Measuring inhibitory control in preschool children: A multi-method perspective

by
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A THESIS

submitted to

Oregon State University

University Honors College

in partial fulfillment of
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degree of

Honors Baccalaureate of Science in Psychology
(Honors Associate)

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Inhibitory control, a salient component of self-regulation, predicts child academic and social competency into the college years. Typical measures of self-regulation (including teacher report, direct assessment, and observation) focus on inhibitory control and are each susceptible to unique flaws. The current study examined whether informant bias or differential contextual environments influenced the resulting measure of inhibitory control in preschool children and whether this varied by child gender.

Three measures of inhibitory control were given to 22 preschoolers in the Pacific Northwest. The results suggest that context has a greater effect on measured inhibitory control than does teacher bias, and that this tendency may be stronger for girls than for boys. Child inhibitory control may be a reaction to contextual cues as much as an innate capacity. Acknowledging the flexibility of self-regulatory skills may allow teachers to draw out hidden potential in their students and to prevent the destructive labeling that can lead to self-fulfilling prophecies.

Key Words: self-regulation, inhibitory control, preschool children, early childhood education, teacher-child relationships, development of self-regulation, development of inhibitory control, HTKS, teacher report, direct observation, inCLASS observations

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I understand that my project will become part of the permanent collection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request.

Zoe M. Alley, Author

Measuring inhibitory control in preschool children: A multi-method perspective

In the classroom, children are faced with very different expectations than those presented at home. One of the most important predictors of children successfully adapting to the school environment is the ability to regulate one's behavior in response to the context. Individual differences in the capacity for self-regulation that manifest in preschool have salient effects on the child's social and academic success that may persist into adulthood (McClelland et al., 2013; Vaszonyi & Huang, 2010). These individual differences can be supported or stunted by interactions with important figures in the child's life. An example of such figures in the classroom environment are teachers, who in fact exert influence on the development of a child's self-regulation (Dominuez et al., 2011; Ewing & Taylor, 2009; Vandell, Belsky, Burchinal, Vandergrift, & Steinberg, 2010; Williford et al., 2013). Encouraging positive engagement in teacher-child relationships can support child self-regulation and therefore the child's success (Ewing & Taylor, 2009).

Self-regulation is a multidimensional construct, made up of several factors that function in concert to manifest in-context appropriate behavior. Of its components, inhibitory control, is largely overt and is uniquely correlated with math and literacy skills in early childhood (Blair & Razza, 2007). As this skill has great influence on a child's development, measuring it accurately is imperative. Those elements contributing to the complexity of self-regulation (and in particular, its subcomponent inhibitory control), the factors influencing its development in a child, and the difficulties in its measurement are addressed below.

Dimensions of Self-regulation

Self-regulation is the ability to appropriately manage one's emotions, cognitions, and behaviors (Calkins, 2007). Children utilize and develop this skill as they engage and interact

with the environment, including interactions at home and in the early childhood classroom (ECE). Behavioral regulation, a subcomponent of self-regulation, consists of the combined utilization of inhibitory control, working memory, and attention to deliberately select a contextually appropriate behavioral response (McClelland et al., 2007). For children in ECE classrooms, there are behavioral demands that may be different from the home environment. For example, shouting out an answer may be acceptable outside of the classroom, but during class it is appropriate to inhibit that dominant reaction and instead raise a hand, thereby engaging in behavioral self-regulation (Kochanska et al., 2000). Because self-regulation is necessary to navigate a classroom environment, it is not surprising that higher levels of self-regulation in preschoolers are correlated with better academic performance and greater improvements over the course of an academic year (McClelland et al., 2007). This proficiency is also correlated with fewer problem behaviors and better social competence (Montroy et. al, 2014).

During the preschool years, self-regulation is under intense development **(**Best & Miller, 2010; Blair, 2002; Center on the Developing Child at Harvard University, 2011; Diamond, 2002; Garon, Bryson, & Smith, 2008; Vaszonyi & Huang, 2010). Improving the self-regulation of preschoolers may dramatically benefit their social and academic competence for the rest of their lives. Individual differences in self-regulation that manifest during preschool can persist into adulthood (Vaszonyi & Huang, 2010) and higher levels of self-regulation in early childhood are correlated with college success (McClelland et al., 2013). Further, preliminary evidence suggests that supporting self-regulatory skills for one child may have beneficial outcomes for the entire classroom (Yurdon, Jones, & Raver, 2014). Intervention for preschool children with lower levels of self-regulation could potentially better their future academic, social, and behavioral

success from kindergarten into adulthood. Such an intervention begins at identification, which hinges on the utilization of an accurate measure of the construct.

Self-regulation is reliant upon three interrelated components: attention, working memory, and inhibitory control (Wanless, McClelland, Tominey, & Acock, 2011). Working memory is a limited capacity system used to access, store, and manipulate information (Baddeley & Hitch, 1974), such as holding the last sentence one read in memory in order to contextually interpret the next one. Attention is the ability to ignore irrelevant stimuli and focus on a task, such as filtering out the sound of whispering classmates while listening to a lecture (Revlin, 2013). Inhibitory control is the ability to inhibit a dominant behavioral response and produce one that is contextually appropriate (Dowsett & Livesey, 2000), such as when a child waits in line to wash hands rather than walking directly to the sink.

Inhibitory Control

Inhibitory control is not separate from the other two components. For example, it is necessary to attend to the task at hand and hold the social rules of the situation in working memory before one can determine that a behavior is inappropriate and inhibit it. Nevertheless, inhibitory control is a standalone component of self-regulation and is uniquely correlated with math and literacy proficiency during early childhood, even after accounting for attention and working memory (Blair & Razza, 2007). Compared to the other components of self-regulation, the construct of inhibitory control is more easily measured in preschool children due to its overt nature. In young children, the frequency and intensity of externalizing behaviors such as inattention and low behavioral control demonstrate a lack of inhibitory control. Therefore, in the current study, inhibitory control will be operationalized as the inverse of externalizing, inattentive behaviors.

Development of inhibitory control. Research suggests that inhibitory control is linked to development of the prefrontal cortex (PFC; Müller & Kerns, 2015). Although the frontal cortex is under development during the early years of life, young children utilize this incomplete structure as they engage with the world (Casey, Gidd, & Thomas, 2000; Fuster, 2002). Around five years of age, neurons create millions of new connections of variable efficacy, leaving the PFC of a five year old a "rough draft" of the finished product. Pruning and sharpening of these connections in the PFC intensifies in adolescence (Petanjek et al., 2011) and continues throughout life (Asato, Terwilliger, Woo, & Luna, 2010; Dosenbach et al., 2010). In tandem with the development of the PFC, inhibitory control improves markedly from ages zero to six and then more slowly into adulthood (Müller & Kerns, 2015). As age increases, so too does performance on inhibitory tests such as go no-go tasks like Simon Says (Carlson, 2005; Jones, Rothbart, & Posner, 2003), with dramatic improvements from ages 3 to 7 (Montgomery & Koeltzow, 2010). The development of inhibitory control in these formative years establishes a foundation upon which later skills are built. Children that suffer brain damage to the PFC early in life are more likely to demonstrate poor academic achievement, lower social competence, and professional consequences (e.g., the inability to hold down a job) into adulthood -- all skills that are related to inhibitory control (Eslinger, Flaherty-Craig, & Benton, 2004). Supporting the development of inhibitory control in early childhood constructs a solid foundation for its continued development into adulthood.

There is evidence for both genetic and environmental components to inhibitory control. For example, specific alleles are associated with higher performance on working memory and inhibitory control tasks (Diamond, Briand, Fossella, & Gehlbach, 2004). However, there is substantial evidence that the environment, and in particular relationships, also influence the

development of inhibitory control (see Müller & Kerns, 2015 for a summary). Experimental animal studies show that sensitive peer and parental relationships increase dendritic length in rat pup's PFC, while deprivation of such relationships can result in shorter dendrites and fewer dendritic spines (Bell, Pellis, & Kolb, 2010; Helmeke et al., 2009). Further, environmental enrichment such as tactile stimulation can increase compensatory dendritic spining after a lesion to the medial prefrontal cortex (mPFC) and behavioral adaptation (Kold & Gibb, 2010), while stress during the prenatal stage of development can lead to decreased spine density in the mPFC for the pup in adulthood (Muhammad & Kolb, 2011). To summarize, a richer social and physical environment during rodent development positively affects the connectivity of the prefrontal cortex (see Kolb et al., 2012, for a review).

In humans, correlations between the development of inhibitory control, relationships, and environmental characteristics are abundant. For example, as early as six to nine months, infants from low socioeconomic backgrounds display less brain activity in the frontal cortex than infants from more affluent households (Tomalski et al., 2013). Additionally, four year olds who live in poor conditions perform poorly on measures of inhibitory control as compared to children with better living conditions, independent of the child's IQ (Lipina et al., 2013). Fortunately, promising research suggests that responsive, sensitive interactions can buffer the negative association between genetic and/or environmental risk. Parenting that is rich in positive regard and sensitivity when children are between seven and 15 months old serves as a protective factor against the influence of poverty on executive function, which includes inhibitory control (Blair et al., 2011). However, the power of parenting to support the development of strong inhibitory control is mediated by child temperament, which is largely determined by genetics early in life. Child temperament simultaneously influences the way a parent responds to a child's needs,

thereby influencing parenting style (Conway & Stifter, 2012). In this way, temperament serves as both a filter through which parenting and teacher interactions must penetrate in order to effect change in inhibitory control and as a factor that influences the kind of parenting the child receives. The interaction between sensitive, responsive relationships and child temperament also extends to teachers. In a study by Pluess and Belksy (2009), infants with a genetic predisposition for a negative temperament displayed more externalizing behaviors than their easy temperament counterparts when in low-quality childcare, but showed fewer problem behaviors when in high-quality childcare. These findings suggest that both nature and nurture play a role in the development of inhibitory control, particularly in the early years of life. It is in these early years that intervention on components of self-regulation, including inhibitory control, is most effective (Wass et al., 2012).

Inhibitory control within early care and education settings. Second to the home environment, children spend the most time in a school setting. Over 60% of children under five years of age spend time in formal ECE classrooms (Laughlin, 2013). Given the power of children's relationships to affect inhibitory control, it is not surprising that the classroom environment, particularly the interactions between the teacher and child, can dramatically shift its development over time (see Hamre, 2014 for a review). The positive effects of preschool relationships for children's development are long lasting. For example, preschool children who experience teachers that are engaged with children, attuned to their needs, and provide scaffolding for their social, behavioral, and academic development, display improved inhibitory control and higher academic achievement at 15 years of age (Vandell et al., 2010). Even so, children only spend about 27% of a typical day in a prekindergarten program interacting with an adult (Early et al., 2005; Fuligni et al., 2012). While the physical classroom environment or

quality of instruction is often discussed with respect to child outcomes, it is becoming clear that the interactions between teachers and children are an essential component for understanding the development of inhibitory control.

Teacher-child relationships can take many forms. However, the most studied relationship styles are close and conflictual teacher-child relationships (Pianta, 1999). A close teacher-child relationship is characterized by warmth, support, affection and enjoyment between the teacher and child. The child views the teacher as a secure base and a source of emotional support. In a conflictual relationship, the teacher perceives the child to be argumentative, behaviorally challenging, and may spend a large portion of his/her day redirecting the child's behavior or attention, to the extent that the child drains his/her energy (Birch & Ladd, 1998; Pianta, 1999). There is evidence that the teacher-child relationship itself can impact the development of self-regulation, in particular inhibitory control, and through that impact the child's academic and social success (e.g., Dominuez et al., 2011; Ewing & Taylor, 2009; Vandell et al., 2010; Williford et al., 2013). However, these relationships may also insert bias into teacher's report of children's inhibitory control.

High-quality, close relationships between teachers and their students are positively correlated with higher skills in inhibitory control, measured via teacher report (Baker, 2006; Ewing & Taylor, 2009; Silver, Measelle, Armstrong, & Essex, 2005) and observation (Howes, 2000). Relatedly, the emotional support of a teacher, specifically the extent to which the teacher supports and acknowledges the child's perspective and interests, is uniquely correlated with improvements in observed children's behavioral control (Williford, Vick Whittaker, Vitiello, & Downer, 2013), especially for children with problem behaviors (Dominuez, Vitiello, Fuccillo, Greenfield, & Bulotsky-Shearer, 2011).

Teacher report of a conflictual teacher-child relationship is also a powerful predictor of subsequent teacher report of disruptive behavior. There is a consistent negative association between teacher report of a conflictual relationship and teacher report of child externalizing behaviors (e.g., Roorda et al., 2014; Silver et al., 2005). At the transition to formal schooling, a conflictual teacher-child relationship predicts later externalizing behavior better than parent ratings of their child's aggression (Ladd & Burgess, 2001). This relationship is increasingly potent for children that display higher levels of aggression (Hamre & Pianta, 2001). Peer relationships and play are also affected by a conflictual teacher-child relationship. A child who has a conflictual relationship with a teacher is also more likely to display higher peer aggression and less social play as measured by teacher report and observations (Hughes, Bullock, & Coplan, 2013).

There is limited work examining discrepancies between teacher-report, observation, and direct assessment of children's skills. The correlations between child inhibitory control and teacher-child relationships may be due to bias in teacher's reporting of child behavior. For example, a teacher with a close relationship with a child may perceive higher skills of inhibitory control than are actually warranted. Conversely, a relationship marked by conflict may negatively influence a teacher's report of child behavior. In fact, teacher report of inhibitory control is negatively correlated with increases in teacher-report of externalizing behavior problems (Birch & Ladd, 1998). Maladaptive, conflictual teacher relationships potentially influence the teacher's perception of these high externalizing children—the very population that has the greatest need for the support of a close relationship (Roorda et al., 2014).

Measuring inhibitory control

Three methodologies, teacher report, direct assessment, and child observations are often used to measure inhibitory control, and each have their own strengths and limitations. Understanding these differences allows researchers to match methodology to the demands of the situation while potentially reducing the misrepresentation of children's innate capacities that may result from bias.

Teacher report is a quick and commonly utilized measure, but it is subject to the reporter's biases. For example, teachers and teaching assistants in the same classroom report different levels of disruptive behaviors for the same child (Wolcott & Williford, 2015), suggesting that teachers vary in their perceptions of a child's disruptive behavior. Further, parents and teacher often disagree on the severity of disruptive behavior (Ladd & Burgess, 2001). As discussed above, one explanation for the bias in teacher report is that teacher-child closeness may affect the teacher's rating. For example, the teacher may rate the child as displaying lower disruptive behaviors because they have a close relationship, regardless of the child's actual behavior. Hughes, Bullock, and Coplan (2013) examined differences in children's aggression by reporter and found that teachers reported higher levels of child aggression when they had a conflictual teacher-child relationship, but parents of the same children did not report the same levels of aggression. Offering further support for this suggestion, there are discrepancies between ratings from trained observers and teacher report regarding the same child (Wolcott & Williford, 2015).

Observations of child behavior also reveal discrepancies with other measures of children's inhibitory control. Teachers report that boys show higher levels of ADHD type behavior (Newcorn et al., 2001) and lower levels of inhibitory control (Suchodoletz et al., 2012),

but observations of boys and girls found no difference in their classroom behavior (Downer et al., 2009). Similarly, in a study by Williford and colleagues (2014), observations were not significantly related to teacher report or direct assessment. Conversely, Downer and colleagues (2009) found teacher report and observations of negative classroom interactions (i.e., externalizing behaviors/lack of inhibitory control) to be quite strong (r = .41 to .50; Downer et al., 2009). These inconsistencies may be due to issues related to the validity of teacher reports, as discussed above, or context of measurement (in classroom versus out of classroom) although this fails to explain the discrepancy recorded between direct assessment and teacher report in Williford and colleagues (2014).

In addition to bias in reporter, it is possible that context may explain some of the discrepancies between observed, reported, and assessed inhibitory control. Teacher report and classroom observation measure children's inhibitory control within the context of the classroom. Direct assessments, on the other hand, are conducted outside of the classroom, and may be less influenced by context. Thus, direct assessments may offer a different perspective of inhibitory control, which may be more indicative of children's innate capacity, but less valid in terms of their actual classroom behavior. Finally, gender differences in reported, observed, and assessments of inhibitory control may add another layer of bias

Gender differences

Children's skills in inhibitory control are responsive to one particular child factor: gender. Boys and girls display different levels of inhibitory control and have varying frequencies of close teacher-child relationships. These variations may differentially affect the measurement of inhibitory control for each gender.

Girls, compared to boys, are more likely to have a close relationship with their teacher (Silver, 2005). Compared to boys, girls with a close teacher-child relationship display higher inhibitory control according to teacher report (Ewing & Taylor, 2009). Alternatively, boys with a conflictual teacher-child relationship display higher hostile aggression, also according to teacher report, than girls in a conflictual relationship (Ewing & Taylor, 2009).

In addition to difference in teacher-child relationships, boys and girls display distinct types of aggression manifest as early as three years of age. According to both teacher and parent report (Achenback, McConaughy, & Howell, 1987; Korsch & Petermann, 2011), boys have a higher incidence of ADHD type problem behaviors (i.e., a lack of inhibitory control) than girls (Sims & Lonigan, 2011). On average, girls tend to display more prosocial behavior and less aggression than boys (Hughes, Bullock, & Coplan, 2013). However, boys are much more likely to engage in physical aggression, such as slamming a door or shoving another person, and this may insert bias in report and/or observation of child behavior.

Girls may have an advantage over boys in direct assessments due their preferred interaction style. Girls prefer to play in dyads, while boys prefer to play in large groups (Benenson, 1993). The one-on-one quality of direct assessments mirrors a girl's social style more so than a boy's, who would typically be playing among large numbers. However, as with reporter bias, the influence of context bias is not consistently reported. Mathews, Morrison, and Cameron-Ponitz (2009) showed that girls consistently outperformed boys in both direct assessment and teacher report, yet observed inhibitory control did not reveal classroom gender differences (Wolcott & Williford, 2015). Conversely, some studies report gender differences only in teacher report; for example Suchodoletz and colleagues (2013) reported no difference between boys and girls in direct assessments, but the gender gap persevered in teacher report.

The present study

Further identifying discrepancies in the measurement of inhibitory control carries important consequences for research and application. For example, if a study is focused on classroom interactions in context, selecting a methodology that is valid in the classroom context may be more important than reducing possible bias in teacher report. In application, children with lower levels of inhibitory control may benefit from intervention, but if identification of these children is based on their relationship with the teacher, children may be mislabeled, thus making a case for the inclusion of direct assessments. To promote the selection of appropriate measures for particular research and intervention goals, the identification of children who need assistance, and the proper allocation of resources to provide such assistance, it is imperative to examine the convergence and divergence of varying measures of inhibitory control.

Many studies have compared direct assessments and teacher report, or teacher report and classroom observations. The current study will add to the existing literature by including all three methods. Direct assessments of child inhibitory control will be assessed via the Head Toes Knees and Shoulders (HTKS); observation (i.e., Individualized Classroom Assessment Scoring System; InCLASS) and teacher report of ADHD symptoms (i.e., the Attention Deficit Hyper Activity Rating Scale-IV and the Oppositional Defiant Disorder Rating Scale) will also be utilized. The goal of this study is to determine whether individual differences in preschool children's inhibitory control vary by methodologies.

Due to some inconsistencies in the literature, three exploratory hypotheses are investigated. The first hypothesis will examine if differences in children's inhibitory control are related to the context of measurement (i.e. classroom versus direct assessment). If context is driving a convergence of scores, teacher report and observations will demonstrate a stronger,

positive correlation compared to direct assessment. Second, if differences in children's measured inhibitory control are a result of reporter bias, observed and direct assessment of children's inhibitory control will correlate more strongly than with teacher report. Finally, gender differences by methodology are also explored. As the dyadic interaction style of direct assessment mirrors a girl's preferred play more than a boy's, correlations of direct assessment with the other two measures may be stronger for females as compared to males.

Methods

Participants

The sample was drawn from a larger study examining the relations between classroom interactions and children's behavioral and physiological regulation. Teachers and directors were recruited from a list of child care centers in one suburban city in the Northwest. Fourteen classrooms with children 3 to 5 years of age agreed to participate. Following consent from teacher and director, parent packets (consent form, welcome letter, eligibility survey) were distributed to each child in the classroom by the teacher. Children were deemed eligible if they a) attended child care at least 20 hours/week, b) were enrolled in the target classroom for at least 4 weeks, c) were English speaking, d) did not regularly take a steroid derivative, e) did not have a diagnosed language delay, and f) consenting parent was at least 18 years of age. A minimum of two and up to eight children were allowed to participate per classroom. In two classrooms, there were not enough consented, eligible children to participate.

The final sample for this study includes 22 children within 12 classrooms that were observed with the inCLASS (Downer et al., 2009). Consented children in this sample were rated by their teacher as having the highest inhibited/shy behaviors and the highest externalizing behaviors. 84% were Caucasian, 5% African-American, 6% Asian, and 5% other. Children

(40% female) ranged from 3 to 5 years in age, with a mean age of 50 months (SD = 8.81). 84% of parents were married, 6% were cohabitating, 5% were divorced, and 5% were single. 10% of families earned less than $3,399 per month, 21% earned between $4,000 to $5,999 per month, 38% earned $6,000 to $9,999 per month, and 31% earned more than $10,000 per month.

Of the participating teachers (all female) 8% had less than three years of experience, 16.7% had 3-5 years of experience, 41.7% had 5-10 years of experience, and the remaining 33.3% had more than 10 years of experience teaching. In regard to teacher education, 8.3% had a high school diploma, 8.3% had a child development associate, 16.6% had an associate's degree, 58% had a bachelor's degree, and 8.3% had a master's degree. 81% of participating teachers were Caucasian, 8.3% American Indian, and 8.3% other. The mean teacher age was 38.3 years (*SD* = 12.4 years).

Procedure

This study collected teacher surveys, observations, and direct assessment data. Before classroom observations, teachers completed a child behavior survey to identify children with high levels of internalizing and externalizing behaviors. Demographic questionnaires were completed by teachers and parents before classroom observations took place. Classroom observations occurred over two typical mornings. One child per classroom was observed with the inCLASS each morning of observation while the whole class was observed using another observational measure not used in this study. Direct assessments of children were scheduled at the child care center, and conducted outside of the classroom.

Measures

Observed child behavior in the classroom

The Individualized Classroom Assessment Scoring System (inCLASS; Downer, Booren, Lima, Luckner, & Pianta, 2009) was used as the observational measure of child inhibitory control. Observers were trained over two days and passed the standard inCLASS reliability test with an 80% or above. Trained observers spent a morning in the classroom observing a target child as s/he interacted with teachers and peers and engaged in tasks. Observation cycles lasted fifteen minutes; ten minutes were spent observing the child, and the final five minutes were used to assign a score to each dimension of the inCLASS. Scores were rated on a 7 point Likert scale (1 = low, 7 = high). These 10 dimensions are Positive Engagement with the Teacher, Teacher Communication, Teacher Conflict, Peer Sociability, Peer Assertiveness, Peer Communication, Peer Conflict, Engagement within Tasks, Self-Reliance, and Behavior Control, which are categorized into four domains of child interactions: Positive Engagement with Teachers, Positive Engagement with Peers, Positive Engagement with Tasks, and Negative Classroom Engagement (Williford et al., 2014). The current study utilizes two dimensions to operationalize inhibitory control: Teacher Conflict and Peer Conflict (or the Negative Classroom Engagement domain). Higher scores indicate that the child struggled to inhibit externalizing behaviors, and thus demonstrated a lack of inhibitory control.

Teacher report of child behavior

To measure teacher report of child inhibitory control, teachers completed a 26-item questionnaire prior to inCLASS observations. Items were adapted for teachers using the Attention Deficit Hyper Activity Rating Scale-IV (ADHD RS-IV; DuPaul, Power, Anastopoulos, & Reid, 1998) and the Oppositional Defiant Disorder Rating Scale (ODDRS; Hommersen, Murray, Ohan, & Johnston, 2006). In a study by McGoey and colleagues (2007), the ADHD RS-IV demonstrated strong internal consistency in preschoolers ($\alpha = 0.86$ to 0.96), and was

moderately correlated with the Conners Rating Scales - Revised (Conners, 1997). Hommersen and colleagues (2006) reported high internal consistency ($\alpha = 0.92$) and demonstrated a strong correlation with the Child Behavior Checklist (Achenbach, 1991). Items on the combined scale utilized in the present study include *fails to give close attention to details or makes careless mistakes in schoolwork, is "on the go" or acts as if "driven by a motor", interrupts or intrudes on others, is angry and resentful,* and *loses tempter*. Behaviors are rated on a 4 point scale ranging from "1 = never or rarely ever" to "4 = very often" based on the child's classroom activity over the past six months.

Direct assessment

The Head-Toes-Knees-Shoulders task (HTKS; Cameron-Ponitz, McClelland, Jewkes, McDonald-Connor, Farris, & Morrison, 2008) was used as the direct assessment of child self-regulation. Test administrators were trained by a certified trainer approved by the authors of the HTKS. After the training, data collectors were certified in all child assessments by a member of the research staff. In the HTKS task, children are instructed to touch the opposite part of their bodies designated by the researcher; for example, if the child is prompted with the command "Touch your toes," the correct response is to touch one's head. Children are provided a series of practice trials in which mistakes are corrected, but no assistance is given during the following 10 scored trials. If a child successfully completes the toes-head segment, a second pair of cues are introduced: shoulders and knees. After a second practice segment, heads, knees, shoulders, and toes prompts are called in an unpredictable order. If the child navigates this successfully, the rules change: knees are paired with head and shoulders are paired with toes. Children are scored via their response to a given cue. If the correct body part is touched, the response is coded as 2. If the child first reaches for an incorrect body part, but then touches the correct one, this self-

correct is coded as 1. If the child touches the incorrect body part, this is coded as 0. Scores are summed to create a total score that ranges between 0 and 60, with previous working showing preschool children average around 24.73 (*SD* = 18.61; McClelland et al., 2014). Participating children must attend to instruction, remember novel rules, and inhibit a dominant response while expressing one that is in line with instructions; in this way, a child must apply attention, working memory, and inhibitory control to complete the task (Cameron-Ponitz et al., 2008). Inter-rater reliability for the HTKS is strong (α = .98; Connor, et al., 2010). The test is also sensitive to age as performance increases steadily with age for all groups, eventually reaching a plateau (Cameron-Ponitz et al., 2008).

Results

At first, the data were examined via a series of histograms to detect skew and outliers. Descriptive statistics were also executed (e.g., standard deviations). Then, correlations were drawn among observed inhibitory control (teacher and peer), direct assessment of inhibitory control, and teacher report of inhibitory control. Finally, these correlations were examined for gender differences.

Descriptive statistics were executed for all variables and are shown in Table 1. Children, on average, did not display high levels of observed conflict in the classroom with teachers or with peers. Additionally, observed child behavior demonstrated positive skew for teacher and peer conflict (Figure 1); children did not score above a 3 on a 7 point scale. Direct assessment of inhibitory control was positively skewed with a range of child responses (Figure 2). Teacher report of child inhibitory control was normally distributed (Figure 3) and represented a range of child behaviors (Table 1).

The three exploratory hypotheses were tested through correlation coefficients (Table 2). The first hypothesis examined if differences in children's inhibitory control varied by the context of measurement. Results supported this hypothesis, as teacher report and observed inhibitory control (with teachers and peers) were positively correlated (r = .64, r = .67, respectively), with a medium effect (Cohen, 1998).

The second hypothesis stated that if differences in the results of these scales are based on bias of the reporter, the correlation between those measures which minimize reporter bias (observations and direct assessment) should correlate strongly with one another, as they are not colored by the relationship a teacher may develop with the child in question. Direct assessment of inhibitory control displayed small, non-significant associations with observed and reported inhibitory control (r -.12 to .05), failing to support the above hypothesis.

The third exploratory hypothesis focused on gender differences in methodologies that may be due to the differences in preferred play styles of boys and girls. Observations and direct assessments of inhibitory control may correlate less strongly for boys as compared to girls, who are more accustomed to the dyadic interaction pattern involved in the direct assessment. This hypothesis was not supported. The pattern of results remained the same across genders, with direct assessment having no significant relationship with teacher report or observations (Table 3). However, teacher report and observations had a slightly stronger correlation for girls as compared to boys.

Discussion

Self-regulation in preschool children is an integral skill for scholastic and social success from the early years (McClelland et al., 2007; Montroy et. al, 2014) through adulthood (McClelland et al., 2013; Vaszonyi & Huang, 2010). One component of self-regulation,

inhibitory control, is uniquely correlated with early school readiness (Blair & Razza, 2007; Montroy, Bowles, Skibbe, & Foster, 2014). Inhibitory control is typically measured by one or more of three methods: teacher report, observation, and direct assessment. In order to understand its development, identify children who need assistance in cultivating this skill, and to avoid spending resources in such interventions unnecessarily, an accurate measure of the construct is required. By comparing the results of these measures, the current study aims to uncover whether reporter bias or contextual bias lead to inconsistencies in the measurement of inhibitory control across methodologies.

The first such comparison explored differences in children's inhibitory control related to context. Due to the unique demands placed on children in the classroom, which are not present during direct assessment, the manifestation of their inhibitory control skills may vary by context. The strong correlations between observed and teacher report of children's inhibitory control in the classroom as opposed to their weaker correlations with direct assessment suggest that the disparities between measures of inhibitory control may be rooted in context. Similarly, Williford and colleagues (2013) found no association between observations and direct assessment. One possible explanation for these non-significant correlations is the dyadic nature of direct assessment. During direct assessment, the child has all of the administrator's attention and is in a quiet environment. Therefore, s/he may be more accountable for her/his behaviors and potentially more focused on the task. Future work may benefit from gathering data outside of the classroom context in addition to direct assessments in order to attain a more complete picture of the child's skills.

The second aim of the study was to explore the role of reporter bias. Results are mixed in that teacher report and classroom behavior showed strong correlations (as discussed above), but

direct assessments were not related to observed classroom behavior or teacher report. This suggests that direct assessments created to reduce bias and administered by study staff may be measuring different aspects of inhibitory control skills, and that this difference may be related to context (as discussed above). Another possible explanation hinges on the impact of the teacher-child relationship on inhibitory control, which was not measured in this study. Close teacher-child relationships correlate with the development of inhibitory control (Dominuez et al., 2011; Ewing & Taylor, 2009; Vandell et al., 2010; Williford et al., 2013) and have even been causally linked with such alterations (Driscoll & Pianta, 2010; Hatfield & Williford, under review). Thus, bias in favor of one child could result in the actual inflation of their skill, at least in the classroom context, thus resulting in the convergence of teacher opinion and direct observation. In this way, teacher perception of child may have manifested in actual change in the child's inhibitory control, causing child behavior to match teacher expectations. This may be particularly true for this study, as data was collected in the late spring. Future studies should compare observations and teacher report before the teacher and child have developed a relationship in order to minimize possible bias.

Although both boys and girls had the same pattern of results, the correlations between teacher report and observations were slightly larger for girls (r = .600 vs. .897; r = .623 vs. .857, respectively), indicating that teachers may have been more accurate reporters of inhibitory control skills in females. Silver (2005) found that girls tend to have a closer relationship with teachers, and perhaps teachers offer them more attention and are thus better reporters of their classroom behaviors. It may also be that girls, who tend to play in dyads (Benenson, Apostoleris, & Parnass, 1997), are more easily tracked by teachers. Boys play in large groups

more often than girls (Benenson et al., 1997), making it more difficult for teachers and trained observers to observe their behavior.

The present study had several limitations. First, sample size was relatively small (n = 22). Furthermore, the sample was drawn from two counties in one region, compromising the generalizability of these findings. For example, research regarding the measurement of child self-regulation has found salient cultural differences (Suchodoletz et al., 2012; Suchodoletz et al., 2013). The results from this current study may not hold outside of the geographical or cultural bounds in which they were found. The present study did not account for child characteristics such as temperament, nor did it control for family income or teacher-child relationship. Finally, children were observed only in child care classrooms. The environment of other contexts, such as the home, may promote different behavioral responses in children. By repeating this study with larger sample sizes, different contexts, and different regions, the possible biases in methods of measuring inhibitory control can be further explored.

In the classroom, children are placed under demands that differ from those typical of the home environment. Given that children's inhibitory control skills outside of the classroom are not related to skills inside of the classroom, the behavior patterns they exert in one context may not fully capture the innate 'capacity' within the child. This suggests that there is the potential for an unruly child to display inhibitory control, given alterations to the context, and that this may be overlooked by relying only on information taken from the classroom context. Future research should examine how the environment can be manipulated to support self-regulation in children that are typically disruptive *in that context,* but who may be capable of a very different behavior set in another.

The assertion that inhibitory control is not merely a capacity, but a *reaction* to external cues, has large implications for teachers' perceptions of children. The teacher-child relationship can influence the development of inhibitory control (Dominuez et al., 2011; Driscoll & Pianta, 2010; Ewing & Taylor, 2009; Hatfield & Williford, under review; Vandell et al., 2010; Williford et al., 2013), and teacher perception of a child's potential to learn can have salient impacts on their academic performance (Rosenthal & Jacobson, 1966). Because teacher interactions can influence the child's development, it is essential to inform them that the behavior they see in the classroom is not necessarily representative of the child as a whole. Given a new context, a child that struggles to inhibit inappropriate behavior in the classroom may display excellent self-regulation. The power of context to influence behavior should be made clear to teachers, parents, and other professionals. Further research in this domain could be utilized to optimize the learning environment to support the expression and development of inhibitory control.

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Tables

Table 1. Descriptive statistics for measures of inhibitory control.

	Mean	**Standard Deviation**	**Range**
Direct Assessment	25.82	13.62	0-57
Observed Teacher Conflict	1.24	0.36	1-2.3
Observed Peer Conflict	1.38	0.44	1-2.5
Teacher Report of Behavior	15.53	20.26	4-49

Table 2. Correlations of measured inhibitory control.

	1.	**2.**	**3.**
1. Direct Assessment	-		
2. Teacher Report	-.06	-	
3. Observed Teacher Conflict	-.12	.64*	-
4. Observed Peer Conflict	.05	.67*	.76*

*$p < .05$

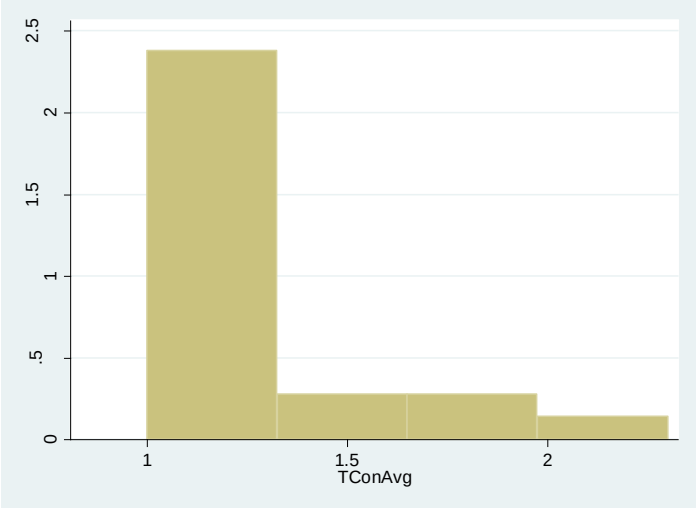
Table 3. Correlations of measured inhibitory control by gender[a]

	1.	**2.**	**3.**	**4.**
1. Direct Assessment	-	.06	.04	-.01
2. Teacher Report	-.24	-	.90*	.86
3. Observed Teacher Conflict	-.21	.60*	-	.73
4. Observed Peer Conflict	.03	.62*	.78*	-

*$p < .05$; [a] Correlations for boys are displayed below diagonal axis, girls above.

Figures

Teacher Conflict



Peer Conflict

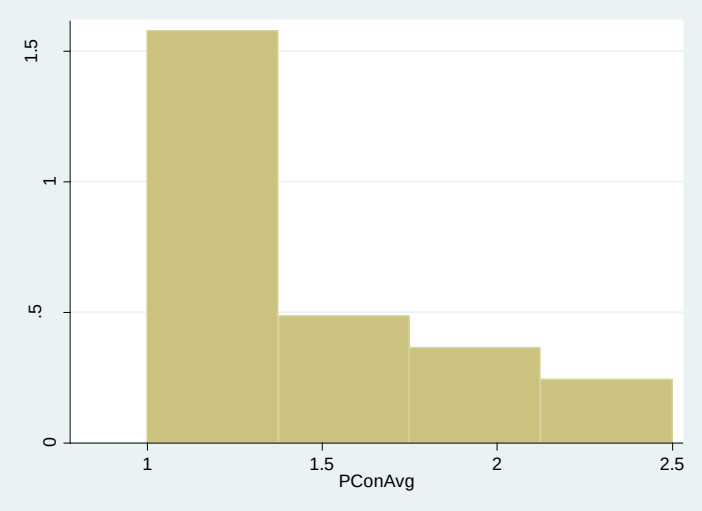


Fig 1. Histograms of observed conflict with teachers and peers.

HTKS

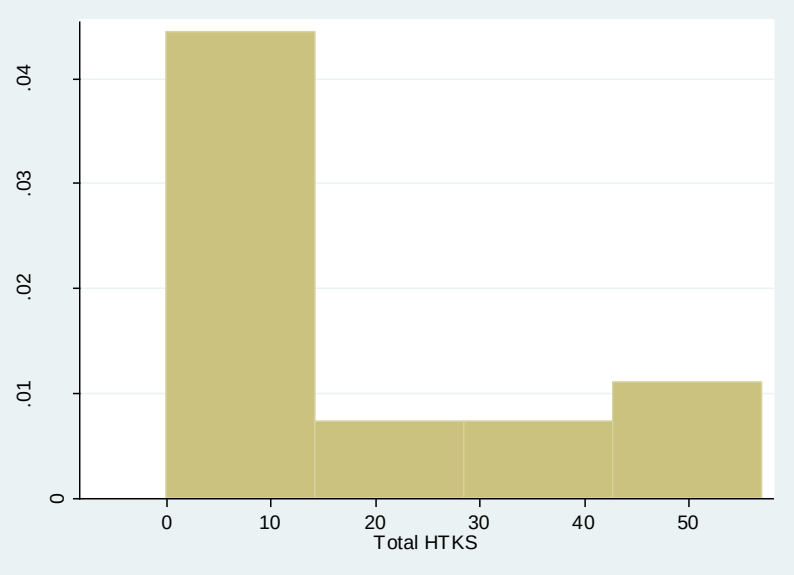


Fig 2. Histogram of direct assessment of child inhibitory control.

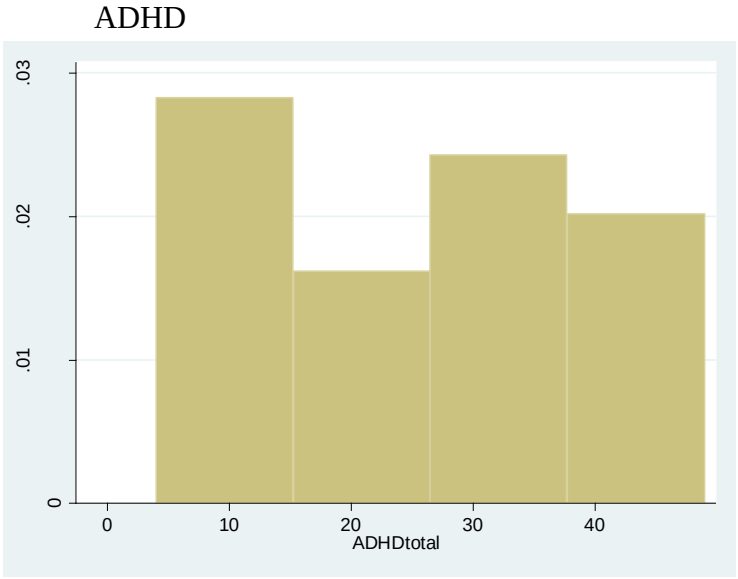


Fig 3. Histogram of teacher report of child inhibitory control.