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# The relationship of age, early motor skills and observable child behaviors in young children with developmental delays

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ABSTRACT

*Background:* Children with disabilities often experience delays in one or more domains of development including motor skill delays. Delays in motor skill development may put children further behind their peers without disabilities in respect to aspects of early learning.
*Aims:* The purpose of this study was to examine how gross motor skills mediated the relationship of age and the observable child behaviors of compliance and adaptive behavior in a group of young children (2–4 years) with developmental disabilities around one time point.
*Methods:* Children with developmental disabilities (N = 113) were assessed on direct measures of motor skills and the child behaviors of compliance and adaptive behavior. Two independent simple mediation analyses were conducted using PROCESS, an ordinary least squares path analysis appropriate for small sample sizes. Results. Age had a positive relationship with gross motor skills ($a = .66$, $p < .001$) when the outcome variable was adaptive behavior and age had a positive relationship with gross motor skills ($a = .66$, $p < .001$) when the outcome variable was compliance.
*Conclusions:* Motor skill development may promote or hinder development in other childhood behaviors such as compliance and adaptive behavior.

## What this paper adds?

Links between motor skill development and other child behaviors associated with early learning have been indicated in empirical research for young children with and without disabilities. This study adds to previous work by examining the mediating effects of motor skills on the relationship of age and the directly observed behaviors of compliance and adaptive behavior in a young group of children with confirmed developmental disabilities. In addition, this study adds to previous work, examining similar constructs, in that all child behaviors were directly observed (motor skills, compliance and adaptive behavior; thus not reported through parent proxy reports) in a relatively large sample of young children with confirmed developmental disabilities (N = 113).

## 1. Introduction

Early childhood is a time of emerging and rapid development (Phillips & Shonkoff, 2000). Noteworthy childhood milestones are typically achieved during this early phase of life and act as building blocks for more advanced skills that develop later in childhood and within multiple domains of development. These milestones might include a child's first smile, rolling over, laughing, language

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skills (e.g., first words), sitting up, pulling from sit-to-stand, cruising and walking, to name a few. These developmental milestones are all a part of early learning, which is critical towards the growth of other broader developmental domains including the social, affective, cognitive, motor and physical domains (Pagani & Messier, 2012). Young children typically progress rapidly and sequentially through motor milestones. This includes skills that usually develop within the first year of life such as raising/ holding the head, rolling over, independently sitting and independently walking (which typically occurs around 12 months of age). In the affective domain, children develop healthy attachments to their primary caregivers, and initiate and respond to various emotions including smiling, laughing as well as expressing appropriate negative emotions (e.g., dislike). Young children also begin to cultivate social skills such as functional, imaginative and reciprocal play skills; attentional skills such as compliance and cooperation; and both non-verbal and verbal communication skills.

The rapid development that occurs within early childhood is critical for healthy development early-on and throughout the lifespan (McClelland, Acock, & Morrison, 2006). Various aspects of early childhood development have been deemed critical for later school success and are referred to as school readiness skills (McClelland & Cameron, 2011; Pagani & Messier, 2012). Multiple developmental constructs have been identified to support school readiness, however proficient social skills, communication skills, self-regulation and executive function have been indicated as critical skills for successful school readiness (Blair & Raver, 2015). As such the child behavior of compliance is an important skill associated with aspects of school readiness. For example, compliance represents a child's ability to follow instructions and/or rules involved in activities and games. In addition, compliance can be indicative of working memory, as the child is expected to remember the instructions and/or rules involved in games or activities. Empirical research suggests that early childhood providers should focus on improving compliance to assist children with their early self-regulation and school readiness skills (Pratt, Lipscomb, & McClelland, 2016). Adaptive behavior has also been recognized as an important child behavior associated with school readiness outcomes (Finlon et al., 2015; MacDonald, McIntyre, Ross, & Tepfer, 2017). Adaptive behavior represents developmentally appropriate behaviors for life circumstances, including social competence and a developmentally appropriate level of independence. How other aspects of development facilitate engaging in school readiness skills has been relatively underexplored, including how motor skills may influence aspects of school readiness. When preschoolers were studied over the course of one preschool year, motor skills predicted aspects of school readiness (MacDonald et al., 2016). In short, better motor skills were predictive of more advanced school readiness skills like higher executive function and better social behaviors. Thus, movement and thereby motor skills are important for young children and motor development has implications for other child behaviors highly linked to school readiness.

Children with developmental disabilities often have delays in some developmental domains of early childhood development, and these delays may occur in all or some developmental domains. For example, children with autism spectrum disorder (ASD), a known developmental disability, typically experience difficulty with social and communication skills. These delays might include non-verbal or verbal responses and initiations, and difficulty sharing enjoyment, making eye contact with others as well as coordinating gestures appropriately (e.g., linking eye contact, gestures and language together) (Lord et al., 2000, 2012). At the same time, children with ASD have known delays in motor skills. This includes weak postural control, difficulty with balance and delays in achieving early motor milestones (Lloyd, MacDonald, & Lord, 2013; May et al., 2016; Provost, Heimerl, & Lopez, 2007; Provost, Lopez, & Heimerl, 2007; Staples & Reid, 2010; Teitelbaum, Teitelbaum, Nye, Fryman, & Maurer, 1998; Vernazza-Martin et al., 2005). Children with attention deficit hyperactivity disorder (ADHD), another developmental disability, have known difficulties with inappropriate attention, impulsiveness and hyperactivity. In addition, about 30–50% of children with ADHD have known deficits in motor skills (Fliers et al., 2008). Children with speech and language disorders typically have delays in some aspects of speech and/ or non-verbal communication and motor difficulties are also common (Hill, 2001; Webster, Majnemer, Platt, & Shevell, 2005). Developmental coordination disorder (DCD), which affects 5–6% of school aged children is specifically defined based on motor coordination and motor skill deficits. By definition children with DCD do not have another disability that explains their motor skill and/or motor coordination difficulties and these motor difficulties can negatively impact other aspects of their quality of life (Zwicker, Suto, & Harris, 2017). However, DCD is typically not diagnosed until children enter school, therefore it is possible that children with motor skill difficulties may ultimately be diagnosed with DCD at a later age. In brief, motor skill delays experienced by young children with developmental disabilities may put children further behind their peers without disabilities with respect to aspects of early learning, which may ultimately result in weaker school readiness skills.

Although it is known that facets of developmental domains work together, such that there are bidirectional developmental processes occurring simultaneously (Libetus & Hauf, 2017; McClelland & Cameron, 2019), it is common for early interventions to be independent from each other in efforts to improve developmental outcomes. For example, an early intervention focused on social behaviors, may specifically target symbolic play (Kasari, Freeman, & Paparella, 2006), while another intervention focused on the same overarching domain (social behaviors) may target reciprocal play skills (Dawson et al., 2010). Other early interventions could be focused on other domains of development; for example, motor skill (Bremer, Balogh, & Lloyd, 2015; Ketcheson, Hauck, & Ulrich, 2016), or speech and language development (Hampton & Kaiser, 2016), may be targeted without simultaneous intervention efforts in other areas of child development (e.g., social, affective, cognitive). How developmental domains work together in aspects of early development to maximize early learning opportunities is relatively unknown.

Studies focused on specific developmental disabilities have indicated strong relationships between better motor skills and other early learning skills. In a sample of young children with ASD (N = 159) between the ages of 12–33 months old (1–2 ½ years), better motor skills were strongly associated with better social communicative skills as indicated through calibrated autism severity scores (MacDonald, Lord, & Ulrich, 2014). The same research group had similar findings when motor and daily living skills of young children with ASD and other developmental disabilities were examined (N = 233) (MacDonald, Lord, & Ulrich, 2013). In short, better motor skills had strong relationships with other child behavior outcomes including daily living, social and communicative skills

(MacDonald et al., 2013). Although strong relationships were indicated, collectively these studies did not tap into underlying mechanisms associated with the potential facilitating role of motor skills and other salient child behaviors associated with school readiness (e.g., executive function, self-regulation, communication and other social behaviors).

A more recent study, focused on young children with developmental disabilities, examined how motor skills mediated relationships between age and the salient child behaviors of socialization, communication and daily living skills in young preschool aged boys (MacDonald et al., 2017). In short better gross motor skills strengthened the relationship between age and socialization, age and communication and age and daily living skills. The authors of this study concluded that content for early intervention needed to include creative learning opportunities and tap into multiple aspects of development including motor skill development. However, in this study the child behavior outcomes of communication, social behavior and daily living skills were based on parent proxy reports (e.g., the Vineland Adaptive Behaviors Scale; Sparrow et al., 2005) and were not directly on observed child behaviors. Although the relationships between better motor skills and other aspects of child development have been studied in young children with developmental disabilities (Kim et al., 2016), relationships with direct measures of both motor skills and directly observable child behaviors have not been readily investigated.

Therefore, the purpose of this study was to examine how gross motor skills mediated the relationship of age and compliance as well as age and adaptive behavior in young children (2–4 years old) with developmental disabilities at one timepoint. More specifically this study aimed to answer the research question "to what extent do early gross motor skills mediate the relationship of age and observed compliance, as well as age and observed adaptive behavior in young children with developmental disabilities at one timepoint"? It was hypothesized that young children's gross motor skills would positively mediate relationships between age and compliance as well as age and adaptive behavior, in young children with developmental disabilities. This study adds to previous work in that all child behaviors were directly observed (motor skills, compliance and adaptive behavior) in a relatively large sample of young children with confirmed developmental delay and/or developmental disability (N = 113).

## 2. Method

### 2.1. Procedures

This study was part of a larger investigation of family-based interventions for caregivers of young children with developmental disabilities (funding source added when manuscript is accepted) and was approved by the institutional review board. The current study was a descriptive cross-sectional study with all primary assessments conducted with children and caregivers in the home environment, at one timepoint.

### 2.2. Participants

Young children (N = 113) were recruited through early intervention programs in the Pacific Northwest region of the United States to participate in the study. Parents/caregivers responded to recruitment flyers that were made available to them through their child's early intervention provider. After obtaining verbal consent, a research assistant screened parents over the telephone to assess whether their child met the following inclusionary criteria: (a) age between 2–3 years (at the time of entrance into the study), (b) documented developmental delay or disability, (c) services received through an Individualized Family Service Plan (IFSP), (d) ambulatory, and (e) living with the primary caregiver for at least 1 year. Exclusion criteria included children who were diagnosed as deaf or blind. For more information please see study XXX.

### 2.3. Measures

#### 2.3.1. Demographic questionnaire

A research assistant administered a questionnaire during an in-home interview. Information on this questionnaire included child age, gender, race/ethnicity, disability status, special education and related service utilization, parent/caregiver age, education, and household income.

#### 2.3.2. Gross motor skills

Research assistants administered the Test of Gross Motor Development-2 (TGMD-2; Ulrich, 2000) to participating children. The TGMD-2 is a valid and reliable assessment of gross motor skills for children and has been used frequently with children with disabilities (e.g., MacDonald et al., 2017; Staples & Reid, 2010). The TGMD-2 assesses essential skills needed in physical education and active play including locomotor skills (running, galloping, hopping, sliding, leaping, and jumping) and object-control skills (overhand throwing, striking, kicking, underhand rolling, dribbling, and catching). The TGMD-2 is not standardized for children younger than 3 years of age and its easy administration and procedural scoring have been deemed reasonable for children within this age range (MacDonald et al., 2017; Pagani & Messier, 2012). In addition, raw scores were used in analyses (see data analysis section).

All research assistants were trained to use the TGMD-2. Training was provided to all research assistants by faculty and graduate students who study adapted physical activity/education. Training to administer the TGMD-2 included specific training on the protocol, practice sessions and consensus coding with practiced TGMD-2 administrators.

*2.3.3. Observed child behaviors*

Observed child behaviors (compliance and adaptive behavior) were coded by trained research assistants during a parent-child interaction task consisting of 10 min of unstructured free play and 5 min of structured activity. The parent and child dyad were provided with common toys, and the parent was instructed to 'play as you normally do" during the 10 min unstructured free play portion. During the final 5 min of play a structured activity took place, 2 min of "clean-up" (cleaning-up the toys from the free play activity) and 3 min of a structured activity (ring-stacking, where the smaller rings were placed on top). The play sessions were video recorded.

*2.3.3.1. Compliance*. Compliance was scored across the entire 15 min of the play session, on a 9-point likert scale where 1 represented "not at all" and 9 represented "very much". Compliance was coded based on answering the following questions: "is the child compliant and cooperative with the parent's directives and requests?", "does the child seem dysregulated and difficult to manage and unable to control his/her behavior or emotions?" (reverse coded) and the research assistant categorized overall compliance based on the duration of the observational session. A higher composite score represented more compliance.

*2.3.3.2. Adaptive behavior*. Adaptive behavior was coded on a 9-point likert scale where 1 represented "not at all" and 9 represented "very much". Research assistants answered questions based on their impressions of the adaptive behavior of the child during the play session. Questions about adaptive behavior were focused on the child's ability to adapt, for example, the child's ability to easily adapt from one activity to another (e.g., cleaning-up after participating in unstructured play, etc). Questions were framed in the negative, thus a lower score represented better adaptive behavior.

The child behaviors of compliance and adaptive behavior were derived from a more comprehensive observation system, which included observations on these child behavior as well as other child behaviors. The inter-rater reliability of the entire observation system was 88%. This was calculated by taking the total number of agreements between raters and dividing by the total number of items on the scale and multiplying by 100 to calculate a percentage.

*2.4. Data analysis*

All analyses were conducted in SPSS version 22. A bivariate correlation analysis was performed on all variables of interest including the independent variable (age), mediating variable (motor skills), outcome variables (compliance and adaptive behaviors) and potential covariates (e.g., SES, gender). Potential covariates were assessed for inclusion using a planned one-way analysis of variance (ANOVA) to test significant effects on the independent, mediating and outcome variables. Two independent simple mediation analyses were conducted using PROCESS, an ordinary least squares path analysis appropriate for small sample sizes (Hayes, 2013). Compared to traditional causal steps mediation analysis, PROCESS accounts for violations of the normality assumption and low power issues due to small samples by use of bootstrapping (Hayes, 2013). The magnitude of the indirect effect of motor skills on child development outcomes was tested using standard 95% confidence intervals with a conventional number (10, 000) of bootstrap samples (Hayes, 2013). In each model age was the predictor variable, motor skills were the mediating variable and an observable child behavior variable was the outcome variable (compliance and adaptive behavior, respectively). In the first model, a simple mediation was used to examine the indirect effect of motor skills on relations between age and adaptive behaviors; a single covariate of ethnicity was applied to the adaptive behavior outcome variable based on ANOVA results. In the second model, compliance was the outcome variable of interest. A simple mediation model was used to examine the indirect effect of motor skills on relations between age and compliance; no covariates were included in this mediation analysis, based on non-significant ANOVA analyses. It should be noted that lower scores were representative of more compliance and better adaptive behavior, thus negative correlations and effects were expected. To assist in understanding the effect of each mediation, a proportion of the total effect that was mediated was calculated $[ab/(c'+ab)]$ and translated into percentage ($[ab/(c'+ab)]$*100).

## 3. Results

Descriptive demographic information about the participants (N = 113) can be found in Table 1, descriptive information about mediating and outcome variables can be found in Table 2. A bivariate correlation analysis revealed expected significant correlations between predictor (age), mediating (motor skills) and outcome variables (compliance and adaptive behavior). All correlations were interpreted using absolute criterion developed by Zhu (2012), see Table 3. All potential covariates were tested using a one-way ANOVA (dependent variables in ANOVAs included both mediating and outcome variables used in the mediation analysis). The only significant covariate was ethnicity, which had a significant relationship with adaptive behavior ($F(108) = 3.5$, $p = 0.01$). Thus ethnicity was treated as a single covariate acting on the outcome ($Y_k$) in the adaptive behavior mediation analysis.

To examine the extent to which age influenced motor skills and in turn facilitated observed child behavior outcomes of adaptive behavior and compliance two independent mediation analyses were conducted using PROCESS in SPSS (version 22). Represented in model 1 (see Table 4) age had positive relations with gross motor skills ($a = 0.66$, $p < 0.001$), when the outcome variable was adaptive behavior. Similarly, age had positive relations with gross motor skills ($a = 0.66$, $p < 0.001$), when the outcome variable was compliance (see model 2 in Table 4). Among children demonstrating equivalent motor skills (similar to holding motor skills constant and independent of age) statistically significant differences were observed in adaptive behavior ($b = -0.021$, $p = 0.014$) and compliance ($b = -0.023$, $p = 0.020$). A bias-corrected 95% bootstrap confidence interval supports a small indirect effect in which age is influencing motor skills, which in turn facilitated better adaptive behaviors ($ab = -0.014$, *95%CI* [(−0.029) –

**Table 1**
Descriptive characteristics of the sample (n = 113).

| Variable | N (%) |
|---|---|
| Gender | |
| Male | 84 (74.3) |
| Female | 29 (25.7) |
| Age (*months*) | M = 45.3, SD = 10.0 |
| Disability (*per parental report*) | |
| Developmental delay | 9 (8) |
| Speech/ language delay | 59(52.2) |
| Autism spectrum disorder | 16 (14.2) |
| Other | 22 (19.5) |
| Unknown | 1 (0.9) |
| Missing | 6 (5.3) |
| Ethnicity | |
| White/ Caucasian | 74 (65.5) |
| Hispanic/ Latino | 6 (5.3) |
| Asian | 2 (1.8) |
| Bi/ multi-racial | 30 (26.5) |
| Other | 1 (0.9) |
| Household Income | |
| < $4, 999 | 1 (.9) |
| $5, 000- 9, 999 | 10 (8.8) |
| $10, 000- 14, 999 | 18 (15.9) |
| $15, 000- 19, 999 | 8 (7.1) |
| $20, 000- 24, 999 | 5 (4.4) |
| $25, 000- 29, 999 | 8 (7.1) |
| $30, 000- 39, 999 | 15 (13.3) |
| $40, 000- 49, 999 | 14 (12.4) |
| $50, 000- 59, 999 | 8 (7.1) |
| $60, 000- 69, 999 | 6 (5.3) |
| $70, 000- 79, 999 | 8 (7.1) |
| $80, 000- 89, 999 | 6 (5.3) |
| $90, 000 + | 6 (5.3) |

**Table 2**
Mean score and range for outcome and mediating variables.

| Variable | N | M (SD) | Range of scores for observed behaviors |
|---|---|---|---|
| Motor skills | | | |
| Locomotor raw | 113 | 21.7 (12.9) | 0–77 |
| Object control raw | 113 | 10.7 (2.8) | 1–16 |
| Child behaviors | | | |
| Compliance | 113 | 3.0(1.5) | 1.3–7 |
| Adaptive | 113 | 2.3(1.3) | 1–6.3 |

**Table 3**
Correlation matrix for primary outcomes, mediating, predicator and potential covariate variables.

| Variable | 1. | 2. | 3. | 4. | 5. | 6. | 7. |
|---|---|---|---|---|---|---|---|
| 1. Compliance | – | | | | | | |
| 2. Adaptive behaviors | .82*** | – | | | | | |
| 3. Motor skills | −.31† | −.34† | – | | | | |
| 4. Age (months) | −.26† | −.39† | .45** | – | | | |
| 5. Annual income. | −.07 | −.13 | .09 | .09 | – | | |
| 6. Ethnicity | .15 | −.19 | .12 | .05 | −.21† | – | |
| 7. Gender | −02 | −.08 | .14 | .11 | .12 | .10 | – |

*Moderate correlation.
† Low correlation.
** Moderately high correlation.
*** High correlation (interpretation based on Zhu, 2012).

(−0.006)]) and better compliance (*ab* = −0.015, *95%CI* [(−0.036)- (−0.004)]). The proportion of the total effect was translated in percentage; the proportion of the effect that was mediated was 26.4% in model 1 (adaptive behavior) and 40.5% in model 2 (compliance).

**Table 4**
Results from two independent simple mediation analyses (model 1–2) for the effect of age (X) on child development domains: adaptive behaviors (Y1), compliance (Y2) through motor skill competency (M). N = 113.

| | Outcome | | | | | |
|---|---|---|---|---|---|---|
| **Model 1** | **M** (Total Motor) | | | **Y1** (Adaptive) | | |
| Predictor | *Coeff.* | *Std. Error* | *P [95% CI]* | *Coeff.* | *Std. Error* | *P [95% CI]* |
| X (Age) | *a* .664 | .127 | < .000*** | *c'* -.039 | .012 | .002 |
| M (Total Motor) | — | — | — | *b* -.021 | .008 | .014 |
| C (Ethnicity) | — | — | — | *g* .100 | .036 | .007 |
| Constant | $i_1$ 2.273 | 5.876 | .700 | $i_2$ 4.407 | .522 | .000*** |
| **Indirect Effect** | ***ab* -.014** | **.006** | **[-.0293 to -.0053]** | **Proportion Mediation (%) = 26.4** | | |
| | $R^2$ = 0.199 | | | $R^2$ = 0.238 | | |
| | F (1, 111) = 27.54, $p$ < .000*** | | | F (3, 109) = 11.39, $p$ = .000 | | |
| **Model 2** | **M** (Total Motor) | | | **Y2** (Compliance) | | |
| X (Age) | *a* .664 | .127 | < .000*** | *c'* -.022 | .015 | .126 |
| M (Total Motor) | — | — | — | *b* -.023 | .010 | .020* |
| Constant | $i_2$ 2.273 | 5.876 | .700 | $i_3$ 4.752 | .607 | .000 |
| **Indirect Effect** | ***ab* -.015** | **.008** | **[−.036 to −.004]** | **Proportion mediation (%) = 40.5** | | |
| | $R^2$ = .446 | | | $R^2$ = .3356 | | |
| | F (1, 111) = 27.54, $p$ < .000 | | | F (2, 110) = 6.98, $p$ = .001 | | |

*Note*: Results for indirect effect (ab), Preacher & Kelley (2011) kappa ($k^2$) and associated std. error and bias-corrected confidence intervals (95%CI) based on 10,000 bootstrap sample; *p < 0.05, **p < 0.01, ***p < 0.001 two tailed.

## 4. Discussion

The results of this study support the facilitating role of gross motor skills in the relationship of chronological age and observed compliance and observed adaptive behavior in young children with developmental disabilities, at one timepoint. It is well known that children with developmental disabilities are at risk for delays in childhood development (especially in early childhood), and that delays may be present in one or more domains. Yet, how various developmental domains work together has had less attention in empirical research. From a school readiness perspective, motor skill and physical development have been indicated as components of school readiness (e.g., health and motor skill development), but less attention has been given to these aspects of development compared to others (e.g., socio-emotional development, motivation to learn, language and early literacy skills and conception knowledge and application). In one recent study, the strength of the relationship between motor skills and other constructs of school readiness were stronger in children with disabilities, and the authors suggested amplified benefits of motor skill development for children with disabilities (Houwen, Visser, van der Putten, & Vlaskamp, 2016). For example, better motor skills may provide opportunities for functional play (e.g., climbing on the jungle gym), and these functional play opportunities may allow for social behaviors and communication skills to be practiced alongside peers (e.g., showing a peer a climbing task on the jungle gym). In addition, motor skills are used in the act of gesturing, an act used in communication. Thus, better motor skills for young children with disabilities may help to compensate for delays in some of these other areas, while simultaneously allowing practice time (e.g., playing alongside a peer in the school yard, and unknowingly practicing reciprocal aspects of communication). Furthermore, previous work indicates that motor skills are malleable (Goodway & Branta, 2003; Goodway, Crowe, & Ward, 2003). Thus, functional motor skills and be taught, practiced and reinforced in everyday childhood activities.

Early childhood is a key developmental period to work on improving known delays, and ultimately work toward closing the developmental gap between children with developmental disabilities and their peers without disabilities. Early intervention contributes efforts towards improving known delays. In the past two decades, substantial effort in early childhood research has focused on national priorities with an underlying theme of school readiness (Panel, 1995). In the US, kindergarten is the entry point for children to enter formal education, where children begin the formal process of academic learning. Prior to entering the education system, children need to develop a skillset that prepares them for school. Domains within school readiness initiatives include 1) physical well-being and motor development, 2) social and emotional development, 3) approaches to learning, 4) language development and 5) cognition and general knowledge (Panel, 1995). Although all five domains have been indicated to be important within school readiness initiatives research has primarily focused on all aforementioned domains, except for physical well-being and motor development. Yet, the results of this study suggest that better motor skills may influence the relationship between age and the observed child behavior outcomes of compliance (social and emotional development) and adaptive behavior (cognition and general knowledge) in young children with developmental disabilities.

Common salient child behaviors like compliance and adaptive behavior improve with age, thus a chronological developmental sequence occurs, typically with substantial gains in early childhood. The results of this study suggest that motor skills influence the relationship of age and compliance and the relationship of age and adaptive behavior. Thus early learning interventions related to social and emotional development (e.g., compliance), cognition and general knowledge (e.g., adaptive behavior), could also benefit from including specific developmental content focused on motor skill development (from the physical well-being and motor development domain).

Children with developmental delays have known deficits early on, especially in school readiness skills. The importance of play to

engage and hone-in on early learning skills has been identified as a critical way to engage young children in developmental outcomes. Motor skill development has functional play implications, thus better motor skills may promote other child developmental outcomes, while poorer motor skills may hinder these outcomes. The results of this study suggest developmental domains are interactive and thus improvements in one domain, like motor skill development, may ultimately have positive implications for other developmental domains, including better school readiness skills.

Finally, this study is not without limitations. For example, it is possible that participants who were more compliant during free play were also more compliant participating in the motor skill assessment. This study was a cross-sectional descriptive study, thus no longitudinal or causal relationships can be established.

## 5. Conclusion

The results of this study indicate that motor skills influence the relationship between age and compliance and the relationship of age and adaptive behavior in young children with developmental disabilities, at one time point. In the field of adapted physical activity, there have been successful interventions when teaching motor skills to young children with disabilities (Bremer et al., 2015; Ketcheson et al., 2016). Thus including motor skill development as a part of early learning initiatives, especially for young children with developmental disabilities, may positively impact positively motor skill development and other important child behaviors.

## Author note

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