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Assimilative Practice and Developmental Intervention

Abstract

It is proposed that developmental learning is integrally tied to children engaging in massive practice of their existing skills and concepts. This is based upon observations that: children's spontaneous play is characterized by their producing behaviors typical for their developmental age; children repeat these behaviors thousands of times before transitioning to higher developmental levels; and children's rate of practicing behaviors associated with their current functioning is correlated with their development. Massive practice corresponds to the concept of assimilation which Piaget identified as one of the two processes involved in developmental learning. Results from intervention research studies that accelerated children's development by increasing their rate of practice are presented. Although the concept of assimilative practice is overlooked as an essential learning activity in early intervention, the difficulties of promoting maintenance and generalization which are often encountered in early intervention may be addressed by integrating a focus on assimilation into contemporary practice.

Keywords: Young Children with Disabilities, Developmental Learning; Early Intervention.

Assimilative Practice and Developmental Intervention

There are two general purposes to this paper. The first is to draw attention to the fact that repetitive practice of the developmental behaviors and concepts that children know and are able to do accounts for the majority of children's play, social and motor activity during the early childhood period. This paper will illustrate how during the early years of life children engage in massive amounts of repetition, or practice, of the developmental behaviors and concepts that characterize their current level of functioning before transitioning to more advanced levels of functioning. In addition, evidence will be presented indicating that massive, repetitive practice of existing skills plays an important role in children's developmental learning not only for typically developing children but for children with disabilities as well. The effects of this type of practice on developmental learning are comparable to the effects of similar types of practice on

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developing proficiency with a range of complex behaviors including music, athletics, art as well as academic skills such as mathematics and reading (Gladwell, 2008). While instruction undoubtedly plays an important role in developmental learning, developmental proficiency, or the ability to use newly learned developmental behaviors spontaneously and appropriately in a variety of contexts, may be highly dependent upon children engaging in massive amounts of practice of the skills and behaviors that they are currently capable of doing.

The second purpose is to propose that the concept of "massive practice of existing skills" has critical implications for early developmental intervention. For children to attain higher level developmental skills and concepts, massive practice may not only play a critical role in becoming proficient with these skills, but may also play a role in developing the awareness and understanding that motivates children to acquire higher level skills and concepts. Moreover, insofar as the learning capabilities of children with disabilities may be compromised by neurodevelopmental disorders or impeded by deficits such as attention, initiation or persistence that interfere with their spontaneous use of their existing skills, children with disabilities may need much more practice or repetition of their existing skills than typically developing children as a prerequisite to learning and spontaneously using higher level concepts and behaviors.

Massive practice of existing skills may be an especially critical consideration for contemporary early intervention in which efforts to promote children's developmental learning have conceptualized "practice" almost exclusively in terms of adults repeating instructional prompts or activities that are designed to encourage children's acquisition and generalization of higher level developmental skills and concepts. The most commonly reported problems with these procedures are that children often fail to spontaneously use behaviors and concepts learned through these methods (e.g., Bruner & Seung, 2009; Guralnick, 2010). One question to consider is whether this is a problem of generalization as it is commonly described; or whether it is an indication that certain instructional procedures, though effective at promoting skill acquisition, are inadequate for promoting developmental proficiency (e.g., Camarata, Nelson, & Camarata, 1994). The importance of this question is highlighted by findings from early intervention research studies that will be reviewed in this paper which reported that children made impressive developmental improvements when intervention procedures focused mostly on encouraging children to practice the developmental skills they already possessed.

Massive Practice

Practice and Spontaneous Play

It is generally acknowledged that one of the primary contexts for early developmental learning is children's play, whether by themselves or with others. Indeed, the saying "Play is children's work" (Shakesby & Dornan, 1974) implies that the kinds of activities children do while playing are the very activities that result in developmental learning. To the extent this is true, a reasonable question to ask is what do children do when they play?

Mahoney and Perales (2008) attempted to address this question by describing the activities of three young children with Down syndrome (DS) while playing by themselves with several toys that were matched to their developmental level. These children were identified as Meghan who was 12 months old, William who was 24 months and Natalie who was 36 months. Each of these children had about a 50% delay in their rate of development as assessed by the Bayley Scales of Mental Development (Bayley, 1993). The parents and adults who conducted these observations made no attempt to attract their children's attention, prompt them, or otherwise encourage them to play. Yet, all three children played spontaneously with the objects and materials that were near them throughout the observation.

During the 5½ minutes that Meghan was observed she performed 24 separate acts which could be classified into five categories: mouthing (N=2); shaking/waving (N=9); patting/ clapping/banging (N=7); throwing/dropping (N=4); and vocal play (N=2). In addition, Meghan engaged in these play activities with several different toys that were accessible to her, seldom sustaining any one activity for more than 15 seconds at a time.

In the 5 minutes that William was observed he attended to the details of objects by touching or manipulating them (e.g., turning the wheels on the telephone) (N=5); used objects according to their intended function (N=2); activated a wire antenna attached to a toy to produce an effect (N=2); used a bib on the doll and strings attached to objects to lift objects (N=6); engaged in object permanence activities such as playing peek-a-boo by covering and uncovering the eyes of the doll with a bib (N=4); or engaged in "in-and-out" activities such as transferring objects from one container to another (N=6). William was highly attentive and performed a total of 25 acts, distributing these activities across 9 different toys. Throughout the observation he vocalized frequently using consonant-vowel (CV), word-like vocalizations and three real words.

Natalie engaged in four different categories of play during the 5 minutes she was observed. This included 5 episodes of functional play including stacking blocks, drinking from a cup, eating with a spoon, and feeding a doll with a baby bottle; one episode of "in and out play" where she put stacking blocks inside a cup; and one episode of simple pretend play where she pretended to drink from one of the staking blocks. However during 75% of her play time she engaged in a simple pretend sequence in which she reenacted her mother feeding her. She pretended to use the spoon to mix food in the cup, scooped the food from the cup and then fed herself. She was animated and expressive during this sequence, constantly jargoning and occasionally using vocalizations that sounded like real words (e.g., hot, good) or familiar phrases (e.g., "Come and get it) that would be appropriate for this sequence.

The play of these children could be characterized in three ways. First, it was a continuous activity. Despite the fact these children had significant developmental delays, without prompting all played continuously with the toys that were near them, pausing at most a total of 20 seconds, or little more than 5% of the time they were observed.

Second, the play activities produced by each of these children typified the play behavior that children commonly do at their respective developmental ages. Meghan who was at the 6 month developmental age level engaged in banging, waving, throwing/dropping, vocal play and occasional mouthing. These are the kinds of behaviors that typically developing children have been observed to do in the 4 to 8 month developmental age range. William whose developmental age was 13 months engaged in "in and out" play, used objects to produce an effect, used levers (e.g., strings, bibs) to obtain objects, and used objects functionally. These behaviors typify the play of children at the 10 - 14 month developmental age range. The pretend sequence that Natalie engaged in was typical of the type of pretend that children engage in from 15 to 18 months developmental age. Third, these children repeated or practiced the same sequences of behavior. Meghan and William repeated the same type of activities with several different toys, while Natalie spent most of her play time reenacting an eating sequence with the same set of toys.

Insofar as these children's developmental ages are an indication of their current level of functioning, it would appear that they were playing in a way that reflected their current knowledge and understanding. In other words, the play of these children could not be characterized as "Down syndrome" or "Developmentally Disabled" play, but rather as the typical play of children whose knowledge and understanding was at the 6, 12 or 18 month level of developmental functioning.

Differences between the types of play observed among these three children were related less to their ability to handle and manipulate the toys and more to their thinking and understanding. For example, many of the behaviors that Natalie performed did not require a greater amount of dexterity with objects than the behaviors William performed. Yet differences between the play of these two children were quite apparent. The overriding theme of Natalie's play was pretending her mother was feeding her, while the theme of William's play was exploring the functional, spatial and relational features of objects.

None of these children engaged in play activities that were similar to the ways that children typically play at their chronological ages. Had the behaviors observed for these children been observed in typically developing 6, 12 or 18 month old children, they might be described as chronologically linked behaviors that reflect the types and quantity of learning opportunities children had at their respective ages. However, when observed in older children with DS these behaviors more likely reflected their cognitive functioning more than their previous learning opportunities.

Practice and Motor Development

The field of child development has carefully documented the types of developmental skills and behaviors that characterize children's play and social activity on a monthly basis, particularly during the first three years of life [e.g., (HELP (Furuno, 1995); Carolina Curriculum (Johnson-Martin, Attermeier, & Hacker, 2004)]. This information has been useful for assessing and monitoring children's development, particularly to

determine whether children might have developmental delays. However, the amount children engage in various social and play activities while acquiring developmental skills has not been well documented.

One exception to this is a program of research on children's motor development reported by Adolph, et al. (2012). These investigators used field observations and computer based technology to record the amount and type of movement that children engage in when they are learning and consolidating various motor skills. In one study (Adolph, Vereijken & Shrout, 2003) recorded the amount that a sample of 212 toddlers practiced walking from the time they took their first steps at about 12 months until they became proficient walkers at approximately 20 months. Adolph, et. al. (2003) summarized their observations as follows:

> "Infants' everyday experiences with locomotion occur in truly massive doses, reminiscent of the immense amounts of daily practice that promote expert performance in world class musicians and athletes."
>
> "…walking infants practice keeping balance in upright stance and locomotion for more than six accumulated hours per day. They average between 500 and 1500 walking steps per hour so that by the end of each day they may have taken 9,000 walking steps and traveled the length of 29 football fields."
>
> "…infants' walking experience is distributed throughout their waking day, with short periods of walking separated by longer rest periods where infants stand still or play."
>
> "…infants' everyday walking experiences occur in a wide variety of events, places and surfaces. … the variety of everyday walking experience resembles variable and random practice schedules …. (that) lead to a process of continually generating solutions anew" (Adolph, et. al., p 494-495).

Based upon their observations, Adolph, et. al. (2003) speculated that the magnitude and diversity of practice that children had in self-initiated movement lay at the heart of motor learning and developmental change.

Is the amount of practice and repetition reported by Adolph, et. al.(2003) only related to motor development, or might massive quantities of practice and repetition of behaviors that children are currently capable of doing also be required for other aspects of child development? Mahoney and Perales (2008) attempted to estimate the amount that children engage in early sensory motor behaviors before transitioning to higher levels of developmental functioning. They argued that that the patterns of play observed for the children with DS described above were likely repeated throughout their day whenever similar play opportunities occurred. Had Meghan been observed when she was in her crib, play pen or on the floor with her parents or other children, she would have likely engaged in the same patterns of "banging, waving throwing and mouthing" (BWTM),

particularly if the toys and material available to her were similar to the ones used in the observation. As Mahoney and Perales (2008) pointed out, "Meghan was so intensely involved in this pattern of play it seemed unlikely that we would have been able to get her to do anything else with toys and materials other than the behaviors we observed" (p. 51).

As displayed in Table 1, it is well documented through developmental tests and play profiles that typically developing children engage in BWTM behaviors from the time they are approximately four months until about eight months of age (e.g., Bayley, 1993; Furuno, 1995). While there are no data to indicate how much children engage in BWTM behaviors during a typical day, based upon observations of Meghan it was estimated that typically developing children likely perform these behaviors at least two times each minute they play. If children play as much as four hours each day, or approximately one–third of their waking hours, at two repetitions per minute children would perform approximately 500 repetitions of BWTM behaviors each day. If they sustained this rate of play every day for four months, typically developing children would engage in approximately 60,000 repetitions of BWTM before transitioning to the next level of developmental play. While only a crude estimate, this analysis suggests that as occurs when learning to walk, children engage in massive amounts of practice of their current developmental behaviors and concepts before acquiring and using higher levels of developmental behaviors and concepts.

Table 1
Hypothetical and Repetitions Needed to Transition Through Banging, Waving, Throwing and Mouthing for typically developing children

Banging, Waving, Throwing, Mouthing	Typically Developing Child
Chronological Age Range To Transition from, Banging, Waving, Throwing, Mouthing	4-8 months
Months to Transition from Banging, Waving, Throwing, Mouthing	4 months
Banging, Waving, Throwing, Mouthing acts Per Month	2 per minute X 4 hours (500/day) 15,000
Total Banging, Waving, Throwing, Mouthing Acts to Transition the set of Developmental Behaviors	60,000

The Role of Practice in Developmental Learning

Insofar as children engage in massive amounts of practice or repetition of their current developmental behaviors, three important questions are: (1) why do children engage in massive practice or repetition of their existing skills before transitioning to the next level of development; (2) how does this type of practice contribute to development; and (3) what impact does practice of existing developmental behaviors have on children's rate of developmental learning.

One way to address these questions is to consider the possibility that, as Piaget described (1963), developmental learning involves two processes: assimilation and accommodation. Assimilation is the process by which children incorporate the world into their existing modes of perceiving, thinking and acting. During assimilation children become increasingly proficient with their current modes of thinking, perceiving, and acting. They also learn how their behaviors can be used across a wide range of toys, materials and activities in a variety of contexts. As this occurs, they are learning about the uses of recently acquired perceptions, cognitions and behaviors as well as the limitations of these behaviors.

Accommodation is the process in which children modify their ways of perceiving, thinking, and acting to better match their emerging understanding of the structure and demands of their world. Accommodation, which is manifested by children acquiring new ways of thinking and acting, is likely motivated both by children's dissatisfaction with their current forms of thinking, perceiving and acting as well as by their discovering different ways of thinking, perceiving and acting. Accommodation, or learning new skills, is likely dependent on children's willingness to give up current ways of perceiving, thinking and acting as well as on their discovering and learning new ways of perceiving, thinking and doing.

The 9000 walking steps that toddlers take each day and the hypothetical 60,000 repetitions of BWTM by children between 4 to 8 months of age may be critical to developmental learning because this is the amount of practice children need to learn or become aware of: (1) the uses of these behaviors; (2) the limitations of these behaviors; and (3) and new ways of perceiving, thinking and acting. Perhaps, these are the assimilative processes that are prerequisite to children making the accommodative modifications in which they begin to learn and use higher level behaviors. Insofar as children's activity and play consists mostly of practice or repetition of their current developmental behaviors, it may be that this type assimilative practice is the engine that drives developmental consolidation and change.

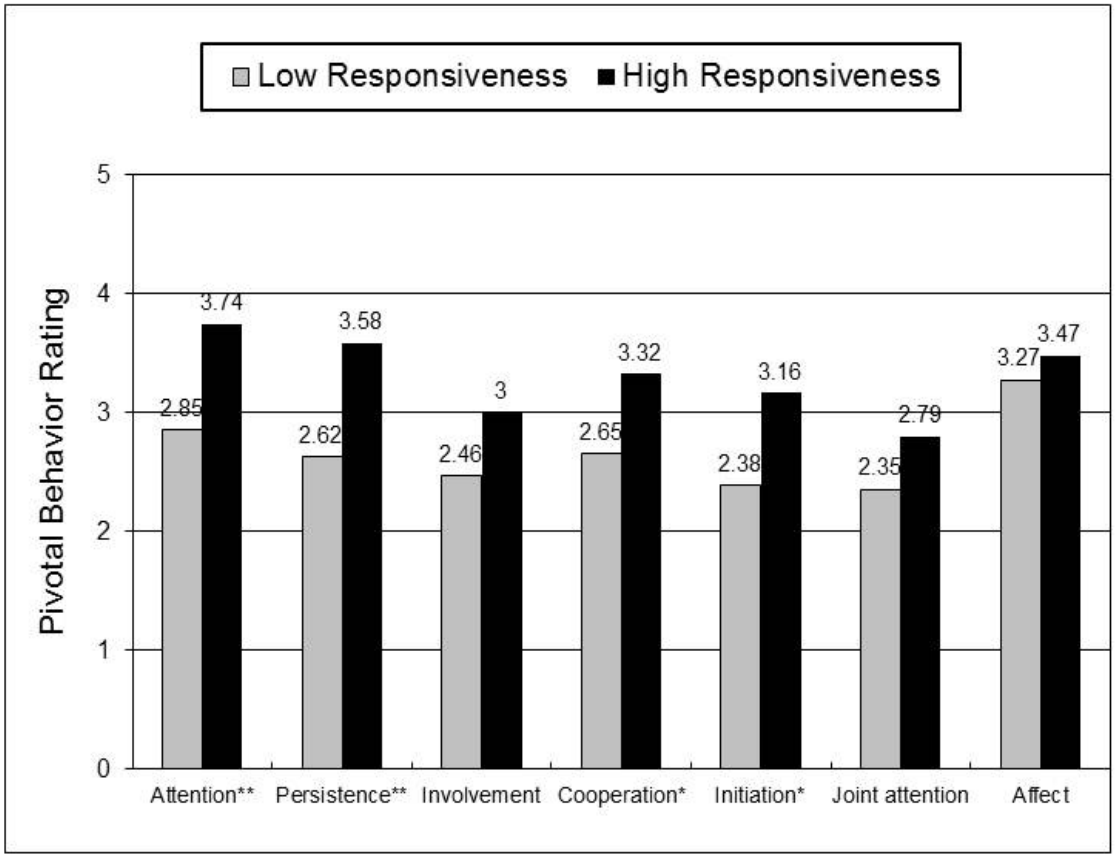
Accommodation, or the acquisition of new developmental behaviors or concepts, occurs toward the end of the assimilative learning cycle when children become ready to learn higher level behaviors and skills due to their flagging interest or dissatisfaction with their current behaviors. The new behaviors and concepts that are the hallmark of children's most recent accommodative modifications may either be behaviors or concepts that children discovered on their own, or behaviors that parents or other

interactive partners modeled or demonstrated while interacting with them throughout the assimilative learning cycle.

Research indicates that children's practice of their existing skills plays a critical role in early developmental learning, reinforcing the notion that repetition or practice of existing skills is an assimilative learning process. For example, Adolph, et. al. (2003) examined the relative contributions of children's neurological maturation (i.e., chronological age), body dimensions and motor practice to their becoming more proficient walkers. Results indicated that when all three of these factors were analyzed simultaneously, only the amount of time children engaged in motor practice was associated with their rate of motor development. In other words, the rate that children became more proficient walkers was primarily dependent upon the amount of spontaneous practice they had with their current gross motor skills.

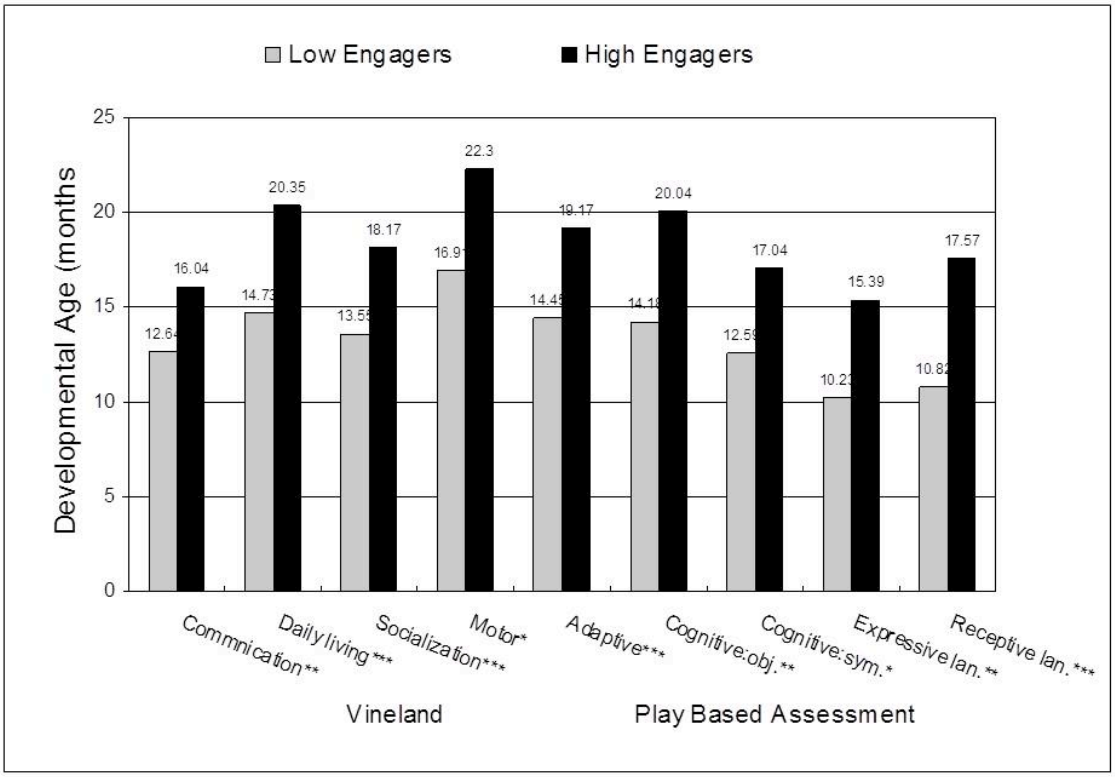
In another investigation, Mahoney, Kim & Lin (2007) reported data which suggested that the association between maternal responsiveness and child development that has been widely reported both with typically developing children (e.g., Bornstein & Tamis-LaMonda, 1997; Landry, Smith, & Swank, 2003; Londen, Juffer, & Van Ijzendoorn, 2007; Poehlmann & Fiese, 2001; Paavola, Kunnari & Moilanen,2005; Tamis-LeMonda, Bornstein, & Baumwell, 2001) and children with disabilities (e.g., Fewell, et. al., 1996; Landry, et. al., 2001; Kim & Mahoney, 2004; Siller & Sigman, 2002, 2008; Tamis-LeMonda, et. al., 1996) may be mediated by the impact that parental responsiveness has on children's practice or use their current behaviors. This descriptive study included 45 mother child dyads in which each of the children had developmental delays. Videotapes of parent-child interaction were used to assess mothers' responsiveness with the Maternal Behavior Rating Scale (MBRS: Mahoney, 1992) and children's engagement using the Child Behavior Rating Scale (CBRS: Mahoney & Wheeden, 1998). Dyads were then divided into two groups based upon mothers' responsiveness: children and High Responsive Mothers (n=28) and children and Low Responsive Mothers (n= 16). As illustrated on Figure 1, when controlling for differences in children's chronological age, children of High Responsive mothers had significantly higher ratings on each of the seven CBRS items (e.g., attention, persistence, interest, cooperation, initiation, joint attention and affect) than did children of Low Responsive Mothers. Since the majority of these CBRS items assess the degree to which children initiate and repeat their current developmental behaviors (e.g., initiation, persistence, interest, and joint attention), these findings suggest that parental responsiveness enhances children's rate of practicing their current developmental skills.

Figure 1.
The relationship between mothers' responsiveness and children's engagement as measured by the Child Behavior Rating Scale (N= 45) (Mahoney, Kim & Linn, 2007)



One way of establishing the importance of practice for children's developmental learning is to determine whether there is a significant relationship between children's rate of practice with their rate of development. To examine this issue Mahoney, et. al. (2007) divided the 45 children into two groups, High Engagers and Low Engagers. High Engagers had average composite CBRS scores that were above the midpoint, while Low Engagers had scores that were at the midpoint or lower. They then compared the average developmental age scores of these children on two developmental measures, the Vineland Adaptive Behavior Scale and the Transdisciplinary Play Based Assessment, controlling for children's chronological age. As illustrated on Figure 2, across the nine developmental subscales of these assessments, children who were High Engagers had significantly higher developmental ages than children who were Low Engagers.

Figure 2.
The relationship between children's level of engagement as measured by the CBRS and their developmental ages assessed by the Vineland Adaptive Behavior Scale and Play-Based Assessment (N = 45) (Mahoney, Kim & Linn, 2007)



Finally, to determine whether differences in developmental functioning between High and Low Engagers were not simply an artifact of the different levels of responsiveness of their mothers, Mahoney, et. al. (2007) examined the relationships between maternal responsiveness, children's engagement and children's level of development. Results indicated that maternal responsiveness was significantly associated with both children's engagement and rate of development. However, when tests of mediation (Barron and Kenny, 1986) were used to assess the simultaneous contribution of children's engagement and mothers' responsiveness on child development, only children's engagement was significantly associated with development. Furthermore, the effect of children's engagement was almost 3 times greater than the effect of mothers' responsiveness. Similar to results reported by Adolph, et. al. (2003) these findings suggest that children's engagement, or rate of using their current developmental skills and concepts, is highly associated with their rate of cognitive and language development. They suggest that the effect of parental responsiveness on children's development is mediated by its impact on children's assimilative learning, or practice and use of their current skills.

Practice, Assimilation and Developmental Delay

Children who have developmental delays require greater amounts of time to transition from one developmental level to the next than children who do not have developmental delays. For example, Meghan who had a 50% delay in development not only began the sequence of BWMT 4 months later than typically developing children, but also engaged in this sequence of behavior for approximately 8 months, or twice the amount of time as typically developing children. If practice or assimilative learning plays a major role in the rate that children develop, then there are at least two possible explanations of how assimilation may be related to developmental delay, at least among children with neurodevelopmental disabilities.

First, when children have learning inefficiencies because of compromised neurological processes such as caused by Down syndrome (Jernigan, et.al., 1993; Pennington, et. al., 2003), they likely require more assimilative practice to achieve the same level of developmental proficiency as do typically developing children. For example, as illustrated on Table 2, if children with DS who have a 50% delay in development engage in the same rate of practice or repetition for the same number of hours each day as typically developing children, then the additional 4 months it takes children with DS to transition to the next level of developmental functioning suggests they need twice as much assimilative practice (i.e., 120,000 repetitions) to learn the same developmental behaviors as typically developing children. Just as individuals who have limited innate athletic ability need more practice to attain the level of proficiency of more gifted athletes, children who are challenged by neurologically based learning inefficiencies may require substantially more assimilative practice to attain the same level of developmental proficiency than children whose learning processes are not compromised.

Table 2.

Hypothetical Time and Repetitions Needed to Transition Through Banging, Waving, Throwing and Mouthing for children with Neurodevelopmental Disorders

Banging, Waving, Throwing, Mouthing	Child with Down Syndrome	Child with Autism/PDD
Hypothetical Reason for Developmental Delay	Learning Inefficiency	Pivotal Behavior Deficit
Developmental Quotient (DQ) (% Delay)	50 (50%)	50 (50%)
Chronological Age Range to Transition from Banging, Waving, Throwing, Mouthing	8-16 months	8-16 months
Months to Transition from Banging, Waving, Throwing, Mouthing	8 months	8 months
Banging, Waving, Throwing, Mouthing acts Per Month	15,000 (500/day)	7,500 (250/day)
Total Banging, Waving, Throwing, Mouthing Acts to Transition	120,000	60,000

Second, as commonly occurs among children with autism, children may have "pivotal behavior deficits" (e.g., Koegel, Koegel, Shoshan, & McNerney, 1999) that limit their rate of engaging in the play and social activities that are the foundations for developmental learning. In other words, as illustrated on Table 2, while typically developing children might engage in 500 repetitions of BWMT per day, children with autism who have pivotal behavior deficits, such as deficits in initiation (Sigman & Ruskin, 1999) or persistence (Koegel, et. al., 1999), may engage in only one half as many BWTM repetitions during the same period of time (e.g., 250 each day). To the extent these children's learning processes are not compromised, they likely require the same amount of assimilative practice or repetition to attain the same level of developmental proficiency as typically developing children. However, because they practice or repeat developmental behaviors at a very low rate, it takes them twice as long (e.g., 8 months or more) to attain 60,000 repetitions of BWTM as it does for typically developing children. The increased time needed to attain the requisite assimilative practice thus results in these children having a 50% delay in development.

Enhancing Developmental Learning through Assimilative Practice Interventions

If developmental learning results from massive amounts of assimilative practice and repetition, and if developmental delays can be conceptualized in terms of children either requiring more practice (i.e., learning inefficiencies) or having a lower rate of practice (i.e., pivotal behavior deficits) than typically developing children, then one way of enhancing children's developmental functioning would be to increase their rate of practice of their existing skills. In the following section we will review results from two intervention studies that produced significant developmental outcomes primarily by focusing on increasing children's rate of practice the skills and behaviors they were currently capable of doing.

The first is a motor intervention study reported by Ulrich, Ulrich, Angulo-Kinzler, and Yun (2001)). These researchers investigated the effects of spontaneous stepping practice on the rate that children with DS learned to walk. Thirty families of infants with DS were randomly assigned to treatment or control groups. Families began to participate when their children were able to sit unassisted and still had the stepping reflex; participation continued until children could walk independently. Both Treatment and Control group children received traditional physical therapy at least every other week. In addition, parents in the treatment group provided their children with practice stepping five days a week for eight minutes each day by supporting them on miniature treadmills which stimulated children's stepping reflex. Results indicated that the spontaneous stepping practice helped children with DS walk independently approximately 3 months sooner than children in the control group.

These are among the most robust motor intervention effects ever reported for children with DS. They appear to have occurred in an intervention that involved only modest amounts of practice of children's existing motor skills (e.g., 40 minutes per week) for approximately months. However, if these children averaged 10 steps per minute on the

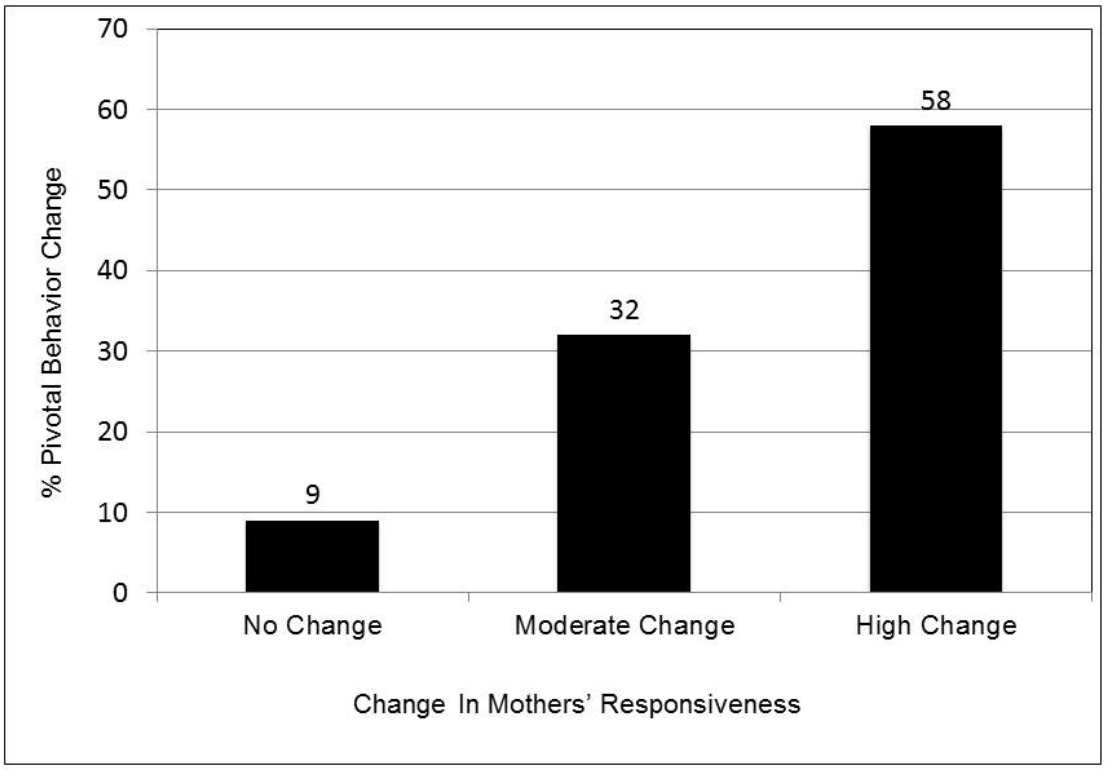
treadmill when they began the intervention and 30 steps per minute when they completed the intervention, over the course of the intervention they could have averaged about 20 steps each minute they were on the treadmill. Thus, even though the amount of practice time per day was relatively brief, over the course of this intervention these children could have engaged in approximately 32,000 more self-initiated practice steps than children in the control group, which constitutes massive group differences in stepping practice. Consequently, results from this study suggest that an intervention that promoted massive increases in children's practice of their existing motor skills played a critical role in accelerating their motor learning.

The second is a study reported by Mahoney and Perales (2005) that evaluated the effects of a relationship focused intervention called Responsive Teaching (Mahoney & MacDonald, 2007). Similar to other relationship focused interventions, Responsive Teaching (RT) encourages parents to use responsive interaction strategies to interact more responsively with their children. However, RT was unique because based it encouraged parents to use these strategies as a means of enhancing their children's use of "pivotal developmental behaviors" that were related to their developmental needs. These included most of the behaviors measured by the CBRS which are directly associated with children's routine use or practice of their current developmental behaviors. Fifty children and their parents participated in this intervention. The average age of the children at the start of intervention was 30 months. Twenty children were diagnosed with Autism Spectrum Disorders (ASD) while the other 30 had a variety of neurodevelopmental delays (ND). The intervention took place for 12 months during which the sample received an average of 32 RT sessions.

Pre-post comparisons indicated that the intervention promoted: (1) increases in parents' responsiveness; (2) improvements in children's use of pivotal behaviors; as well as (3) improvements in children's cognitive, communication and social emotional functioning. However, there was considerable variability in parents' response to this intervention. As indicated on Figure 3, how much parents increased their responsiveness during intervention was directly related to increases in their children's use of pivotal behaviors. Children of parents who did not become more responsive (n=16) made a 9% increase in their pivotal behaviors; children of parents who made moderate increases in responsiveness (n=12) made a 32% increase in their pivotal behaviors; while children of parents who made substantial increases in responsiveness (n= 22) made a 58% increase in their pivotal behaviors.

Furthermore, the degree to which children increased their pivotal behaviors was associated with the impact of intervention on their cognitive and communication development. Children who made large pivotal behavior increases attained 22% higher cognitive development ages and 45% higher communication ages compared to children who did not improve their use of pivotal behaviors (Mahoney & Perales, 2005).

Figure 3.
The association of changes in mother's responsiveness to changes in children's pivotal behavior (N = 50) (Mahoney & Perales, 2005)



Another noteworthy finding is related to the impact that Responsive Teaching had on children with different types of developmental delays. Although the two groups of children were matched on their cognitive and communication functioning at the beginning of intervention, the overall pivotal behavior ratings for the children with ASD were 20% lower than those for children with ND. Thus children with ASD appeared to have pivotal behavior deficits, suggesting that their developmental delays may have been caused partly by their lower rate of assimilative practice. Nevertheless, during the course of intervention the children with ASD made substantially greater improvements in their pivotal behavior ratings (69%) than children with ND (14%). These differences were directly related to the fact that parents of children with ASD made changes in responsiveness that were 172 % greater than changes made by parents of children with ND. Furthermore the developmental improvements for children with ASD were nearly 2 times greater than the improvements attained by children with ND.

To the extent that pivotal behavior changes reflect increases in the rate that children practice their existing developmental skills, results from this study not only suggest that children's rate of assimilative practice can be enhanced by encouraging parents to interact more responsively, but also that the magnitude of the developmental improvements children attained were associated with the degree to which their

assimilative practice increased. Regardless of whether their developmental delays were related to inefficient learning processes or to pivotal behavior deficits, the children who made the greatest increases in assimilative practice made the greatest improvements in their cognitive and language development.

Discussion

Summary

This paper has described how early development occurs in the context of children engaging in massive amounts of repetition or practice of their existing skills while playing and moving. This repetitive practice may be an essential component of developmental learning that corresponds to the concept of assimilation described by Piaget. To support the notion that practice of existing skills is related to development leaning, we described two studies which indicated that the amount children practiced their existing skills was associated with their rate of development.

It was proposed that developmental delays among young children may also be related to issues associated with assimilative practice. Children who have learning inefficiencies caused by neurodevelopmental disorders may need to engage in substantially more practice of their existing behaviors because they need to have a greater number of learning experiences both to become proficient with these skills and to complete the developmental tasks associated with assimilation (i.e., learning the uses and limitations of these behaviors) that are prerequisite to acquiring higher level behaviors. The developmental delays observed among these children may be partly associated with the increased time needed to amass this additional practice. Children with developmental delays who have deficits in the use of pivotal developmental behaviors such as attention, initiation and persistence, may require the same amount of assimilative practice as typically developing children. However, because their pivotal behavior deficits result in a low frequency of practice, it takes them more time to attain the requisite amount of practice needed to complete the process of assimilative learning thus delaying the age at which they acquire higher level developmental skills and behaviors.

The proposition that massive practice of existing skills lies at the heart of developmental change may appear to be fundamentally at odds with the field of early intervention which has evolved exclusively in terms of teaching children higher levels skills and behaviors. Yet, two lines of research with children with disabilities were described that support the critical role that practice may play in the developmental learning of these children. First, research was described which indicated that children's rate of assimilative practice as assessed by their use of pivotal behaviors mediated the relationship between parental responsiveness with their rate of developmental functioning. Second, two early intervention studies which focused on enhancing children's practice of existing skills as opposed to teaching higher level behaviors were reported. In these studies, children's increased practice resulted in their learning higher level skills as indicated by enhanced rates of motor, cognitive and communication development.

Implications for Early Intervention

Over the past 30 years there has been an accumulation of evidence to support the proposition that early intervention is effective at enhancing the development of young children with developmental delays and disabilities (Guralnick, 2005; 2006). Yet despite the success of this endeavor, it is generally recognized that in many cases the effects of early intervention are far less robust than hoped for (Guralnick, 2007). Contemporary efforts to improve developmental intervention services have focused almost exclusively on the accommodative elements of learning. This not only includes the frequency of instruction children receive, but also several other considerations such as what to teach children, who should do the teaching, where the teaching should occur, as well as how to keep children actively involved in learning activities designed to promote higher level skills (Childress, 2004; McWilliam, 2010). Many of these efforts have reflected a more sophisticated understanding of the complexities entailed in developmental learning, and some, such as activity based intervention and natural environments instruction, have been identified as "best practices" (Sandall, Hemmeter, Smith, & McLean, M.E., 2005). Nonetheless, while there is evidence that increased hours of instruction can lead to better developmental outcomes (Makrygianni and Reed, 2010), evidence that the other innovations listed above have enhanced the effectiveness of early intervention is limited.

As indicated previously, the main challenges of conteporary developmental intervention has less to do with helping children learn new developmental skills and behaviors and more to do with helping them generalize, or incorporate, newly learned behaviors into their spontaneous activities and social interactions (Bruner & Seung, 2009; Guralnick, 2010).

When intervention focuses on teaching new behaviors and activities, it is hoped that these behaviors will replace children's current developmental behaviors. For example, children are taught new words with the hope that they will use these words to replace their existing nonverbal communicative behaviors. Perhaps problems of generalization occur because the accommodative modifications that are being encouraged (i.e., learn and use new words) are implemented without consideration of the assimilative processes in which children are currently engaged. Thus, if children are currently focused on learning the uses and limitations of their existing modes of nonverbal communication, they may have little interest or motivation to remember the words they are being taught and even less understanding of how these words will enhance their ability to communicate, thus accounting for their failure to generalize, or incorporate, newly learned words into their spontaneous communication.

Infusing assimilative practice into early intervention would shift the emphasis from encouraging children to learn higher level behaviors to enhancing children's practice or use of their current competencies as well. This focus need not negate the importance of teaching higher level skills. Rather it could help to balance the two components of developmental learning. That is, while modeling higher level behaviors that are responsive to children's current intentions and activities, adults might also encourage

children to use their existing skills by not pressuring them to imitate or respond to these behaviors. As children discover the limitations of their existing actions and conceptions, this interactive process would set the stage for children to make accommodative modifications by integrating the higher level behaviors which they heard adults model numerous times into their spontaneous repertoire.

This process is analogous to the "conversational recast" procedure described by (Camarata, et. al., 1994) which was reported to be more effective at promoting children's spontaneous use of grammatical structures and mean length of utterance than instructional procedures based upon elicited imitation and rote repetition (Camarata, et., 1994; Yoder, Spruytenburg, Edwards, and Davies 1995). Conversational recast is a child-lead instructional procedure in which the adult (a) follows the child's play lead, (b) uses language to label or describe the child's focus of attention, and (c) grammatically recasts the child's utterances by repeating a major element of the child's preceding utterance and adding semantic and grammatical information without pressuring the child to repeat their exemplar. Perhaps, conversational recast is effective at promoting spontaneous communication, because, unlike elicited imitation or rote repetition, it promotes assimilative practice by responding supportively to children's current communicative behaviors. While demonstrating higher level language models that match the child's communicative intention, conversational recast also encourages the child to continue using or practicing his existing communication behaviors. This may promote the type of assimilative learning that children need to acquire higher level developmental skills.

The implementation of massive assimilative practice in early intervention would undoubtedly require far more time or resources than professionals are capable of providing. In other words, the amount of assimilative practice that children likely need to attain higher level developmental concepts and behaviors cannot be attained only through the activities that take place during weekly therapies, home visits, or developmental playgroups. Yet, just as the learning of other types of human behaviors such as music, athletics or reading depends upon parents encouraging their children to practice, so too parents must play an active role in encouraging their children to practice their existing developmental skills.

In a hypothetical analysis of the opportunities adults have to interact with young children, Mahoney and MacDonald (2007) reported that if children received ½ hour of therapy each week and attended a developmental play group four half days each week, even if a parent only interacted with their child one hour a day, over the course of year the parent would engage in 10 times more interactions with their child than therapists and teachers combined. If professionals use their intervention time to teach parents how to increase their effectiveness at engaging in responsive interactions with their children, even if parents followed through for as little one hour per day, this might have a substantial impact children's rate of assimilative practice and greatly improve the effectiveness of children's early intervention experience.

Conclusion

As the field of early intervention struggles to identify more effective procedures for promoting the developmental learning of young children with disabilities, this paper calls attention to the possibility that children's spontaneous or assimilative practice of their existing skills may play a critical role in this regard. However the evidence reviewed in this paper only points to the possibility that (1) assimilate practice is a critical element of developmental learning, and that (2) interventions which enhance assimilative practice can play a role in developmental intervention. Clearly, this line of inquiry is in its infancy and much more research needs to be done to explore the potential contribution of assimilative practice to developmental learning and early intervention.

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