Journal of Psychological Abnormalities in Children

Perna and Loughan, J Psychol Abnorm Child 2013, 2:1
DOI: 10.4172/2329-9525.1000105

Research Article Open Access

Early Developmental Delays: A Cross Validation Study

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Abstract

Developmental delay is a common diagnosis given in clinical practice to young children whose developmental milestones fail to be met in a typical age-expected manner. Research on early delays in speech and motor milestones remains unclear regarding long-term developmental outcomes. The purpose of this study was to cross-validate and further investigate subsequent diagnoses (more than 4 years post delay diagnosis) and potential neuropsychological weaknesses in children who suffered early developmental delays in speech or motor. Participants (N=95) completed a neuropsychological evaluation. Though similar in age, grade level, and economic status, the children with developmental delays were compared with children without delays. Results revealed that the group of children with developmental delays had significantly lower Full Scale IQ's and academic achievement scores (Reading and Mathematics). Across other neuropsychological measures, children with delays had lower scores than non-delayed children; however, no measureable impairments (when neuropsychological variables are compared to Full Scale IQ). Chi square showed the delay group to be more likely to subsequently be diagnosed with ADHD.

Keywords: Developmental delay; Delay; Speech; Language; Motor; ADHD

Introduction

Assessment of developmental milestones and the relative meaning of delays are not always clear. Some clinicians may consider a delay to simply represent a developmental lag and others may view the delay as central nervous system pathology that may resolve or subsequently manifest differently with aging of the Central Nervous System (CNS). Developmental delay is considered when a child fails to meet one or more developmental milestones related to motor, speech and language, social functioning, or daily living skills [1-5]. Incidence reports that a diagnosis of developmental delay occurs in up to 15% of children under age five, with the incidence increasing from 12.84% to 15.04% over the past 12 years [6]. For the purposes of this paper, developmental delay is defined as a significant developmental difficulty achieving specific milestones when compared with same age peers [7]. Most relevant literature defines significance as performance that is one to two standard deviations below the mean on age appropriate, standardized, norm reference testing [1-4,8,9].

Delays may present as varying issues and result in different prognosis among children. The research on early delays is somewhat unclear in terms of persistence of impairments or evolution to other disorders. Dearlove and Kearney reported no long-term educational difficulties in children who failed their preschool developmental examinations. Snowling, Bishop, Stothard, Chipcase, and Kaplan also claim limited association between having a history of speech and language delay and later development of psychiatric disorders in adolescence [11]. However, other evidence suggests that having an early delay may increase the risk of subsequent cognitive, behavioral, or academic problems, particularly when children are longitudinally followed. Relationships between developmental delays in speech and motor disorders and other cognitive impairments have been found in some research [12-20]; For example, a growing body of research suggests that speech and language delays are often associated with subsequent difficulty with reading, writing, attention, and socialization [11,21,22]. Some delays that may simply appear to affect motor developmental may also affect a variety of sensory functions [23] in a much less apparent manner. Although up to 60% of children between the ages of 2 and 3 may eventually resolve their mild speech or language delay without ever receiving treatment [24,25] many require early intervention. Children with more severe delays may have persisting problems while children with mild delays may be at risk of not being identified until school age [26,27] and thus not receive early intervention. To date, the literature remains inconsistent regarding the degree of residual problems and prognosis of children diagnosed with developmental delay.

Subsequent social or emotional disorders

Pre-school children with developmental delays are found to be four and five times more likely to display social skill deficits [1] along with increased rates of behavior problems as young as ages 2 and 3 [28]. This suggests that an early identified delay may be a precursor to later classifications of social-emotional disorders. Developmental delays have also been associated with later occurring social anxiety, manic episode, bipolar affective disorder, and psychotic depression [29,30]. More specifically, children with a history of language impairments often show evidence of ongoing difficulty interacting with their peers and may have associated behavior problems, emotional difficulties, and complex social interactions [31,32]. Found that behavior disorders were identified in 29% of children with language delay as compared to 19% of same-grade controls; establishing a 1.5 increase in percentage rates. When evaluating children at age 12 who were diagnosed with a speech and language impairment by age 5, the percentage of classified psychiatric disorders was more than double compared to non-delayed children (42.9% compared to 20% [12]. Additionally, during a 15 year longitudinal study, children with early language impairments were 2.7 times (16% versus 6.5%) more likely to have future anxiety, specifically social phobia, at age 19 [31].

Subsequent developmental, cognitive or academic challenges

Research by Rappaport et al. [33] examined children (N=51) between ages 8 and 10 who suffered from inattention, speech delays and/or motor delays between age 2 and 4 years of age. Twenty (39%) subsequently developed Attention Deficit Hyperactive Disorder (ADHD). They also found that those children who had early interventions had a reduced incidence of developing ADHD. Similarly, Miniscalco et al. [34] studied

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Received July 24, 2013; **Accepted** August 23, 2013; **Published** August 26, 2013

Citation: Perna R, Loughan AR (2013) Early Developmental Delays: A Cross Validation Study. J Psychol Abnorm Child 2: 105. doi:10.4172/2329-9525.1000105

children at age 30 months who screened positive for language delay. Follow-up testing again at age 6 and 7 (N=21) revealed 71% to have at least one diagnosable DSM-IV disorder with many classified as co-morbid including five with autism spectrum disorder, 11 with ADHD (5 predominantly inattentive type and 6 combined type), seven with developmental coordination disorder, eight had borderline IQ or mild learning disabilities, and four with reading disorder. Baker et al. [35] found a 3.21 to 1 increase in ADHD symptomology in 5 year-old children who were diagnosed with developmental delay (n=95) when compared to non-delay children (n=141). Perna and Loughan [20] found that children (N=60) with speech and language delays as toddlers subsequently had lower Full Scale IQs and memory scores.

Academic development is an area of concern for those who suffer from developmental delays and research suggests an increased need in special education [36]. Law et al. [25] found that up to 75% of children identified with expressive language delay progressed to develop reading problems by the age of 8. Children with reading disorders were found to have five times the prevalence of a previously diagnosed language delay (52%; N=164) when compared against same-grade controls (9%) [32]. Sullivan and McGrath [37] even suggested a direct association with motor delay and school performance in their research of a premature population. Out of 168 children investigated, 51 (30.4%) were identified at age 4 with mild motor delay. Follow-up testing at age 8 revealed that larger impairment were associated with a reduction in reading, math, and spelling achievement scores. Academic achievement scores were on average one standard deviation below normative values when analyzed with fine and gross motor delay and 17-50% of these children were receiving school support to keep up with academic demands.

When early delays are no longer overtly apparent these children may no longer be followed or sufficiently researched. Even with mixed results, the literature summarized above supports a connection between developmental delays and the possible subsequent development of other disorders. To help clarify the nature of long-term effects, the current sets out to cross-validate previous findings [20] investigating 60 children; 55% (n=33) of which had been previously diagnosed with developmental delay compared to 45% (n=23) who were referred for a neuropsychological evaluation with no history of language or motor delay. Results revealed that the delay group had many scores lower than the no-delay group including IQ scores with performance on measures of achievement, executive functioning, and visual memory reaching significance. The children with delays also had a higher rate of subsequent diagnosis including ADHD, learning disabilities, and emotional/behavioral disorders; with ADHD reaching significance. We set out to cross-validate this study with a larger sample size. Our hypothesis is that children who have suffered developmental delays in speech or motor delays during toddlerhood will have significantly lower scores on several neuropsychological measures and a higher rate of subsequent diagnoses.

Methods

Participants

Data was collected on a sample (N=95) of children who completed a neuropsychological evaluation. The sample was divided into two groups, those who had diagnosed developmental disorders (Dev-Delay; n=49) and those with no diagnosed or reported developmental delays (No-Delay; n=46), but whom have been referred for neuropsychological evaluations at their current age for behavioral or academic issues. All children in the Dev-Delay group had developmental delays which had been diagnosed before age four and most had either speech/language therapy or occupational therapy for those issues. Group comparisons showed that the groups differed significantly in mean age t (-2.138), p=.035 with the relative age means being 10.9 (Dev-Delay) and 11.9 (No-Delay) respectively. No significant difference was found between gender [t (0.197)=p=.844; boys=67 (71%) & girls=28 (29%].

Demographics	Whole Sample	Dev-Delay (n=49)	No-Delay (n=46)	P value
Age	11.2 (3.3)	10.5 (3.3)	11.9 (3.2)	0.035*
Gender				
Male	67 (70%)	35 (71%)	32 (70%)	0.844
Female	28 (30%)	14 (29%)	14 (30%)	

Note. *Indicates statistical significance at 0.05 level

Table 1: Group differences on demographic variables.

Children were excluded from this study if they had any documented neurological history (Concussion, Traumatic Brain Injury, Cerebral Vascular Accident, Cerebral Palsy, Fetal Alcohol Syndrome, Neoplasm, seizures) or other injuries that could cause neurological impairment. No children were included who had a prolonged cyanotic episode, required intubation, or who had cyanosis due to a major medical condition. Children were not excluded from this study if they had a history of ear infections (Table 1).

As part of the assessment, data were collected regarding a documented history of developmental delays (in motor functioning or speech), and a diagnosis of Attention Deficit Hyperactivity Disorder (ADHD) or Learning Disorders (Reading or Mathematics). Diagnoses were made based strictly on DSM-IV-TR diagnostic criteria. For example, the children diagnosed ADHD had at least 6 of 9 of the Inattention or Hyperactive/Impulsive symptoms. For learning disorder diagnoses a discrepancy analysis was utilized with a 1.5 to 2 SD discrepancy (FSIQ/GAI vs. academic achievement). Data were also coded regarding whether the child had a diagnosed behavioral or emotional disorder (as defined by one of the following diagnoses: Disruptive Behavior Disorder, Oppositional Defiant Disorder, Conduct Disorder, Major Depression, or Anxiety Disorder). Children's diagnoses were based on clinical interviews with the child and a parent, review of a DSM-IV diagnostic checklist, records review, CBCL, YSR, CDI, and test data.

Measures

All participants completed a neuropsychological evaluation consisting of a clinical interview, records review, and tests including the Wechsler Intelligence Scale for Children-Fourth Edition, Wechsler Individual Achievement Test (WIAT-II or WIAT-III) [38,39], Wisconsin Card Sorting Test (WCST) [40], and Children's Memory Test (CMS) [41], as well as several other measures that were not entered into this database. The WISC-IV is a cognitive ability assessment of verbal comprehension, perceptual reasoning, working memory, and processing speed. Together these indexes combine to measure a child's Full Scale IQ (FSIQ). The WIAT is a measure of academic strengths and weaknesses. It includes 16 subtests of reading, math, writing, and language. The WCST is a measure of executive functioning including pattern recognition and cognitive flexibility. The CMS is a measure of memory. It provides 8 index scores including attention and working memory, verbal and visual memory, short and long delay, recall and recognition, and learning characteristics.

Analyses

The data was entered into and analyzed via SPSS; descriptive statistics, Chi-Squares, and ANOVAs were performed on relevant variables. Those identified as having a developmental disorder (Dev-

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Neuropsychological Measures	Whole Sample (N=95)	Dev-Delay (n=49)	No-Delay (n=46)	Sig	r^2
WISC-IV					
Full Scale IQ	90.1 (16.6)	85.8 (15.6)	94.8 (16.5)	0.000†	0.176
Verbal Comprehension	96.0 (15.2)	92.3 (13.3)	99.6 (16.2)	0.009†	0.125
Perceptual Reasoning	94.8 (16.1)	90.5 (15.2)	99.0 (16.2)	0.008†	0.129
Working Memory	89.8 (15.4)	86.0 (14.4)	93.5 (15.7)	0.080	0.071
Processing Speed	86.2 (14.4)	85.1 (13.2)	87.2 (15.6)	0.017*	0.110
WIAT-II					
Word Reading	91.6 (18.1)	86.5 (16.8)	96.5 (18.1)	0.030*	0.096
Numerical Operations	90.3 (15.4)	87.0 (12.1)	93.5 (17.6)	0.037*	0.091
WCST					
Categories	91.6 (14.3)	88.5 (17.1)	95.2 (9.1)	0.090	0.075
Perseverations	96.0 (15.7)	92.7 (19.7)	99.9 (15.0)	0.060	0.087
Maintenance of set	90.3 (15.7)	88.7 (17.2)	92.1 (13.6)	0.335	0.035
CMS					
Verbal Immediate	96.9 (15.7)	98.1 (17.0)	95.6 (14.5)	0.349	0.030
Verbal Delayed	93.4 (18.3)	94.9 (15.1)	91.8 (21.2)	0.277	0.037

Note. r^2 is effect size
- *Indicates statistical significance at 0 .05 level
- † Indicate statistical significance at 0 .01 level

Table 2: Group differences controlling for full scale-IQ (ANCOVA).

Developmental Diagnoses	Whole Sample (N=95)	Dev-Delay (n=49)	No-Delay (n=46)	P value
Behavior/Emotional Problems	74%	84%	67%	0.055
Dx with ADHD	72%	78%	66%	0.435
Dx with Reading Disorder	14%	18%	9%	0.113
Dx with Math Disorder	12%	12%	11%	0.707

Note. Dev=Developmental; Dx=Diagnosis; ADHD=Attention Deficit Hyperactive Disorder

Table 3: Group differences on subsequent diagnoses.

Delay) were compared with those who did not have a reported developmental disorder (No-Delay), and the two were analyzed in terms of pattern of performance and variability of performance.

Results

Developmental delay vs. non delay group (on neuropsychological testing)

Comparisons showed that there were several significant group differences (Table 2). To control for Age differences, that variable was made a covariate (Analysis of Covariance; ANCOVA) for subsequent analyses. Full Scale IQ was significantly different between the groups [F=9.721, p=.000] whereby the No-Delay group had a higher IQ (94.8 versus 85.8). Comparisons also found significant group differences with the Dev-Delay group performing lower on the academic measures (WIAT) involving Word Reading [F=3.696, p=.030] and Mathematics [F=3.469, p=.037]. Group differences were not evident during measures of executive functioning (WCST) or memory (CMS).

Neither group had any scores significantly below their Full Scale IQ. The largest Full Scale versus other test difference was 0.7 points for the Dev-Delay group and 7.6 points for the No-Delay group. This pattern may suggest that long-term effects of early developmental delay may not manifest as focal impairments (Table 2). Both groups were similar in terms of number of measured weaknesses and impaired scores. A case by case review found that eight members of each group had at least one test score significantly (≥ 15 points) below Full Scale IQ (Table 2).

Dev-delay group vs. no-delay group (on subsequent diagnoses)

At the time of this evaluation the participants were on average seven to eight years post developmental delay diagnosis. To assess if the groups were subsequently diagnosed with other disorders, chi-square analyses were run comparing groups. Significant group differences were not found between the Dev-Delay and the No-Delay group (Table 3). Both groups had significantly higher percentages of ADHD and Behavioral and Emotional Disorders than the general population. Their percentage of learning disabilities was also relatively higher than general population norms (Table 3).

Discussion

Developmental delays may result in diverse long-term outcomes. Some research suggesting delays equate to long-term cognitive impairment [9], while others claim that these children achieve major achievement milestones in the same manner, order, and with parallel organization as do typically developing children. In general, research appears to support a wide range of cognitive abilities within this population. Riou et al. [9] found that the majority of globally developmentally delayed preschoolers (N=93; M age=3 years, 8 months) fell within the low average to borderline cognitive range (45%) of intellectual ability; however, close to 20% had average intellect and a small proportion scored in high average (5%).

In the current study, the Dev-Delay group to have a significantly lower Full Scale IQ and academic achievement involving reading and mathematics. This finding is somewhat consistent with previous research [9]. The Dev-Delay group has a Full Scale IQ that is 0.66 standard deviations lower than the no-delayed group. Though this finding may be partially attributable to sample effects, the group differences are consistent with previous research [9,20].

Though this data appears to suggest long-term impairments, some of our findings appear to suggest many group similarities. Specifically, the finding that neither group had any test scores significantly below Full Scale IQ and the finding that both groups had the same number of individuals with impaired scores (≥ 15 points below FSIQ). It may be that the delay group has a lower IQ due to the previous reported tendency toward delay children to have lower IQ's [9], Given that several studies show that early childhood brain injuries are associated with lower subsequent IQ's [42], it may be that the brain dysfunction involved in some delays, may also lower subsequent IQ. However, if it is not assumed that the delays caused a global cognitive decline affecting Full Scale IQ and other cognitive functions relatively equally, then the findings only appear to suggest possible small long-term effects on cognitive functioning and not findings that would be diagnosable as impairments.

Children in this study with early developmental delays had an increased risk of a subsequent ADHD diagnosis. The later development of attention challenges is consistent with past research revealing similar results [33,34,36,43]. This may be suggestive that attention and perhaps executive function systems are affected by diverse areas of brain dysfunction, a finding which is consistent with the diverse neuropathology associated with ADHD. It should be noted that a large percentage of both study groups, dev-delayed and no-delayed, demonstrated a high incidence of behavioral/emotional subsequent diagnoses. The Dev-Delay group would appear considerably more pathological in terms of diagnosis if compared to the general population base rates.

Approximately 80% of developmental screenings, when appropriately used, prove reasonable accuracy in the identification of childhood developmental delays [40]; however, up towards 65% of developmental disabilities are failing to be identified prior to school entry [10,44], which may place these children at risk for negative education outcomes. Our data suggest that early delays could be a risk factor for future development of ADHD. Early identification and intervention may improve areas of weakness and perhaps reduce the risk of subsequent diagnoses. As such, diagnoses or observations of developmental delays during the pre-school age should not be taken lightly. A subset of these children should perhaps have ongoing screening. Early identification is important given the growing body of research that suggests lingering weaknesses and benefits to early interventions often optimizing long-term outcomes including academic and social/emotional success [27,34,45].

Though this study aimed to reduce error through having reasonably pure groups, a limitation of this study was that speech and motor delay groups were combined and may actually have different long-term outcomes. Further research will be needed to continue to cross-validate and clarify our findings and to fully clarify the effects of delays on subsequent intellectual ability.

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