psychology in the Schools*, *36*, 109-115

Teicher, M. H., Ito, Y., Glod, C. A., & Barber, N. I. (1996). Objective measurement of hyperactivity and attentional problems in ADHD. *Journal of the American Academy of Child and Adolescent Psychiatry, 35,* 334-342.

Tryon, W.W. (1985). Human activity: A review of quantitative findings. In W.W. Tryon (Ed.), *Behavioral assessment in behavioral medicine* (pp. 257-299). New York: Springer.

Tryon, W.W. (1991). *Activity measurement in psychology and medicine.* New York: Plenum Press

Tryon, W.W. (2005). The reliability and validity of two ambulatory monitoring actigraphs. *Behavior Research Methods Instruments & Computers, 37,* 492-497.

Tryon, W. W., & Pinto, K. P. (1994). Comparing activity measurements and ratings. *Behavioral Modification, 18,* 251, 261.

Tryon, W. W., Tryon, G. S., Kazlausky, T., Gruen, W., Swanson, J. (2006). Reducing hyperactivity with a feedback actigraph: initial findings. *Clinical child psychology and psychiatry, 11,* 607-617

BIOGRAPHICAL SKETCH

Leah Newlove Clionsky was born in Springfield, Massachusetts. The daughter of two psychologists, she was raised in Springfield and graduated from the Loomis Chaffee School in 2003. She earned her B.A. in psychology and French and graduated with honors from Vassar College in 2007.

In August of 2007, she enrolled in a dual Master of Science and Doctor of Philosophy program at the University of Florida's Department of Clinical and Health Psychology. Leah currently has a research assistantship in the Child Study Laboratory under the mentorship of Sheila Eyberg, Ph.D. She received her Master of Science in 2009. Leah will continue her Doctor of Philosophy work in the Department of Clinical and Health Psychology.