The influence of the family environment on adaptive functioning in the classroom: A longitudinal study of children with developmental disabilities

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ARTICLE INFO

ABSTRACT

Background: No study has examined trajectories of school-based adaptive functioning (AF) for children with developmental disabilities (DD). This is a critical gap in the literature, since AF is context dependent, and high levels of AF at school facilitate meaningful participation at school.
Aims: This study examined trajectories of school-based AF for 170 children with DD from age 3 to 15 years, and indicators of the early childhood home and family environment as predictors of these trajectories.
Methods: Multilevel modeling was used to explore trajectories of school-based AF and identify early childhood home and family predictors of these trajectories.
Results: Children's school-based AF raw scores increased over time. There was significant variability in initial status and rate of change of AF. As hypothesized, higher quality mother-child interaction predicted more positive functioning.
Conclusions: Findings indicate the influence of the early childhood home and family environment on school-based AF over time.

What this paper adds

This study is the first to explore trajectories of school-based AF of children with DD. It is important to understand these trajectories because AF in the classroom affects children's abilities to participate meaningfully in classroom activities and benefit from opportunities for cognitive, academic, and social/emotional development. This study also investigates relationships between experiences at home and with family members during early childhood and AF in the classroom, where task demands undoubtedly differ from the demands within the home and family context. The identification of significant early childhood family environment predictors of school-based AF has implications for policies related to early intervention services.

1. Introduction

The level of a person's functioning within an environment influences the extent to which that person is able to engage in stimulating interactions that promote development (Bronfenbrenner & Morris, 2006). Adaptive functioning (AF), defined as "the behavioral skills that people typically exhibit when dealing with the environmental demands they confront", is especially important

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(Widaman & McGrew, 1996, p. 97). AF includes communication, socialization, and daily living abilities, and it underlies the ability to participate in many significant life activities. It is especially relevant for children with developmental disabilities (DD), which are a group of disabilities that are usually lifelong and impact development in physical, learning, language, or behavioral domains.

A body of research has investigated AF within the home, and has identified predictors of positive development in this domain, including family cohesion, maternal education, and maternal directiveness (Dieterich, Hebert, Landry, Swank, & Smith, 2004; Fenning & Baker, 2012; Hauser-Cram et al., 1999). Longitudinal research on home-based AF indicates that children with DD generally display growth in this domain; this has been demonstrated in children with Down syndrome, autism spectrum disorder (ASD), and motor impairment (Baghdadli et al., 2012; Hauser-Cram et al., 2001). Research on AF in the home also indicates that different disability groups display different typical patterns for growth; for example, children with Down syndrome (when compared to children with other DD) display pronounced growth in socialization trajectories (Hauser-Cram et al., 2001).

Importantly, research on AF within the school is scarce. Extant cross-sectional research has identified discrepancies between parent and teacher report of AF (Voelker, Douglas, Hakim-Larson, & Bruner, 1997), indicating that functioning differs across home and school. Another cross-sectional study explored differences between children in inclusive versus segregated educational settings, and found that the two groups were similar in their social competence, an outcome under the umbrella of AF (Hardiman, Guerin, & Fitzsimons, 2009). Longitudinal investigations are lacking, although one study tracked 14 students with DD over the course of one school year and observed gains in AF during this time period (McDonnell et al., 2003). The overall lack of research pertaining to school-based AF is a gap in the literature, since positive functioning in the classroom environment is a prerequisite for meaningful participation in school.

Studies with typically developing children indicate that interactions that transpire at home during early childhood relate to school-based outcomes, including academic achievement and social-emotional functioning in the classroom (Aram & Aviram, 2009; Baker & Iruka, 2013). From a theoretical perspective the home is important due to the centrality of early relationships with care-givers. For example, attachment theory posits that young children with sensitive and responsive mothers acquire confidence to explore their immediate world and engage socially with others (Bowlby, 1969). This exploration and social engagement contributes to the achievement of developmental outcomes throughout the life span (Bowlby, 1969). Importantly, for children with DD, very few studies explicitly address the hypothesis derived from contextual theories that processes observed in one context result in developmental outcomes manifested in another.

There is empirical support, however, for the relationship between the early childhood family environment, including quality of interaction between parents and children, and children's AF *as displayed at home* (Dieterich et al., 2004; Hauser-Cram et al., 1999). Parents directly teach skills related to AF, such as how to bathe, prepare food, and follow directions. Also, the *quality* of parent-child interactions during episodes of teaching likely influences the effectiveness of these episodes. For example, young children are especially motivated to please and imitate parents when the parent-child relationship is characterized by warmth and responsiveness (Grusec, Goodnow, & Kuczynski, 2000).

Each study that has linked characteristics of the home and family during early childhood to AF measured AF via parent-report (Dieterich et al., 2004; Fenning & Baker, 2012; Hauser-Cram et al., 1999). As such, these measures of AF likely reflect functioning in the context most familiar to the parent: the home. More research is needed to identify predictors of school-based AF, since the school environment contains context-specific levels of support and demands. For example, the school environment contains professionals specifically trained to provide disability supports and accommodations. On the other hand, professionals lack parents' in depth knowledge about their children's strengths and difficulties, and the support that professionals provide is impacted accordingly.

The hypotheses for the current study of children with DD are as follows. First, classroom-based AF (raw scores) will increase over time. This reflects the premise that with the provision of appropriate support, children will continuously gain skills. Second, in light of observed variability in studies that have examined AF in the home, there will be significant variability in average levels of school-based AF and in rates of change. Third, indicators of the early childhood home and family environment will predict variability in AF (raw scores), such that children with higher quality home and family environments will display higher levels of school-based AF over time. Support for the third hypothesis will extend the body of work that has identified relationships between the home and family environment and AF as displayed at home.

2. Methods

2.1. Participants

This study utilizes data from the Early Intervention Collaborative Study (EICS), a longitudinal investigation of children with DD and their families (Hauser-Cram et al., 2001). EICS was initiated in 1985 in order to explore the adaptation of children with DD and their families over time. Families enrolled in EICS when they originally signed up to receive Early Intervention Services in 29 publicly funded programs in Massachusetts and New Hampshire. This original sample consisted of 190 children and families. All children had early diagnosed DD, including Down syndrome (N = 54), motor impairment (N = 77), or DD of unknown etiology (N = 59). Diagnosis of Down syndrome was confirmed via review of medical records. Children with motor impairment displayed delayed or abnormal motor development and either abnormal muscle tone or a coordination deficit.

The current sample includes 170 children. Each of these children received school-based services pertaining to their disabilities (an IEP or a 504 plan) at one or more of the time points at which AF was measured in the classroom (at ages 3, 5, 8, 10, and 15). Children who did not receive school-based services pertaining to their disability were excluded from the study. Table 1 displays a summary of child and family characteristics. Approximately half of the 170 children are of each gender (54.7% male), and approximately one

Table 1
Family and Child Demographic Characteristics at T3 (N = 170).

	%	Mean (SD)
Child		
Type of disability		
Down syndrome	30.6%	
Motor impairment	39.4%	
Developmental delay of unknown etiology	30.0%	
Gender		
Male	54.7%	
Racial/ethnic origin		
European American	91.5%	
African American	1.4%	
Hispanic	4.2%	
Mixed race/other	2.8%	
Family		
Income (1989-1991)		
Less than 20 K	25.6%	
Between 20 K and 30 K	23.3%	
Between 30 K and 40K	19.7%	
More than 40K	31.3%	
Mother		
Education (years)		13.85 (2.42)
Father		
Education (years)		13.99 (3.02)

third are in each of the three disability categories (30.6% Down syndrome, 39.4% motor impairment, and 30.0% other DD). The majority of the children are of Euro-American descent (91.5%). At age 3, the children's mean cognitive performance score was measured via the Stanford Binet Intelligence Scales (Thorndike, Hagen, & Sattler, 1986) and was equal to 60.34 (SD = 23.05). This is more than two standard deviations below the population mean for the measure (M = 100; SD = 15). When the families initially enrolled in the study, mothers and fathers had respectively completed an average of 13.85 and 13.99 years in school (SD = 2.42 for mothers, 3.02 for fathers). In 1990, the median income in the United States was equal to $29,943 (United States Census Bureau, 2012), and 51% of families in this sample reported incomes higher than $30,000 when the children were 3 years old (data collected between 1989 and 1991).

2.2. Procedure

Data pertaining to the early childhood home and family environment were collected at home visits by trained research assistants. Home visits occurred within six months of the children's first, second, and third birthdays. Research assistants were trained in order to achieve reliability of 85% or more on all study measures. The assistants were blind to the hypotheses of the study. Home visits included multidimensional structured assessments of the children and of the mother-child dyads. Mothers and fathers also responded to interview questions and completed several self-administered questionnaires. Home visits were approximately two to three hours in duration, and parents received compensation.

Data pertaining to the school were collected when the children were ages 3, 5, 8, 10, and 15. School-based data included self-administered questionnaires, which were completed by the teachers. The University of Massachusetts Medical School Institutional Review Board (IRB) approved the procedure for the data that were collected at ages 3 and 5. The Brandeis University IRB approved the procedures for data collected at age 8, and the Boston College IRB approved the procedure for ages 10 and 15.

2.3. Measures

2.3.1. Early childhood home and family context
2.3.1.1. Child and family demographic information. At the time of enrollment in EICS, families provided demographic information including the gender of the child with a disability and the type of disability diagnosis (Down syndrome, motor impairment, DD of unknown etiology). Gender and type of disability are included in equations predicting school-based AF as covariates. Gender was coded as follows: 1 = male, 0 = female. Type of disability was coded such that Down syndrome comprises the reference group. This is due to research findings suggesting that children with Down syndrome have unique characteristics related to AF (Dykens, Hodapp, & Evans, 2006).

2.3.1.2. Family socioeconomic status. During home visits when the children with DD were 3 years old, mothers provided socioeconomic information about the family, including family income and maternal years of education. Family income and maternal years of education were recoded into z-scores, and a composite variable was formed by summing the two z-scores. This

composite variable represents the socioeconomic status of the family, an indicator of the early childhood home environment, and is included as a predictor of AF.

2.3.1.3. Child evocative effects in the home. During home visits when the children with DD were 3-years-old, mothers and fathers each completed the Parenting Stress Index (PSI) (Abidin, 1995). The PSI was designed for the "early identification of stressful parent-child systems" (Abidin, 1995, p. 1). It yields a score of total stress, as well as two subscales, one for stress in the child domain and one for stress in the parent domain. The following three child domain subscales are particularly relevant to child evocative effects, and are utilized in this study: child adaptability, demandingness, and mood. For most of the items on each of these subscales, parents indicated the extent to which they agreed with the item. Options ranged from 1 (strongly agree) to 5 (strongly disagree). A few items utilize five-point Likert scales with unique response options (i.e., 1 = almost always, 5 = almost never).

Total scores were calculated for both mothers and fathers. For each parent, the total scores represent the sum of the adaptability, demandingness, and mood subscales, with higher sores indicating more parental difficulty related to these characteristics of their child's evocative effects. For mothers and fathers, Cronbach's alpha for the total scores are 0.87 and 0.86, respectively. Mothers' and fathers' total scores are highly correlated ($r = 0.56$, $p < 0.01$). Each of the two total scores were recoded into z-scores, and a composite variable was formed by summing the two z-scores. This composite score therefore represents the child's evocative effects on multiple family members: the mother and the father. Higher values of the composite indicate more stressful child evocative effects, and thereby account for the impact of the child on the early childhood home and family context.

2.3.1.4. Mother-child interaction. During home visits when the children with DD were 3- years- old, mothers and their children completed the Nursing Child Assessment Teaching Scale (NCAST) (Barnard, 1978). Mothers taught their children how to play with a toy that was moderately challenging for the child. Toys were selected for individual children in order to provide moderate difficulty levels. Trained research assistants observed the interactions and coded for the presence or absence of 50 behaviors that mothers might exhibit (1 = yes, 0 = no). The 50 maternal behaviors comprise the following four subscales: sensitivity to cues, response to distress, social-emotional growth fostering, and cognitive growth fostering.

In this study, the mother's total score is included as a predictor of classroom-based AF ($\alpha = 0.82$). The NCAST has demonstrated good internal reliability and test-retest reliability scores of 0.85 (Sumner & Spietz, 1994).

2.3.2. Classroom characteristics and dynamics
2.3.2.1. Classroom placement type. Classroom characteristics and dynamics are included as covariates because children's levels of AF are dependent on the environments in which they are displayed. As such, classroom placement type, inclusive versus substantially separate, is included as a covariate. At the first four time points that included a measurement of classroom-based AF (ages 3, 5, 8, and 10), teachers completed a questionnaire on which they indicated the proportion of children in the class with IEPs. This reflects the extent to which the child spent time alongside typically developing peers, versus attending a segregated educational context. This is an important characteristic of the classroom context to address, because it likely relates to factors including extent of support available to the child, teachers' extent of expertise regarding disability, and the skill levels of classmates to whom the teacher is likely to compare the focal child. Each of these factors might influence teacher-report of AF.

The age 15 classroom characteristic variable is unique because at this age, children do not spend their entire day with the same group of peers. At age 15, mothers completed a questionnaire that asked them to select the best description of their child's school day, with options reflecting a continuum of substantially separate to inclusive.

Each of these variables (percentage of children in the class with IEPs at ages 3, 5, 8, 10 and description of children's school day at age 15) were coded to reflect whether or not the focal child was in a substantially separate setting. If more than 70% of the class had IEPs (at ages 3, 5, 8, and 10), this was considered substantially separate. At age 15, responses from the mothers that were considered inclusive were as follows: one to two hours of special education with the remainder of time in general education; general education with support; general education without support. Other responses were more restrictive and were considered substantially separate. Data were coded 1 for substantially separate and 0 for not substantially separate. At each time point, more than 50% of the participants were in substantially separate placements.

2.3.2.2. Child evocative effects in the classroom. Children's evocative effects impact the quality of their relationships with their teachers (Eisenhower, Blacher, & Bush, 2015). The quality of these relationships may influence teachers' ratings of children's AF, and therefore classroom evocative effects are included as a control.

At ages 3 and 5, teachers completed the Kohn Problem Checklist (Kohn, 1988). The Kohn problem checklist consists of 49 items; for each item teachers indicated whether the item described a behavior that was not at all typical, somewhat typical, or very typical (not at all typical = 0; somewhat typical = 1; very typical = 2). The 49 items are divided into two factors: the apathy-withdrawal factor (25 items) and the anger-defiance factor (24 items). The anger-defiance factor is used in the current study. For the current sample, at age 3 Cronbach's alpha on this factor is equal to 0.84. At age 5, Cronbach's alpha is equal to 0.91.

The Kohn Problem Checklist was designed for preschool and kindergarten children only (Kohn, 1988). At ages 8, 10, and 15, teachers completed the Teacher Version of the Child Behavior Checklist (Achenbach & Edelbrock, 1983). To complete this measure, teachers responded to 112 items describing children's behaviors. For each item, they indicated whether it was not true, somewhat or sometimes true, or very true or often true (0 = not true, 1 = somewhat or sometimes true, 2 = very true or often true). The externalizing scale, consisting of the inattentive, nervous-overactive, and aggressive subscales, represents the measure of classroom evocative effects at ages 8, 10, and 15. Cronbach's alpha for the current sample (on the externalizing scale) is equal to 0.95 at age

Table 2

List of Measures.

Construct	Measure	Reporter	Time Points	Cronbach's Alpha
Mother educational attainment	Demographic questionnaire	Mother	3	n/a
Family income	Demographic questionnaire	Mother	3	n/a
Child gender	Demographic questionnaire	Mother	3	n/a
Child type of disability	Demographic questionnaire	Mother	1	n/a
Child evocative effects	Parenting Stress Index (Abidin, 1995)	Mother and father	3	0.86 (father) – 0.87 (mother)
Mother-child interaction	Nursing Child Assessment Teaching Scale (Barnard, 1978)	n/a	3	0.82
Classroom placement type	Teacher questionnaire	Teacher	3, 5, 8, 10	n/a
Construct	Measure	Reporter	Time Points	Cronbach's Alpha
Classroom placement type	Mother interview	Mother	15	n/a
Classroom externalizing behaviors	Kohn Problem Checklist (Kohn, 1988)	Teacher	3,5	0.84-0.91
Classroom externalizing behaviors	Child Behavior Checklist – Teacher Version (Achenbach & Edelbrock, 1983)	Teacher	8, 10, 15	0.93- > 0.99
Child adaptive functioning	Vineland Adaptive Behavior Scales-Classroom Edition (Sparrow et al., 1985)	Teacher	3, 5, 8, 10, 15	≥0.99

8, > 0.99 at age 10, and 0.93 at age 15.

Scores from the anger-defiance factor of the Kohn Problem Checklist and the externalizing subscale of the Teacher Version of the Child Behavior Checklist were converted into z-scores. The z-scores are used as covariates in models predicting school-based adaptive-functioning.

2.3.3. Adaptive functioning

The dependent measure consists of the total score from the daily living, communication, and socialization domains, of the Vineland Adaptive Behavior Scales – Classroom Edition (VABS – CE, Sparrow, Balla, & Cicchetti, 1985). At ages 3, 5, 8, 10, and 15, teachers responded to 244 items in the self-administered VABS-CE questionnaire by indicating whether the child was able to complete a task never, sometimes, or usually (never = 0, sometimes = 1, usually = 2). For the total score of AF, alphas for each time point are 0.99 or higher. The decision to use the *raw* total score aligns with other studies that have investigated AF in children with DD (Gabriels, Ivers, Hill, Agnew, & McNeill, 2007).

Total scores were used as the outcome instead of scores from each domain because the domains of AF are highly correlated with each other, both within and across time points. For example, at the age 3 time point, socialization scores are highly correlated with communication scores ($r = 0.80$, $p < 0.01$) and daily living scores ($r = 0.81$, $p < 0.01$). Also at age 3, daily living scores and communication scores are highly correlated ($r = 0.80$, $p < 0.01$). These substantial relationships between AF domains at each time point persist over time; at age 15, correlation coefficients between AF domains are highly significant and equal to or greater than 0.91. Table 2 contains a list of all measures included in the study.

2.4. Analytic approach

2.4.1. Missing data

Prior to conducting analyses, five data sets were imputed and results were pooled (Widaman, 2006). Imputation was conducted using SPSS version 22.

2.4.2. Main analyses

Hierarchical linear modeling (HLM) was conducted using SPSS version 22 in order to test the hypotheses of this study. HLM is an appropriate methodology because it does not require independence of cases, which is appropriate when multiple observations are from the same participant (Hox, 2010). In this study, multiple measurements of school-based AF are nested within individuals. Level-2 covariates and predictors do not vary over time and include child's gender, child's type of disability, family socioeconomic status during early childhood, child evocative effects at home, and mother-child interaction. The covariates representing classroom characteristics and dynamics (specifically, classroom evocative effects and the variable indicating whether the child was in an inclusive or substantially separate setting) vary over time, since children were in different classrooms at different time points. Therefore, these variables are included as level-1 covariates.

The following continuous predictors and covariates are centered around their means: the composite variable representing socioeconomic status, the measure of classroom evocative effects at each time point, the composite variable representing mothers' and fathers' ratings of children's evocative effects, and the score representing the quality of mother-child interaction.

An unconditional growth model was used to test hypotheses 1 and 2: raw scores of AF increase over time and show significant variability in initial status and rates of change. The unconditional growth model includes child age (a time varying predictor, because it was measured at multiple time points) as the only predictor of school-based AF. Age is centered at 36 months, because 36 months is the age of the first measurement of classroom-based AF, and so the intercept becomes the average level of AF at the initial AF measurement. Age is entered as a linear term in order to test the hypothesis that raw scores increase over time. Age is also entered as a

Table 3
Descriptive Statistics.

	Mean	Standard Deviation	Range
Mother-child interaction	37.61	6.07	15–49
Child evocative effects (home)			
Adaptability (mother report)	26.00	6.31	12–44
Demandingness (mother report)	21.07	5.68	9–37
Mood (mother report)	9.73	3.08	5–18
Adaptability (father report)	27.63	6.09	13–43
Demandingness (father report)	21.35	5.50	10–26
Mood (father report)	10.20	2.78	5–19
Child evocative effects (school)			
Age 3	49.61	8.67	41–85
Age 5	51.16	10.49	41–100
Age 8	56.37	9.29	39–80
Age 10	55.78	9.48	39–78
Age 15	57.46	9.20	42–81
Adaptive functioning			
Age 3	68.33	41.37	0–203
Age 5	125.73	68.03	0–320
Age 8	186.60	97.92	2–381
Age 10	222.60	117.74	2–416
Age 15	270.64	115.10	16–428

squared term, in order to account for the possibility that growth slows or stops (Van Duijn, Dijkxhoorn, Scholte, & van Berckelaer-Onnes, 2010).

To test hypothesis 3, that early childhood home and family environment predicts variability in initial status and rates of change, covariates and indicators of the early childhood home and family environment were added as predictors.

3. Theory and calculation

This study fills extant gaps in the literature through the exploration of trajectories of school-based AF over time. It is important to understand these trajectories because AF in the classroom affects children's abilities to participate meaningfully in classroom activities and benefit from opportunities for cognitive, academic, and social/emotional development. This development will be important for achievement of long-term outcomes, including employment and independent living. This study also investigates relationships between experiences at home during early childhood and later AF in the classroom, where task demands undoubtedly differ from the demands within the home and family context. Moreover, the identification of significant early childhood family environment predictors of school-based AF has implications for early intervention service design.

4. Results

4.1. Preliminary analyses

Table 3 displays descriptive statistics. From Table 3, total AF raw scores increase between ages 3 and 15, providing preliminary support for hypothesis 1.

Table 4 displays bivariate correlations between the covariates and predictors, and AF total scores at each time point. From Table 4, quality of mother-child interaction is consistently associated with AF across time points, such that higher levels of mother-child interaction is associated with higher levels of AF. There are no significant relationships between family socioeconomic status and AF. Child evocative effects at home is not significantly correlated with AF during early childhood, but there are modest correlations with adolescent AF. Finally, there are several significant correlations between disability diagnosis and AF at individual time points. Diagnosis of Down syndrome is associated with lower levels of AF at multiple time points, while diagnosis of developmental delay of unknown etiology is associated with higher levels of AF. Table 5 shows bivariate correlations between covariates and predictors.

4.2. Primary analyses

4.2.1. Unconditional model

Results from the unconditional model are displayed in Table 6. The estimate representing the intercept was equal to 69.45 and was statistically significantly different than zero ($p < 0.01$). The value of this estimate (69.45) represents the average total score of AF for the sample at age 3.

The coefficient representing age was positive and statistically significantly different than zero ($\beta = 2.40$, $p < 0.01$), indicating

Table 4

Correlations Between Predictors, Covariates, and Adaptive Functioning Total Scores.

	Adaptive Functioning				
	Age 3	Age 5	Age 8	Age 10	Age 15
Predictors					
Child evocative effects	−0.13	−0.10	< 0.01	−0.06	−0.15*
Mother-child interaction	0.18*	0.22**	0.18*	0.10	0.20**
Family SES	−0.06	−0.10	−0.14	−0.13	−0.07
Covariates					
Child gender	−0.10	−0.02	−0.06	−0.05	−0.04
Down Syndrome	−0.20**	−0.23**	−0.24**	−0.21**	< 0.01
Motor Impairment	−0.06	< 0.01	0.02	< 0.01	−0.09
Other developmental delay	0.27**	0.23**	0.21**	0.20**	0.09
Classroom evocative effects					
Age 3	−0.26**	−0.11	−0.10	−0.04	−0.04
Age 5	−0.16*	−0.25**	−0.20**	−0.15*	−0.13
Age 8	−0.18*	−0.09	−0.19*	−0.16*	−0.05
Age 10	−0.19*	−0.18*	−0.28**	−0.25**	−0.14
Age 15	−0.08	−0.13	−0.16	−0.16	−0.13
Classroom placement type					
Age 3	−0.21*	−0.19	−0.18*	−0.15*	−0.21**
Age 5	−0.18	−0.27**	−0.21**	−0.23**	−0.26**
Age 8	−0.29**	−0.34**	−0.38**	−0.37**	−0.32**
Age 10	−0.30**	−0.38**	−0.38**	−0.43**	−0.36**
Age 15	−0.32**	−0.41**	−0.41**	−0.40**	−0.43**

Note. *p < 0.05, **p < 0.01. For child's gender, 1 = male, 0 = female. For each disability category, 1 = diagnosis within that category, 0 = other diagnosis. For classroom placement type, 1 = substantially separate setting, 0 = inclusive setting.

support for hypothesis 1, that AF scores increase over time. The squared age term was negative and statistically significantly different than zero (β = -0.007, *p* < 0.01), indicating a slight decline in rate of growth over time. Finally, the significance of the covariance parameters indicated support for hypothesis 2, that there is variability between children with regard to initial status and rate of change in total scores of AF. The value of σ_0^2 represents variability in initial status; it was equal to 1517.91 and was statistically significantly different than zero (*p* < 0.01). The value of σ_1^2 represents variability in rate of change. It was equal to 0.22 and was also statistically significantly different than zero (*p* < 0.01).

4.2.2. Model with covariates and predictors

First, disability categories were entered into the model, and Fig. 1 shows trajectories of growth for each disability diagnosis. From Fig. 1, each group showed consistent growth across time.

Then, additional covariates and predictors were added. Model 2 in Table 6 shows results from the initial iteration of the model including all covariates and predictors. In this model, gender, child evocative effects, and family socioeconomic status were non-significant predictors of the intercept and therefore they were excluded in the subsequent model. Each of these variables were also tested as predictors of rate of change, and they remained nonsignificant.

Model 3 in Table 6 displays results from the final model. The value of the intercept was equal to 68.17. Taking into account each of the other variables in the model, this value represents the average total AF score at age 3 for children with Down syndrome, in inclusive placements, with mean levels of classroom evocative effects, and mean levels of mother-child interaction quality. The coefficient associated with the linear age term was positive and significant (β = 1.76, *p* < 0.01), indicating that total AF scores for children with Down syndrome were estimated to increase by 1.76 units per year. The coefficient associated with the squared age term was not significant (*p* > 0.05).

The following covariates were significant predictors of the intercept: diagnosis of developmental delay of unknown etiology (β = 29.52, *p* < 0.01), classroom placement type (β = -17.82, *p* < 0.01), and classroom evocative effects (β = -8.31, *p* < 0.01). The positive coefficient associated with developmental delay of unknown etiology indicates that on average, children with this diagnosis had age 3 total AF scores that were 29.52 units higher than the average score of children with Down syndrome. Children in substantially separate settings had age 3 AF scores that were on average 17.82 units lower than the scores of children in inclusive settings. For each unit higher that a child scored on the measure of classroom evocative effects, that child's age 3 total AF score was predicted to decrease by 8.31 units.

With regard to hypothesis 3, mother-child interaction was positively and significantly associated with AF. For each unit increase in the measure of mother-child interaction quality, children's age 3 total AF scores were predicted to increase by 1.37 units.

In contrast, mother-child interaction was not a significant predictor of growth in AF. Predictors of the linear slope included diagnosis of motor impairment and diagnosis of developmental delay of unknown etiology (β = 0.72 and 0.87 respectively, *p* < 0.01 for each). The positive values of these coefficients indicate that children in each of these disability categories demonstrated more rapid growth than children with Down syndrome. There were also significant interactions between the squared age term and each of

Table 5
Correlations Between Predictors and Covariates.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Demographic information																	
1. Child's gender	–	-.16**	.07*	.09*	-.06	-.04	-.02	< 0.01	.07	.02	< .01	-.06	.15	.22**	.02	.01	-.04
2. Diagnosis of Down syndrome	-.16**	–	N/A	N/A	.22**	-.09	-.03	-.03	.07	.10	-.06	.11	.16*	.26**	.12	-.23**	.06
3. Diagnosis of motor impairment	.07*	N/A	–	N/A	-.10**	-.05	-.07	.05	.04	< 0.01	.07	-.11	-.11	-.08	-.03	.14**	-.05
4. Diagnosis of other DD	.09*	N/A	N/A	–	-.11**	.14	.10	-.02	-.11	-.10	-.02	< 0.01	-.05	-.18**	-.09	.08*	-.01
5. Family socioeconomic status	-.06	.22**	-.10**	-.11**	–	-.06	.05	.05	.14	.14	-.10	-.05	< 0.01	.14	-.09	-.07	.23**
Classroom placement																	
6. Age 3	-.04	-.09	-.05	.14	-.06	–	.33**	.16	.13	.13	< 0.01	.09	< 0.01	< 0.01	.04	.13	-.11
7. Age 5	-.02	-.03	-.07	.10	.05	.33**	–	.18	.15	.10	-.04	-.01	-.02	.06	,12	.13	-.04
8. Age 8	< 0.01	-.03	.05	-.02	.05	.16	.18	–	.48**	.17**	.15	.14	.03	.13	.15	.05	-.18*
9. Age 10	.07	.07	.04	-.11	.14	.13	.15	.48**	–	.26**	.22	.14	.11	.26**	.04	-.02	-.15
10. Age 15	.02	.10	< 0.01	-.10	.14	.13	.10	.17**	.26**	–	.04	.07	.04	.16	.10	.05	-.14
Classroom evocative effects																	
11. Age 3	< .01	-.06	.07	-.02	-.10	< 0.01	-.04	.15	.22	.04	–	.43**	.23**	.18*	.12	.07	-.33**
12. Age 5	-.06	.11	-.11	< 0.01	-.05	.09	-.01	.14	.14	.07	.43**	–	.18*	.27**	.24**	.02	-.24**
13. Age 8	.15	.16*	-.11	-.05	< 0.01	< 0.01	-.02	.03	.11	.04	.23**	.18*	–	.48**	.11	.05	-.19*
14. Age 10	.22**	.26**	-.08	-.18*	.14	< 0.01	.06	.13	.26**	.16	.18*	.27**	.48**	–	.27**	.08	-.14
15. Age 15	.02	.12	-.03	-.09	-.09	.04	.12	.15	.04	.10	.12	.24**	.11	.27**	–	.08	-.05
Early childhood home and family environment indicators																	
16. Child evocative effects	.01	-.23**	.14**	.08*	-.07	.13	.13	.05	-.02	.05	.07	.02	.05	.08	.08	–	-.11**
17. Mother-child interaction	-.04	.06	-.05	-.01	.23**	-.11	-.04	-.18*	-.15	-.14	-.33**	-.24**	-.19*	-.14	-.05	-.11**	–

Note. *p < 0.05, **p < 0.01. For child's gender, 1 = male, 0 = female. For the 3 disability categories, 1 = diagnosis within that category, 0 = other diagnosis. For classroom placement type, 1 = substantially separate setting, 0 = inclusive setting.

Table 6
Multilevel Models Predicting Total Scores of Adaptive Functioning.

	Model 1 (unconditional model)		Model 2		Model 3	
	Estimate	Standard error	Estimate	Standard error	Estimate	Standard error
Fixed effects						
Intercept	69.45**	3.91	67.54**	8.29	68.17**	7.52
Age	2.40**	0.10	1.76**	0.17	1.76**	0.17
Age^2	−0.007**	< 0.01	−0.002	< 0.01	−0.002	< 0.01
Predictors of the intercept						
Diagnosis of DD			28.86**	10.20	29.52**	9.98
Diagnosis of MI			10.59	9.67	10.38	9.40
Substantially separate setting			−17.64**	4.32	−17.82**	4.33
Classroom evocative effects			−8.24**	2.02	−8.31**	2.03
Mother-child interaction			1.52*	0.62	1.37**	0.60
Family socioeconomic status			−4.05	2.55		
Home evocative effects			−3.63	2.63		
Predictors of the slope						
DD*Age interaction			0.87**	0.24	0.87**	0.24
DD* Age^2 interaction			−0.007**	< 0.01	−0.007**	< 0.01
MI*Age interaction			0.73**	0.22	0.72**	0.22
MI* Age^2 interaction			−0.006**	< 0.01	−0.006**	< 0.01
Covariance parameters						
Residual (σ_e^2)	1514.89**	94.70	1317.01**	81.53	1316.64**	81.61
Variability in initial status (σ_0^2)	1517.91**	249.28	1489.92**	230.49	1545.42**	236.70
Variability in slope (σ_1^2)	0.22**	0.04	0.26**	0.04	0.26**	0.04
Fit Statistics						
−2 Log Likelihood	9530.42		9286.45		9290.32	
AIC	9544.42		9322.45		9320.32	
BIC	9577.96		9408.28		9391.85	

Note. *p < 0.05, **p < 0.01. Child externalizing behaviors and placement in a substantially separate setting are level-1 predictors; all other predictors are level-2. DD = developmental delay of unknown etiology; MI = motor impairment.
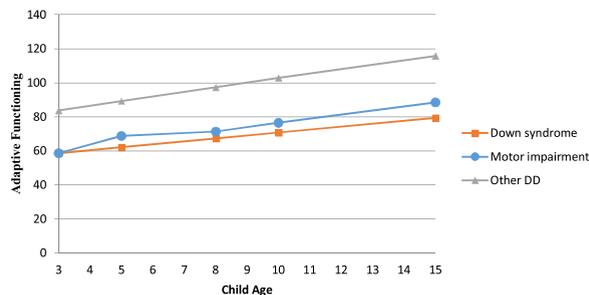

Fig. 1. Trajectories of Growth.

the following: diagnosis of developmental delay of unknown etiology and diagnosis of motor impairment (β = - 0.007 for developmental delay of unknown etiology, β = -0.006 for motor impairment, *p* < 0.01 for each). The fact that these coefficients were negative indicate that compared to children with Down syndrome, children in each of these disability categories exhibited a more pronounced decline in their rates of growth.

5. Discussion

Results from this study depict growth in school-based AF for children with DD between the ages of 3 and 15. Results also identified variability between children in initial levels of school-based AF as well as rates of change. Finally, the early childhood home and family environment, specifically quality of mother-child interaction, emerged as predictive of school-based AF trajectories.

This study is the first study to examine trajectories of school-based AF for children with DD. As such, it provides much needed information about the timing and extent of growth in this domain. This study also builds on literature that indicates the salient and enduring effects of the early childhood home environment for typically developing children (e.g., Bowlby, 1969; Bronfenbrenner & Morris, 2006) and children with DD (Hauser-Cram et al., 2001). Finally, this study is one of few studies of children with DD that has explored whether the influence of these effects extends into the school setting (Baker, Fenning, Crnic, Baker, & Blacher, 2007). It is the only study that has explored the influence of the early childhood home and family environment on trajectories of school-based AF

for children with DD.

Results from this study provide clear support for hypothesis 1, that there are increases in raw scores of classroom AF. In the unconditional model, the coefficient associated with the linear age term was positive and significant ($\beta = 2.40$). Since the unit of time in these analyses is the year, each year children's AF raw scores are predicted to increase by the value of this coefficient. An increase of 1.0 on the measure of AF corresponds with the occasional demonstration of a novel task, and an increase of 2.0 corresponds with consistent demonstration. Tasks included in the measure have impactful implications for everyday functioning, such as "follows school rules". Therefore, the observed rate of change signifies meaningful growth.

This general pattern of growth (i.e., the finding that growth occurs over time) is consistent with research that has examined trajectories of AF for children with Down syndrome, ASD, motor impairment, and developmental delay of unknown etiology (Baghdadli et al., 2012; Hauser-Cram et al., 2001; Van Duijn et al., 2010). For example, Van Duijn et al. (2010) compared adaptive skills of children with Down syndrome between the ages of 0 and 12, and compared their skills to skills of children without Down syndrome. They found that growth occurred more slowly for children with Down syndrome, but the sequence of skill acquisition was similar across the two groups, thus indicating the presence of growth. Previous research, however, has concentrated on trajectories of AF as displayed in the home (Baghdadli et al., 2012; Hauser-Cram et al., 2001; Van Duijn et al., 2010). The results of this study provide novel empirical support for longitudinal growth in school-based AF.

The results also support hypothesis 2, that there is variability between children in initial levels of school-based AF and in rates of change. This is consistent with the body of work that has examined AF as assessed via parent-report (Anderson, Oti, Lord, & Welch, 2009; Baghdadli et al., 2012; Dieterich et al., 2004; Fenning & Baker, 2012; Hauser-Cram et al., 2001). This body of work on home-based AF has focused on identifying predictors of this variability, including family characteristics and child characteristics, such as health status (Baghdadli et al., 2012; Hauser-Cram et al., 2001). This is the first study to identify this variability in school-based AF. With this observed variability, it will be important to identify predictors of positive development, so that relevant predictors may become intervention targets.

Results from this study point to the quality of mother-child interaction as an especially salient predictor of school-based AF. Children who have mother-child interaction scores one standard deviation above the sample mean, compared to children with mother-child interaction scores one standard deviation below the sample mean, have AF scores that are 16.64 points higher. This translates to the consistent demonstration of 8 novel tasks as specified on the measure of AF, each of which impacts children's abilities to function and participate in the school environment. The observed relevance of mother-child interaction may be due to that fact that through children's early relationships with caregivers, children develop perceptions of self and others. They carry these perceptions through place and time, across home and school, and their subsequent experiences and interactions are affected accordingly. Also, children with warm and supportive maternal relationships may be relatively likely to persist in challenging situations, regardless of whether these challenges occur at home or at school, since they likely have confidence in their ability to ultimately succeed.

Finally, while classroom evocative effects were included as a covariate and not a predictor, they emerged as a salient indicator of children's AF. Children who displayed more negative evocative effects in the classroom were rated by their teachers as having lower levels of AF. Behavior problems were the proxy for evocative effects, and it is likely that classroom-based behavior problems interfere with opportunities to build classroom-based AF skills.

5.1. Practical significance and implications

Findings related to the enduring effects of the early childhood home and family environment have significant policy and program implications for children with DD. According to federal law, children with DD from birth to age 3 are eligible to receive early intervention services (United States Department of Education, 2014). These services are available in every state and seek to enhance children's development through a family-centered service delivery system, with possible services including training and / or the provision of support for parents. Therefore, results from this study lend empirical support to the recommendation that supporting mothers to effectively interact with their young children should be a priority within the constellation of EI services.

5.2. Limitations and directions for future research

In light of the salience of mother-child interaction, one limitation of this study is the inability to identify specific elements of mother-child interaction that positively contribute to the development of school-based AF. The measure of mother-child interaction used in the current study consists of the sum of scores from four subscales: sensitivity to cues, response to distress, social-emotional growth fostering, and cognitive growth fostering (Barnard, 1978). It is possible that each of these characteristics (sensitivity to cues, response to distress, social-emotional growth fostering, and cognitive growth fostering) provide a unique contribution to children's AF capabilities. It is also possible that certain characteristics are especially important for AF in general or for specific domains of AF in particular. Social-emotional growth fostering, for example, might be particularly relevant for growth in the socialization domain, which encompasses skills that include "controls anger or hurt feelings when denied own way." Future research is needed in order to develop the interventions that will be most effective at enhancing mother-child interaction so that it facilitates growth in school-based AF.

Finally, the inability to generalize findings to other samples is an important limitation of this study. As described, most of the participants were middle class and of Euro-American descent. While this is representative of the population receiving EI in Massachusetts and New Hampshire at the time of study enrollment, the current sample represents a relatively homogenous one. It is

important to acknowledge that patterns of mother-child interaction vary across cultures (Moscardino, Bertelli, & Altoe, 2011) and their influences on child development vary accordingly.

6. Conclusions

This study depcits school-based trajectories of AF for children with DD. Also, this study identifies early childhood home and family predictors of school-based AF for these children. As such, it indicates elements of the early childhood home and family that should be targeted through the early intervention service system in order to enhance AF outside of the home, in the classroom setting.

Acknowledgments

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