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ORIGINAL PAPER

Individual and Environmental Determinants of Engagement in Autism

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Abstract Engagement is a core component of effective educational programs for children with autism. Analysis of 711 naturalistic goal-directed classroom behaviors of four school-age children with autism and four comparable children with Down syndrome (DS) was conducted. The definition of engagement was expanded to include child compliance and congruence. A main finding was both child and environmental factors influenced type of engagement. Children with DS produced 20% more goal-directed behaviors that were both congruent and compliant compared to children with autism. Large group instruction was associated with less congruent engagement but more compliant engagement for children with autism. These findings suggest specific types of engagement which may lead to advances in developing evidence-based practices for specific developmental disorders.

Keywords Autism · Down syndrome · Engagement · Naturalistic observation · Classroom behavior · Instructional setting

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Introduction

Identifying effective educational practices is a priority for the Department of Education (Odom et al., 2005). Research on predictors of educational outcomes identifies student engagement as a primary component in understanding the relationships between student and teacher behaviors and academic and developmental success. For many years, educational researchers have studied engagement, and their efforts have resulted in the identification of complex and indirect interactions between student and teacher behaviors and outcomes (DiPerna, Volpe, & Elliott, 2002; Greenwood, Horton, & Utley, 2002).

Over the last 30 years, child engagement research has identified specific environmental influences such as physical and social environments and types of instructional strategies (Doke & Risley, 1972; Hall, McClannahan & Krantz, 1995; Jones, 1988; Krantz & Risley, 1977; Macduff 1995; MacDuff, Krantz, & McClannahan, 1993; Massey & Wheeler, 2000; McWilliam, Trivette, & Dunst, 1985; Montes & Risley, 1975; Raspa, McWilliam, & Ridley, 2001; Sarokoff, Taylor, & Poulson, 2001; Warren & Kaiser, 1986). For autism in particular, most researchers have evaluated the effects of instructional strategies and contexts on engagement and have documented increased academic and task engagement with use of specialized techniques or methods such as photographic activity schedules (Hall et al., 1995; Krantz, MacDuff, & McClannahan, 1993; Macduff, 1995; MacDuff et al., 1993; Massey & Wheeler, 2000), self-monitoring (Shearer, 1996), cooperative group learning (Dugan, Kamps, Leonard, & Watkins, 1995; Kamps, Leonard, Potucek, & Garrison-Harrell, 1995), and choral

responding (Kamps, Dugan, Leonard, & Daoust, 1994). Researchers have also evaluated social and language strategies and have shown that social stimulation (Lewy & Dawson, 1992), peer-directed pivotal response training (Pierce & Schreibman, 1995), peer tutoring (Kamps, Dugan, Potucek, & Collins, 1999), peer imitation (Garfinkle & Schwartz, 2002), script fading (Sarokoff et al., 2001), and choice-making (Carter, 2001) increase social and language engagement. A clear link between environmental variables and child engagement in autism has been established.

Engagement has also been identified as an essential ingredient in programs for young children with autism (National Research Council (NRC), 2001). The NRC (2001) stipulated that a minimum of 25 h a week of active engaged time is necessary for children with autism. Researchers clarify, however, that it is important to distinguish the number of hours of *engaged* time from the number of hours of intervention (McGee, Morrier, & Daly, 1999). Because it is necessary to differentiate engaged time from unengaged time, it is essential to have a clear, measurable, and objective definition of engagement that is also meaningful for outcomes. Such a definition has promise to facilitate the development and evaluation of programs for young children with autism and other developmental disorders and identify external as well as internal factors influencing engagement that may lead to advances in developing evidence-based practices.

Various definitions of engagement are described in the literature. The NRC (2001) vaguely defines engagement as ''sustained attention to an activity or person'' (p. 160). Other definitions are more specific and vary according to the developmental level or age of the children under consideration. For older children, engagement has been defined globally as behaviors related to academic responding (writing, reading aloud, reading silently, asking questions, answering questions) and behaviors related to task management (attending, raising hand, looking for materials) (Greenwood, 1991). Using these definitions, researchers have found students with low incidence disabilities were engaged more than 75% of the time in academic responding and task management behaviors (McDonnell, Thorson, McQuivey, & Kiefer-O'Donnell, 1997).

Others recognize still that child engagement is composed of multiple dimensions, including qualitative features that expand the construct of engagement from a state (what children are doing) to a trait (how they are doing). Merely measuring the amount of time a child spends in an activity may fail to capture important behaviors for learning argues McWilliam and colleagues (de Kruif & McWilliam, 1999). They have conducted a number of studies on child engagement and have specifically expanded the definition from a state to a trait construct in developmental terms as ''the amount of time children spend interacting appropriately with the environment at different levels of competence'' (McWilliam & Bailey, 1992, p. 234). They also advanced the concept of engagement from a dichotomous variable (amount of time engaged vs. amount of time unengaged) to a qualitative construct and include the focus and level of engagement (e.g., pretend play, attention, persistence, participation, and undifferentiated behavior). Also included is the child's motivation for mastery by examining the extent of goal-directed behavior. They believe that mastery motivation, as a form of engagement, is essential for understanding what leads to learning (McWilliam & Bailey, 1992). In summary, engagement appears to be a stable construct that relates to internal child factors (temperament or diagnosis), observable child behaviors (level of play skill), and environmental factors (type of classroom activity) (de Kruif & McWilliam, 1999; McWilliam & Bailey, 1995; McWilliam et al., 1985).

The core elements of McWilliam's definition of engagement concerns the ''what'' and ''how'' of child behavior. An important component for children with autism is the ''why'' of behavior. Researchers who have analyzed the intentions or functions of behavior from the child's viewpoint have identified key behaviors that are distinct in autism and helpful for making differential diagnoses and identifying intervention targets (Wetherby, Prizant, & Schuler, 2000). Mundy and Sheinkopf (1998), for example, analyzed children's intentions and revealed pronounced differences in specific nonverbal social communication behaviors such as joint attention. Wetherby (1986) and Prizant and others (Prizant & Duchan, 1981; Prizant & Rydell, 1984) found that stereotyped utterances from children with autism, such as echolalia, had functional meaning in purpose (such as requesting, protesting, affirming, declaring, calling, rehearsing, and self-regulating) when behavior was examined from the child's viewpoint. They also identified distinct patterns of communicative strengths (such as regulating others' behaviors) and weaknesses (such as communicating for social reasons) by analyzing children's communicative intentions. Based on the specific patterns of weaknesses identified, these studies have led to specific interventions designed to increase the quality of early social and communication skills (Prizant, Wetherby, & Rydell, 2000).

Because engagement is a critical component in effective programs, it is surprising that there are many gaps in the literature on this construct, the foremost being a lack of a clear operational definition as offered

by the NRC (2001). Second, researchers on the multivariate relationships of child engagement have not conducted studies on the effects of internal child factors such as diagnoses (i.e., autism) on engagement. Given the extent of the significant core social, communication, and play impairments, the degree to which previous research applies to children with autism is unknown and research does suggest that internal child factors play a role (Travis, Sigman, & Ruskin, 2001). Identifying differences based on diagnosis can lead to better understanding of the behavioral manifestations and the identification of evidence-based practices for improving engagement and educational outcomes across children with specific developmental disorders. Also, there appears to be disagreement on whether engagement is a trait or state construct. Previous work suggests engagement as a trait; however, there is much evidence on the influence of instructional strategies on the engagement of children with autism. Examining the construct of engagement as a product of specific environmental influences (Wolery, 2000; Wolery & Garfinkle, 2002) that interact with internal child factors may provide unique contributions to the literature on specific behaviors and instructional strategies critical for positive outcomes (Ruble & Dalrymple, 1996, 2002).

The purpose of this article is to expand the definition of engagement by incorporating two types of engagement that have been used in treatment outcomes research. These are also representative of behaviors important for educational researchers. The first type is referred to as compliant engagement and is best associated with traditional behavior therapy characterized by Lovaas (1981). Compliant engagement measures the quality of the child's naturalistic goal-directed behaviors in response to teacher behavior. If the teacher or assistant made an attempt to change the child's goal-directed activity and the child did not adjust his behavior, the child's behavior was coded as noncompliant using a dichotomous coding scheme. To be compliant, the child had to be involved in an activity willingly and without resistance. An example is a child sitting at his desk and writing in his notebook. Noncompliance may look like a child sitting at his desk and dropping his pencil repeatedly despite directions from the teacher to complete his worksheet.

The second type of engagement measured was congruent engagement, which examined the degree to which the child's goal-directed behavior was consistent with that of the goals of his classmates. Congruent engagement is most closely aligned with developmental approaches (e.g., Prizant et al., 2000) because it focuses on the creation of interactions of shared meaning and occurs when both the child and interactive partner have the same intentions. A dichotomous coding scheme was also used to measure congruence. If classmates, for example, were working on a math worksheet and the child was also working on math (the same worksheet or an adapted/modified math activity) the child's goal-directed behavior was congruent. If, on the other hand, the child was doodling his name over and over in a notebook, while classmates were focusing on math, the child was coded as incongruent. Also, in this case, if the teacher made no attempt to change the child's goal-directed behavior (by redirection, repeating instructions, correction), the child was also compliant. Thus, compliant engagement and congruent engagement are mutually exclusive categories that occur independently in the goal-directed behaviors of children.

Although no experimental comparative treatment studies of traditional behavioral approaches and developmental approaches have been conducted, reports indicate that about 50% of children make significant gains (Dawson & Osterling, 1997). It is unclear, however, why some children with autism benefit from specialized approaches and others do not (Kasari, 2002). Efforts in identifying the sources of variability in outcomes (Wolery, 2000) are necessary and may include evaluation of qualitative aspects of child engagement such as compliance and congruence.

A naturalistic observation method with roots in ecological psychology (Barker, 1963; Barker & Wright, 1955/1971) was selected as the systematic approach for understanding engagement of children's naturalistic goal-directed behaviors. The methods used in ecological research involve the recording of the stream of behavior, dividing the stream into units, and analyzing the units (Wright & Barker, 1967). Home-based observations using these methods provided new information on the characterization of social behaviors (Ruble, 2001) and executive functions in autism (Ruble & Scott, 2002). This report is the first to examine the classroom engagement of children with autism and Down syndrome (DS) using methods of ecological psychology.

The following questions were asked in this preliminary descriptive study: (a) how many naturalistic goal-directed behaviors did children with autism and children with DS produce?, (b) what type of engagement was observed during the goal-directed behaviors of the children?, (c) how did the type of engagement compare for both groups?, and (d) how did type of engagement vary within the instructional context for both groups? No directional hypotheses were proposed due to the exploratory nature of the study.

Methods

Participants

Children with autism and children with DS were recruited from local public school programs. Directors of Special Education Programs were contacted and asked to identify teachers of students with moderate to severe disabilities, including autism and DS. Information describing the study and letters of consent were sent to the teachers who forwarded letters to parents. Parents interested in participating in the study contacted the researchers directly. Parents of four boys with autism and four boys with DS agreed to participate and have their children observed at school. Their teachers also agreed to participate. Both groups of children had comparable chronological ages and adaptive behavior standard scores (see Table 1). The boys had various educational placements, from full time special education to full time inclusion as noted in Table 1. Professionals not connected to this study had previously identified the boys with autism and the boys with DS. The boys with autism met the DSM-IV diagnostic criteria (American Psychiatric Association, 1994) and were receiving services at school under the eligibility category of autism. Cognitive functioning was determined by record review of previous psychological assessments. The mean cognitive level of the children with DS was 38 and of the children with autism was 47. One child with DS and two with autism did not have intelligent quotients and were described in the psychological assessments as ''untestable.'' (Table 2)

Collecting Behavioral Records

Observers were trained in the methods of data collection of narrative records called chronologs (Scott, 1980) using an established training protocol (Bowman, 1980). Adequate chronolog records provide (a) an acceptable level of behavioral descriptions at the molar level, (b) an acceptable level of low inference descriptions, and (c) a time-line reference. The rules for recording behavior are described in Appendix A and were adapted from Wright and Barker (1967). An advantage of these data collection methods is that the observation protocol was based on tape recordings of behaviors rather than videotape recordings. Issues of following the student from room to room and protecting confidentiality of other students are minimized in this approach.

Setting, Observations, and Apparatus

Teachers were asked to identify a 2 h continuous block of time comprised of both unstructured (i.e., free or independent time) and structured activities (e.g., academic instruction, seatwork). Prior to data collection, two practice observations were conducted during this designated time in order to facilitate teacher and student adaptation to the observer's presence and the equipment. Adaptation occurred when the teachers and students acclimated to the presence of the observer. Specific behavioral observations based on the criteria established by Scott (1980) were used to evaluate adaptation. During adaptation, the observer followed the child, spoke into the stenomask and recorded behavior (Schoggen, 1964). A stenomask is a device that covers the lower half of the face, allowing for the quiet and confidential recording of the observer's comments. The stenomask was attached to a portable tape recorder that had a switch, and allowed the recorder to be turned on and off unobtrusively. A stopwatch was used to record time notations. When the people in the environment are adapted, they tune out

Table 1 Comparison of participant characteristics

Student	Age (years)	VABS composite	Communication	Socialization	Daily living	# AUs	Classroom type
Autism							
Matthew	10.7	34	40	52	19	66	General Ed, fourth grade
Bill	10.1	21	21	32	19	76	Special Ed
Brian	6.2	32	37	49	19	110	Kindergarten
Freddie	8.6	43	44	45	52	107	Kindergarten
Mean (SD)	8.9 (2.0)	32.5 (9.0)	35.5 (10.1)	44.5 (8.8)	27.3 (16.5)	89.8 (22.1)	
Down syndrome							
Brandon	9.1	31	33	49	19	142	Special Ed
Alex	9.9	42	42	42	52	64	General Ed, fourth grade, and special Ed
Michael	9.8	42	32	56	50	76	Special Ed, third grade
Trey	6.8	56	56	73	55	70	General Ed, first grade
Mean (SD)	8.9 (1.4)	42.8 (10.2)	40.8 (11.1)	55.0 (13.3)	44.0 (16.8)	88.0 (36.3)	

Table 2 Percent and number of type of engagement by diagnosis and instructional grouping

Engagement type	Diagnosis	Instructional grouping				Total N
		Large group % (N)	Small group % (N)	1:1 Adult % (N)	Independent work % (N)	
Not compliant and not congruent	Autism	22.6 (44)	0	35.3 (6)	6.7 (4)	54
	DS	25.1 (45)	0	9.2 (7)	14.8 (8)	60
Compliant and not congruent	Autism	45.4 (99)	0	11.8 (2)	46.7 (28)	129
	DS	25.7 (46)	0	22.4 (17)	31.5 (17)	80
Not compliant and congruent	Autism	1.4 (3)	6.7 (1)	5.9 (1)	1.7 (1)	6
	DS	12.8 (23)	0	5.3 (4)	1.9 (1)	28
Compliant and congruent	Autism	32.3 (70)	93.3 (14)	47.1 (8)	45 (27)	119
	DS	36 (64)	100 (10)	63.2 (48)	50.9 (27)	149
Total N		394	93	113	25	

the observer. When the children walk away, they stop looking at the observer. Observers see more behaviors, a wider range of behaviors, and more uneven behaviors when adaptation occurs (e.g., head scratching, yawning). If someone looks at the observer, the observer is trained to look at the person's hairline, above their head at the wall, etc. Observers were also trained on ''hints'' to blending in the classroom, e.g., standing is better than sitting, sit away from activity, stand near a wall or next to upright furniture. Previous studies in the homes of children indicated that adaptation occurred after about two 2 h observations on consecutive days. Children under the age of ten easily adapt to the observer's presence (Barker & Wright, 1966; Ruble, 2001), as is consistent with Gardner's (2000) summary that reactivity to the observer poses no threat to the validity of observational data. After adaptation, a total of 16 h of observational data were collected (2 h for each child).

Reliability of Unitization and Categorization

The audiotape recordings were transcribed into written records called chronologs (Scott, 1980) (see Appendix B). The continuous real-time behavioral transcriptions were then partitioned into structural units of behavior called activity units (AU). An AU is a naturally occurring chunk of behavior from the perspective of the actor and occurs along a constant goal direction (Scott, 1980). AUs represent molar level behaviors that can be observed by a layperson. In the classroom examples of AUs were ''walking to desk,'' ''asking for help,'' ''gathering materials,'' ''completing worksheet,'' and ''putting materials away.'' Figure B1 shows an excerpt of a chronolog. The AUs were unitized by a rater who was unaware of the diagnosis of the children. A description of unitizer training is provided in Appendix C. The Scott and Hatfield (1985) method was used to determine the percentage of inter-rater agreement. This method allows for the duration of behavior as part of the analysis (see Appendix C). Two independent raters unitized 20% of the data and achieved an acceptable reliability of 85.5% agreement.

After unitization, each AU was coded by a rater unaware of the diagnosis of the children. For compliance, if the teacher made no or one attempt to redirect the child's behavior and the child responded and corrected his behavior during the AU, the AU was coded as compliant. For congruence, if the child was engaged in an activity that was consistent with the goals for the other students or of the teacher, the AU was congruent. For example, if the children were discussing what they were having for lunch, and the child with autism or DS was holding up pictures of food items at lunch for the classmates to observe, the AU was compliant and also congruent. In Appendix, AU_1 is ''sitting down.'' This AU is compliant and also congruent. In AU_2, however, Freddie is compliant, but not congruent. He is on the floor with the group; but he is not attending to the video and instead while laying on the floor is tapping his head and looking around. His teacher makes no attempt to direct his attention to the video. Another example comes from a different chronolog. The teacher was conducting a lesson on science (parts of a plant), and the child with autism was doodling in a notebook, writing his name over on restricted interests (in this case tornadoes). Like Freddie's second AU, this AU was also coded as compliant and not congruent. From an outside observer, he demonstrated sustained attention to an activity, showing good engagement using the NRC definition. Upon closer inspection however, his activity was not related to the goals of the children in the classroom.

Type of instruction was also coded. Large group instruction was defined as instruction that was comprised of more than three children. Small group was instruction with two to three children. The other two settings were 1:1 adult and child and independent

work. An inter-rater reliability of 84% for compliance, 86% for congruence, and 94% for type of instruction was achieved for 170 min of the data.

Results

The numbers of goal-directed behaviors exhibited by both groups of children were compared. The children with autism exhibited 359 goal-directed behaviors (M = 57.9; SD = 40.7), and the children with DS exhibited a comparable number of 352 (M = 62.1; SD = 43.8) for a total of 711 AUs (M = 60; SD = 42.3). Of the 711 AUs, 49.2% (321) were coded as congruent and 76.8% (506) as compliant for both groups. Children with autism produced 41.5% (136) congruent and 58.5% incongruent AUs, and 80.8% (269) compliant and 19.2% noncompliant AUs (see Fig. 1). Children with DS produced a similar pattern of more compliant vs. congruent AUs—72.7% (237) vs. 56.9% (185) AUs, respectively. Overall, children with autism produced about 27% fewer congruent AUs compared to the children with DS, and the children with DS produced 10% fewer compliant AUs compared to the children with autism.

Each AU was analyzed for its combination of congruence and compliance. Figure 2 shows that the most highly engaged code combination—AUs coded as compliant and congruent, were observed in fewer than half of the AUs. However, these AUs were the most frequently coded and occurred in similar percentages (about 39%) for both groups of children. The second most frequently coded AU was compliant and noncongruent. Significant differences between groups were observed for this particular code. Children with autism produced 63% more of these types of AUs compared to those of children with DS (34% vs. 22%). The next most frequently coded AU was noncompliant and noncongruent. These AUs occurred in 15% of the AUs of children with autism and 14% of the AUs of children with DS. The last category captured AUs that were noncompliant yet congruent. Only about 8% of children with DS produced these AUs compared to about 3% of children with autism. Overall, it appears that children with autism are better at producing compliant vs. congruent AUs when compared to children with DS.

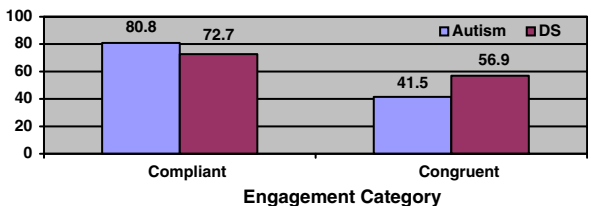

Fig. 1 Percent number of compliant and congruent AUs by diagnosis

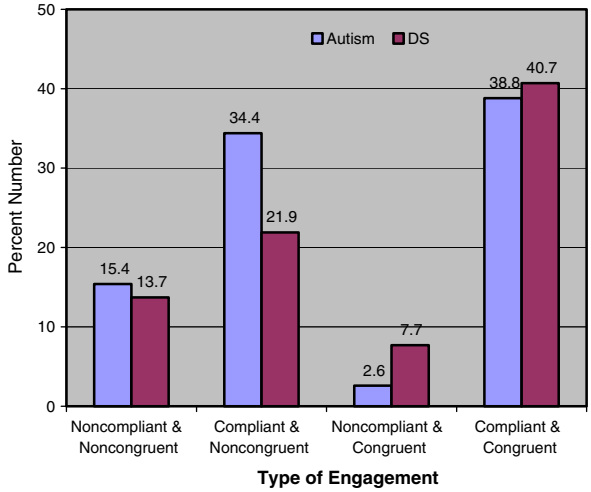

Fig. 2 Percent number of goal-directed behaviors by type of engagement and diagnosis

Interesting differences were observed in type of engagement based on instructional groupings. The percentage of children with autism coded as congruent during large group instruction was significantly lower compared to the percentage for children with DS. Compared to children with DS, children with autism produced 30% fewer congruent AUs during large group instruction (see Table 2; Fig. 3). About 77% of the AUs of children with autism were compliant during large group instruction compared to 62% of the AUs of children with DS. Again, compliant engagement appears to be a relative strength for children with autism, especially during large group instruction.

The next most frequently delivered setting was based on 1:1 adult and child instruction. During this highly structured setting, most of the AUs were compliant for

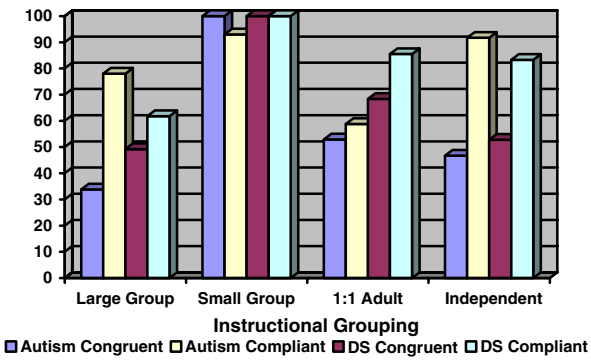

Fig. 3 Percent number of goal-directed behaviors by type of engagement, diagnosis, and instructional setting

the children with autism (58.9%) and the children with DS (85.6%) and less were congruent (53% for children with autism and 68.5% for children with DS). Noncompliance was relatively high for children with autism during 1:1 instruction. About 41% of AUs were noncompliant compared to 14.5% of AUs of children with DS. This type of instruction appeared to be most associated with noncompliance in children with autism.

The best quality of engagement—congruent and compliant AUs occurred the most within small group instruction. For children, 100% of their AUs of those with DS and 93% of the AUs of children with autism, displayed this highest level of engagement.

The least most frequent type of instructional setting, independent work, only produced 25 AUs to code. During independent work, both groups of children exhibited high compliance, about 92% of AUs of children with autism and 82% of AUs of children with DS. For congruence, the percentages were significantly smaller. For autism, about 47% of AUs were congruent, and for DS, about 53% were congruent. Therefore, when involved in independent work, many children demonstrated sustained attention to an activity, but were involved in activities unrelated to the goals of the other students or academic instruction.

The final analysis examined engagement as produced by individual children. Figure 4 provides a line chart of the percent number of AUs coded compliant and congruent by child. The range of percentages of AUs coded as congruent was significantly greater compared to the range of percentages of compliant AUs. For autism, congruent AUs ranged greatly from 14 to 74% in autism (M = .41; SD = .25) and for DS, AUs ranged from 39 to 79% in DS (M = .55; SD = .18). For compliance, the percentages of AUs for autism ranged from 64 to 79% (M = .75; SD = .07). For DS, the percentages of compliant AUs ranged from 56 to 83% (M = .70; SD = .11).

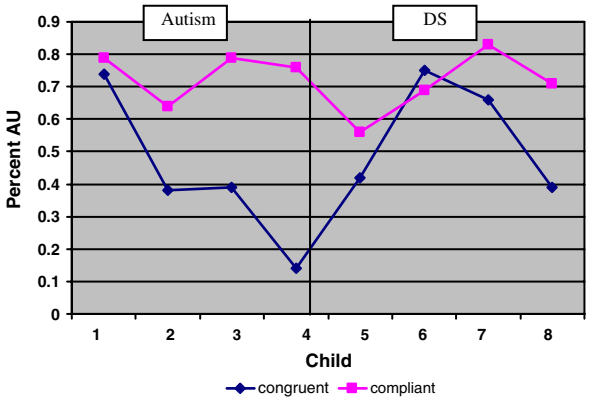

Fig. 4 Percent number of congruent and compliant AUs by child

Discussion

Generating a meaningful and measurable definition of the construct of engagement is important for several reasons. First, studies on engagement are necessary for advancing intervention and services outcomes research. Second, understanding the various influences on engagement will help identify important child and environmental factors (e.g., inclusive educational settings, specific teacher behaviors, or teaching methods) that influence outcomes. Third, research on differences of engagement based on developmental disorders may lend important information on the identification of evidence-based practices for specific disorders.

Findings from this preliminary study revealed that children with autism and children with DS produced a similar number of goal-directed behaviors, and almost half of the goal-directed behaviors were congruent and about 75% were compliant overall. The discrepancy between the percent of goal-directed behaviors coded as congruent and as compliant for both groups was unexpected. Improving congruent engagement may be a target important for programs for children with disabilities in general.

The main finding was that both internal child factors as well as external environmental factors influenced type of engagement. This finding suggests engagement is a state construct, influenced by external events, but also mediated by trait or internal factors. Children with autism produced about 81% of goal-directed behaviors coded as compliant and only 42% coded as congruent; 39% were coded as both. A similar pattern was observed for the children with DS, who produced 73% compliant, 57% congruent, and 38% compliant and congruent AUs. The quality of engagement for the children with DS was significantly better for congruence compared to the children with autism as the children with autism produced almost 30% fewer congruent AUs. Compliant engagement, on the other hand, was a relative strength for both groups of children, but especially for children with autism who produced 10% more than children with DS. When specific combinations of compliance and congruence were examined, children with autism produced 63% more AUs with a combined code of compliant and noncongruent engagement.

Environmental influences of type of instruction also identified interesting influences on child engagement. Large group instruction was the instructional setting where most goal-directed behaviors occurred. Children with autism showed a relative strength of compliant engagement during large group instruction; on the other hand, congruent engagement was a significant

challenge. Children with autism produced 30% fewer congruent AUs during this setting. A caution is that it is likely that children who are more compliant were more likely to be educated in large group settings and those that were less compliant were more likely to have a paraprofessional. Directionality, therefore, cannot be assumed.

In contrast to large group instruction, children with autism produced the fewest compliant AUs during one-on-one instruction with an adult. Compared to children with DS, children with autism produced 28% more noncompliant AUs during this setting. This finding suggests that children with more problematic behaviors were more likely to receive extra assistance compared to the children with DS. Small group instruction, however, benefited both groups of children equally as congruent and compliant engagement made up more than 90% of the AUs. Although the last setting studied, independent work, occurred in a small number of the goal-directed behaviors of the children, illuminating findings were revealed. During independent work, more than 90% of the AUs of the children with autism were compliant and engaged meaningfully using the NRC's (2001) definition of sustained attention to an activity. Less than half of these AUs were congruent, however. This instructional setting as well as large group were most problematic for children with autism because the discrepancy between compliance and congruence was greatest during these settings. Thus, a goal for children with disabilities is how to adapt and modify instruction in various settings to improve both compliance and congruence.

Analysis of type of engagement produced by individual children showed wide variability compared to the children with DS. For congruent AUs, the range varied from 14 to 74% for children with autism and from 39 to 75% for children with DS. This range in congruent engagement may be a predictor important for elucidating differences in treatment outcomes.

An objective, meaningful, and measurable definition of engagement has the potential to influence current programs. The Department of Education has prioritized efforts to identify effective educational practices (Odom et al., 2005), and states have taken additional responsibility for the quality of programs for children with autism in particular. The New Jersey Department of Education, for example, recently published ''Autism Program Quality Indicators'' as a quality improvement guide for programs for children with autism (New Jersey Department of Education, 2004). On page 1 of their manual, it is stated ''students with autism, who participate in intensive educational experiences with a focus on engagement, make substantial gains in academic, communication, and social domains.'' The authors then include the NRC's definition of engagement, ''sustained attention to an activity or person'' (p. 1). Obtaining a more meaningful and objective measurement of engagement is essential given these efforts to improve outcomes for all children with autism.

These data suggest that inclusion or mainstreaming is not a sufficient outcome as has been suggested (Lovaas, 1987) because children with autism can learn to sit and display behaviors that are consistent with their classmates, yet may be engaged in an activity that is unrelated and even unproductive. Thus, analysis of type of engagement may provide more important information for outcomes. This issue is echoed in a recent quasi experimental study comparing outcomes of eclectic treatments used in public school programs to an intensive behavior analytic treatment program. In this study, Howard, Sparkman, Cohen, Green, and Stanislaw (2005) analyzed the cognitive, language, and adaptive behavior outcomes of young children with autism who received 25–40 h a week of discrete trial training to children who received 30 h a week of intensive eclectic intervention in public funded programs and 15 h a week of nonintensive public school programming. The children in the discrete trial program made significant and impressive gains in all comparative outcomes, except motor development. The authors concluded that intensive behavior treatment is more efficacious than eclectic approaches. An issue with this conclusion is the use of ''intensive.'' Without knowing how much time children in the public school programs were actively engaged, it is difficult to compare treatment methods because the number of hours of engaged time was not calculated as an independent variable. These issues with internal validity will remain until more sophisticated methods for measuring engagement are developed.

Clearly more information is needed to understand the relationships between engagement behaviors and instructional environments and the implications of engagement on developmental outcomes. It is not possible to generalize these findings due to sampling issues and limited number of participants. These preliminary findings do suggest, however, variables that are important for a larger scale study of predictors of child engagement. The findings also suggest that engagement is a state construct, and able to be influenced by trait variables such as diagnosis. Identifying the relationship between child engagement and objective measures such as academic achievement and development of independence, social, and communication skill development is critical for translational research.

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Appendix A Rules of recording behaviors

1. Focus upon the behavior and the situation of the child
   a. It is useful to report an action of someone other than the child if the action or the circumstance is one that would ordinarily be expected to register upon and somehow make a difference to the child
   b. It is useful to report an action of someone other than the child or a circumstance if the action or the circumstance is one that led up to a change in the situation of the child
2. Observe and report as fully as possible the situation of the child
3. Never make interpretations carry the burden of description. All interpretative comments should be bracketed
4. Give the ''how'' of everything the child does
5. Give the ''how'' of everything done by any person who interacts with the child
6. Report in order, in the final writing, all of the main steps through the course of every action by the child
7. Wherever possible, state descriptions of behavior positively, say what the child did, not what the child did not do
8. Describe in some detail the scene, as it is when each behavior setting is entered
9. Put no more than one unit of molar behavior in one sentence
10. Put in one sentence no more than one thing done by a person in the situation of the child
11. Do not report observation in terms of time intervals

Appendix B Example chronolog of child with autism

Name: Freddie, child with autism walking into class.
Teacher: West
Age: 8 years

Sitting Down[1]

0'00" Freddie walks into the classroom a few minutes after the filmstrip begins.

His face is expressionless and he does not appear to pay much attention to what is going on in the room [does not look at the filmstrip, the other students, or the teacher].

He walks right over to the table just to the left of the students and begins to sit in a chair at one of the tables [Mrs. West says Freddie tries to sit at the tables everyday when entering the room].

West says, "Come over here Freddie. Sit down" in a welcoming voice.

He walks over to the group of students where he lies on the floor next to the coat hooks and puts his hands on his head [all the other students are sitting].

Laying on the floor[2]

The other students continue to watch the filmstrip, not paying much attention to Freddie.

He stares up at the ceiling, not appearing to pay attention to the filmstrip.

He taps his head gently 3 or 4 times with his hand.

During the filmstrip, West makes comments and asks the kids questions about feelings. Most of the kids respond to what she says as a group.

Freddie does not say anything, look at West, or show much expression.

He continues to lay on the floor with his right hand tucked underneath his head, tapping his head with left hand.

1'05" Still lying, he sucks on his arm, lifts it straight up into the air and starts tapping his head again.

Appendix C Description of unitizer training

1. They reviewed the definition of the unit and the rules for marking the record
2. They read the entire record to get an overview or what the subject was doing, making mental notes of where the major, natural breaks in the subject's behavior fall
3. They returned to the beginning of the records and asked, ''What did the subject think he or she was doing?'' Then they started to identify and mark the units. They tried to identify major units first, and then go back to find minor units. If in doubt about whether a minor segment is itself a contained or enclosed unit or simply part of a larger unit, they tested the definition. One rule of thumb was that there may rarely if ever be more than three units proceeding simultaneously
4. As they worked, they continued reading a page or two ahead in the record
5. They marked each unit by drawing a tick mark at the start and at the end, and then connected the tick marks
6. They numbered the units on the record in the order in which they began
7. As appropriate, they labeled each unit with a descriptive, participial phrase in everyday language. For example, ''writing on worksheet,'' or ''walking to desk'' are acceptable labels
8. They compared their work with that of another unitizer, and determined inter-unitizer agreement by using the formula:
   $P = 100 \times (\mathrm{Axy}_1\mathrm{Bxy}_1) + (\mathrm{Axy}_2\mathrm{Bxy}_2) + \cdots + (\mathrm{Axy}_n\mathrm{Bxy}_n)$
   $[(Axy_1 \quad \mathrm{Bxy}_1) + (\mathrm{Axy}_2\mathrm{Bxy}_2) + \cdots + (\mathrm{Axy}_n\mathrm{Bxy}_n)] +$
   $[(\mathrm{D}_1\mathrm{B}_1) + (\mathrm{D}_2\ \mathrm{B}_2) + \cdots + (\mathrm{D}_n\ \mathrm{B}_n)]$
   Axy = units marked by both x and y independent analysts
   D = units marked by analyst x or y, but not by both
   B = time weight in minutes or fractions of minutes
9. The unitizers used this protocol to begin a series of practice sessions. During each session, unitizers followed the procedures and marked the AUs using a sample chronolog. The unitizers met to discuss problems and determine reliability. It was estimated that the unitizers needed three to five practice sessions in order to meet the criterion

This training provided the unitizers with the skills to correctly identify and mark the two ecologically meaningful units relevant to the research, AUs were judged as needing to meet a minimum reliability criterion of 80%. The unitizers were referred again to the ecological articles and studies described previously. They met with the trainer to discuss any questions or confusing aspects of the units and then were introduced to the procedures below (adapted from Bowman 1980)

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