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Early Learning Rate as a Predictor of Outcome in an EIBI Program

Le taux d'apprentissage précoce en tant que prédicteur de résultat dans un programme d'ICI

Author Information

Maria Pongoski,[1]
Geneviève Roy-Wsiaki,[2]
C.T. Yu [1,3]

[1]Department of Psychology, University of Manitoba, MB, Canada
[2]Département des sciences humaines et sociales, Université de Saint-Boniface, Winnipeg, MB, Canada
[3]St.Amant Research Centre, Winnipeg, MB, Canada

Correspondence:

umpongos@myumanitoba.ca

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Abstract

The current study sought to examine the predictive value of early learning rate on 1-year outcome measures for autism severity, adaptive behaviour, and intelligence quotient (IQ), as well as the predictive value of intake scores on early learning rate, for children with autism spectrum disorder in an early intensive behavioural intervention program. Using archived data, participants were assigned to one of two groups based on their early learning rate, either the Rapid Learners group or the Less Rapid Learners group, and descriptive analyses were assessed for outcome measures. Results indicated that scores were significantly different between groups at Year 1 for scores on adaptive behaviour and autism severity. As well, a simple linear regression was used to assess the predictability of early learning rate on Year 1 outcome measures and the predictability of Intake scores on early learning rate for the total sample. Results indicated that early learning rate only significantly predicted adaptive behaviour and autism severity scores at Year 1 and only adaptive behaviour Intake scores significantly predicted early learning rate. As a limitation of this study was the use of archived data, future researchers should consider acquiring current skills databases from service providers to better evaluate the variety of skills being taught to each child.

Résumé

La présente étude visait à examiner la valeur prédictive du taux d'apprentissage précoce sur les mesures de résultats à l'an un concernant la sévérité de l'autisme, les comportements adaptatifs et le quotient intellectuel chez les enfants ayant un trouble du spectre de l'autisme. Elle s'intéressait également à la valeur prédictive des scores au début d'un programme d'intervention comportementale précoce et intensif sur le taux d'apprentissage précoce. À l'aide de données archivées, les participants ont été répartis en deux groupes selon leur taux d'apprentissage précoce, soit le groupe des apprenants rapides et le groupe des apprenants moins rapides. Des analyses descriptives ont été effectuées sur leurs résultats. Les scores de comportement adaptatif et de sévérité de l'autisme différaient significativement entre les deux groupes à l'an un. Une régression linéaire a été effectuée sur l'échantillon entier afin d'évaluer la valeur prédictive du taux d'apprentissage précoce sur les mesures des résultats à l'an un et celle des scores en début de programme sur le taux d'apprentissage précoce. Le taux d'apprentissage précoce ne prédisait de manière significative les scores de comportement adaptatif et de sévérité de l'autisme qu'à l'an un. De plus, parmi les scores en début de programme, seuls les scores de comportement adaptatif prédisaient de manière significative le taux d'apprentissage précoce. Étant donné que l'utilisation de données archivées a limité la portée de cette étude, les chercheurs devraient envisager d'acquérir des bases de données portant sur les compétences actuelles auprès des prestataires de services afin de mieux évaluer la variété de compétences enseignées à chaque enfant.

Mots-clés : Intervention comportementale intensive précoce, trouble du spectre de l'autisme, prédicteurs, taux d'apprentissage précoce, résultat

Introduction

Autism spectrum disorder (ASD) is classified as a neurodevelopmental disorder typically characterized by deficiencies in communication and social skills, as well as tendencies to engage in repetitive movements or behaviours. Symptoms of ASD manifest differently in every child, thus making ASD a diagnosis with a wide spectrum of functioning levels (American Psychiatric Association [APA], 2016).

Early intensive behavioural intervention (EIBI) has been widely studied as a treatment intervention for young children with ASD (Debodinance, Maljarrs, Noens, & Van den Noortgate, 2017; Makrygianni, Gena, Katoudi, & Galanis, 2018), with many studies reporting positive outcomes for children enrolled in an EIBI program when compared to minimal treatment groups (Hayward, Eikeseth, Gale, & Morgan, 2009; Lovaas, 1987; Smith, Groen, & Wynn, 2000), non-ABA groups (Virués-Ortega, 2010), and when comparing across initial adaptive functioning levels (Hedvall et al., 2015; Perry et al., 2008).

Predictors of outcome for children with ASD have also been widely studied to identify potential characteristics that may predict their progress, both during and following an EIBI treatment

program. Some of the most common predictor variables studied to date include cognitive ability, language, adaptive level, age at treatment onset, and autism symptom severity (Ben-Itzchack, Watson, & Zachor, 2014; Hayward et al., 2009; Hedvall et al., 2015; Klintwall & Eikeseth, 2012; Perry et al., 2011; Perry et al., 2013; Sallows & Graupner, 2005; Smith, Klorman, & Mruzek, 2015).

Sallows and Graupner (2005) identified language, daily living, imitation, and socialization skills as the greatest pretreatment predictors of 2-year outcomes for children enrolled in an EIBI program. Additionally, low IQ scores and absence of language were predictive of limited progress. Hedvall et al. (2015) found that children presenting with higher cognitive levels at intake were 18 times more likely to make the most gains in regard to adaptive functioning. Smith, Klorman, and Mruzek (2015) sought to identify predictors of outcome for children in a community based EIBI program. Results indicated that social engagement was a strong predictor for IQ and adaptive behaviour, and stronger cognitive skills were predictive of higher adaptive behaviour scores and lower autism symptom severity scores at follow-up.

Although some studies have touched on rate of learning as a predictor of outcome (Hayward et al., 2009; Sallows & Graupner, 2005), only two studies have directly evaluated its effects. Weiss (1999) explored rate of skill acquisition as a potential predictor of 2-year outcomes and found that faster learners exhibited the greatest changes in scores relating to autism severity and adaptive behaviour after 2 years of EIBI treatment. Similarly, Weiss and Delmolino (2006) found that overall learning rate at intake was correlated with improvements in scores for adaptive behaviour and rate of skill acquisition 4 years following intake. However, learning rate was not related to improvements in autism severity scores. Both studies acknowledged the lack of IQ data as a limitation due to the potential predictive value of this variable. Although both studies found that faster learning rates were associated with greater improvement in adaptive behaviour scores, further research is needed to assess this variable amongst other outcome variables (Gabriels, Hill, Pierce, Rogers, & Wehner, 2001; Weiss & Delmolino, 2006).

The purpose of this study was to assess the predictive value of early learning rate on 1-year outcome measures of adaptive behaviour, autism severity, and IQ. Changes in these outcome measures were examined from Intake to Year 1. Archived data were analyzed for a large sample of children diagnosed with ASD enrolled in a government funded EIBI program in Manitoba, Canada. It was predicted that children with faster learning rates would perform better on outcome measures at Year 1 than children with a moderate learning rate.

Method

Participants

Archived data were obtained for 254 children who received services from an EIBI program between 2012 and 2015. This EIBI program is a community based, government funded program located in Winnipeg, Manitoba, Canada. It provides between 20 and 40 hours per week of individualized treatment to preschool children with a diagnosis of ASD. The teaching programs are based on the Assessment of Basic Language and Learning Skills-Revised (ABLLS-R; Partington, 2006) and on applied behaviour analysis principles and procedures (Cooper, Heron, & Heward, 2007; Martin & Pear, 2019).

Children were included in this study if they met the following criteria: (a) they received a minimum of 1 year of EIBI services, (b) Intake and Year 1 data were available for at least one outcome measure (adaptive behaviour, autism severity, and IQ), and (c) Intake and 6-month data were available for the ABLLS-R measure. From the sample of 254 children, 87 children (72 boys and 15 girls) with a mean age of 46.2 months at intake (*SD* = 9.5) met the inclusion criteria and were included in the analysis.

Independent Variable and Group Assignment

The ABLLS-R is used by this EIBI Program as a curriculum guide, an assessment of current skills, and a skills' tracking system. It is comprised of 4 broad domains, consisting of 25 skill areas, and 544 total target skills. Results from this assessment are typically used to design each child's EIBI training curriculum. A child's skill repertoire is evaluated first at intake and every 6 months until the child's exit from the program. For the purposes of this study, early learning rate was defined as the number of ABLLS-R skills acquired in the first 6 months of intervention and was determined by calculating the difference between 6-month ABLLS-R scores and Intake ABLLS-R scores.

Participants were assigned to one of two groups: Rapid Learners (RL) or Less Rapid Learners (LRL). Group assignment was determined by a median split (*Mdn* = 41) on the early learning rate variable. The RL group consisted of 44 children, 37 boys and 7 girls, with a mean age of 48.2 months (*SD* = 9.9), and a mean early learning rate of 12.5 skills gained per month. The number of skills gained in 6 months ranged from 41 to 131. The LRL group was comprised of 43 children, 35 boys and 8 girls, with a mean age of 44.1 months (*SD* = 8.8), and a mean early learning rate of 3.3 skills gained per month. The number of skills gained in 6 months ranged from 1 to 39.

Dependent Measures

Autism symptom severity. The Pervasive Developmental Disorder Behavior Inventory (PDDBI; Cohen, Schmidt-Lackner, Romanczyk, & Sudhalter, 2003) is a parent directed inventory designed to measure adaptive as well as maladaptive behaviours in children diagnosed with a pervasive developmental disorder. For the purposes of this study, the Autism Composite score, comprised of subscales reflective of ASD diagnostic criteria, was used. Autism Composite scores are given as T-scores with a mean of 50 and a standard deviation of 10 where a higher score represents higher stereotyped behaviours and greater deficiencies in communication. The PDDBI has demonstrated good internal consistency, high inter-rater reliability, and high construct and criterion-related validity (Cohen et al.).

Adaptive behaviour. The Scales of Independent Behavior-Revised (SIB-R; Bruininks, Woodcock, Weatherman, & Hill, 1996) is a standardized instrument that measures functional independence and adaptive functioning. The assessment can be administered as either an interview or a checklist. An individual is scored on 259 different items, divided into four main domains including social interaction and communication skills, community living skills, motor skills, and personal living skills. Standard scores have a mean of 100 and a standard deviation of

15. Higher SIB-R scores are representative of higher adaptive functioning compared to low SIB-R scores. The SIB-R has demonstrated high test-retest reliabilities, inter-rater reliabilities, and high internal consistency (Bruininks et al.).

IQ. The Wechsler Preschool and Primary Scale of Intelligence (WPPSI-IV; Wechsler, 2012) is a standardized assessment that measures full-scale IQ in children. The full-scale IQ is calculated based on performance across five subsections, including a verbal comprehension index, visual spatial index, processing speed quotient, fluid reasoning index, and working memory index (Soares & McCrimmon, 2013). Standardized composite scores are provided, with a mean of 100 and a standard deviation of 15. The WPPSI-IV has been shown to have high internal consistency, test-retest stability, and inter-rater reliability. Additionally, good internal structure and concurrent validity have been reported (Syeda & Climie, 2014).

Data Analysis

Descriptive analyses were run to determine the mean scores at Intake, Year 1, and the Change in Scores from Intake to Year 1 for each of the independent and dependent variables. As well, a multiple regression was run to evaluate the predictability of early learning rate on each outcome measure as well as change in scores from Intake to Year 1 for all participants.

Results

Autism symptom severity

Table 1 summarizes the descriptive results for the PDDBI assessment. This outcome measure had the least amount of missing data, with only one score missing for the LRL group at Intake. At Intake, the RL group ($N = 44$; $M = 54$) scored 3 points higher than the LRL group ($N = 42$; $M = 51$). However, at Year 1, the RL group ($N = 44$; $M = 45$) scored 4 points lower than the LRL group ($N = 43$; $M = 49$). When examining the mean change in scores for each group, the RL group ($N =44$) improved an average of 8 points compared to an average of 3 points for the LRL group ($N = 42$) after one year of EIBI. Both groups demonstrated a decrease in PDDBI scores, reflecting a decrease in autism symptom severity after one year of EIBI.

Adaptive behaviour

Table 2 summarizes the descriptive results for the SIB-R assessment. Due to missing data, sample sizes varied for each assessment period. At Intake, the RL group ($N = 43$; $M = 62$) scored 12 points higher than the LRL group ($N = 40$; $M = 50$). This difference increased at Year 1 for the RL group ($N = 39$; $M = 81$) scoring 28 points higher than the LRL group ($N = 33$; $M = 53$), however there was also a slight decrease in sample size. Nevertheless, a notable difference remained when examining the mean change in scores for each group, with the RL group ($N = 38$) improving an average of 18 points compared to an average of 5 points for the LRL group ($N = 32$) after one year of EIBI.

Table 1
Descriptive Summary for PDDBI Scores for Rapid Learners and Less Rapid Learners

	Mean	*SD*	N
PDDBI Intake			
Rapid Learners	53.52	8.63	44
Less Rapid Learners	51.36	42.00	42
PDDBI Year 1			
Rapid Learners	45.36	10.47	44
Less Rapid Learners	48.58	10.16	43
Change Score from Intake to Year 1			
Rapid Learners	-8.16	9.05	44
Less Rapid Learners	-3.21	7.75	42

Table 2
Descriptive Summary for SIB-R Scores for Rapid Learners and Less Rapid Learners

	Mean	SD	N
SIB-R Intake			
Rapid Learners	61.77	21.61	43
Less Rapid Learners	49.95	25.14	40
SIB-R Year 1			
Rapid Learners	81.00	18.25	39
Less Rapid Learners	53.48	25.31	33
Change Scores from Intake to Year 1			
Rapid Learners	18.21	16.07	38
Less Rapid Learners	4.91	17.19	32

IQ

Table 3 summarizes the descriptive results for the WPPSI-IV assessment. Due to missing data, sample sizes varied for each assessment period. At Intake, the RL group ($N = 26$; $M = 72$) scored 1 point higher than the LRL group ($N = 10$; $M = 71$). This difference increased slightly at Year 1 to 3 points higher for the RL group ($N = 39$; $M = 76$) over the LRL group ($N = 14$; $M = 73$). When examining the mean change in scores for each group, the RL group ($N = 25$) improved an average of 7 points compared to an average of 10 points for the LRL group ($N = 6$) after one year of EIBI. Overall, both groups displayed a small increase in IQ scores after one year of EIBI.

Table 3
Descriptive Summary for WPPSI-IV Scores for Rapid Learners and Less Rapid Learners

	Mean	SD	N
WPPSI Intake			
Rapid Learners	72.35	16.23	26
Less Rapid Learners	70.60	20.22	10
WPPSI Year 1			
Rapid Learners	75.62	15.08	39
Less Rapid Learners	72.71	21.07	14
Change Scores from Intake to Year 1			
Rapid Learners	7.36	15.90	25
Less Rapid Learners	10.50	11.83	6

Early Learning Rate

Table 4 summarizes the descriptive results for the ABLLS-R scores. Data was obtained at Intake and 6-Months for all 87 participants. At Intake, the RL group (M = 88) scored 25 points higher than the LRL group (M = 63). At 6-Months, the RL group (M = 163) scored 80 points higher than the LRL group (M = 83), gaining an average of 75 skills compared to 20 skills for the LRL group across 6 months. This increase in skills gained at 6 months is also observable in the range of scores, with a range of 45 to 389 for the RL group, and a range of 9 to 451 for the LRL group.

Table 4
Descriptive Summary for ABLLS-R Scores for Rapid Learners and Less Rapid Learners

	Mean	SD	N
ABLLS-R Intake			
Rapid Learners	87.70	61.41	44
Less Rapid Learners	62.65	82.53	43
ABLLS-R 6-Months			
Rapid Learners	162.86	70.24	44
Less Rapid Learners	82.51	86.08	43
Change Scores from Intake to 6 Months			
Rapid Learners	75.16	26.38	44
Less Rapid Learners	19.86	10.06	43

Predictability of Early Learning Rate

Results of a multiple regression (see Table 5) indicated that early learning rate significantly predicted SIB-R scores ($F(1, 70) = 28.55$, $p < .001$, $r = .54$) and PDDBI scores at Year 1 ($F(1, 85) = 7.56$, $p = .007$, $r = -.29$), but did not predict WPPSI-IV scores at Year 1 ($F(1, 51) = .18$, $p = .675$, $r = .06$). Additionally, early learning rate significantly predicted change in SIB-R scores from Intake to Year 1 ($F(1, 68) = 10.89$, $p = .002$, $r = .37$), but did not significantly predict change in WPPSI-IV scores ($F(1, 29) = .67$, $p = .42$, $r = -.15$), or change in PDDBI scores ($F(1, 84) = 3.82$, $p = .054$, $r = -.21$).

Table 5
Multiple Regression for Outcome Scores at Year 1 and Change from Intake to Year 1

	F	*p*	df	R	Adjusted R Square
Year 1					
SIB-R	28.550	0.000	1, 70	0.538	0.280
WPPSI	0.177	0.675	1, 51	0.059	-0.016
PDDBI	7.558	0.007	1, 85	0.286	0.071
Change in Scores					
SIB-R	10.894	0.002	1, 68	0.372	0.125
WPPSI	0.672	0.419	1, 29	0.150	-0.011
PDDBI	3.817	0.054	1, 84	0.208	0.032

Discussion

This study sought to replicate and expand on the Weiss (1999) study, in order to examine the predictive value of early learning rate on 1-year outcomes for autism severity, adaptive behaviour, and IQ, as well as changes in outcomes from Intake to Year 1, for children with ASD in an EIBI program. Participants were assigned to one of two groups based on their early learning rate, either the RL group or LRL group, and descriptive analyses were conducted with the outcome measures. Results indicated that both groups demonstrated a positive trend representing improvements in all outcomes from Intake to Year 1. As well, a multiple regression was used to assess the predictability of early learning rate on Year 1 outcomes and change in outcomes from Intake to Year 1 for the total sample. Results indicated that early learning rate significantly predicted adaptive behaviour and autism severity scores at Year 1 and change in adaptive behaviour scores from Intake to Year 1. These results are consistent with Weiss' findings.

Additionally, the relationship between learning rate and adaptive behaviour was replicated in the current study, demonstrating that slower acquisition rates were associated with lower scores for adaptive behaviour. Inconsistent with Weiss, however, were the changes in scores from Intake to Year 1 for autism severity, as they were not significantly related to rate of acquisition. In

other words, improvement on autism severity scores were not predicted by the number of skills gained after 6-months of EIBI. This difference could be attributed to the different assessments used to measure autism symptom severity between both studies. Where Weiss used Childhood Autism Rating Scale (Schopler, Reichler, & Renner, 1988) scores to determine symptomology, this study used scores provided by the PDDBI. As well, this study examined scores after 1 year of treatment in an EIBI program whereas Weiss examined scores after 2 years of treatment.

Results of this study were also consistent with results presented by Weiss and Delmolino (2006), who examined 4-year outcomes. Descriptive analyses in the current study revealed similar relationships between learning rates and outcome scores after only 1 year of EIBI treatment. Weiss and Delmolino concluded that children with higher learning rates demonstrated more improvement in adaptive behaviour scores than children with slower learning rates, demonstrated by a large difference in adaptive behaviour scores between learning rate groups. These children also showed greater improvement in adaptive behaviour scores post-treatment. In the current study, adaptive behaviour scores exhibited the greatest difference between groups on 1-year outcome measures, indicating that children in the RL group demonstrated a higher adaptive behaviour score at Year 1 than the LRL group, thus lending support to the previous literature.

Results of this study present contributions and address certain limitations found in the existing literature. An important contribution involves the larger sample size (87 children) obtained for this study, allowing for a more representative sample of data and greater power. This study also sought to expand on current knowledge by examining the relationship between learning rate and IQ scores, as the lack of IQ data was noted as a limitation in both Weiss (1999) and Weiss and Delmolino (2006). Based on the descriptive analyses conducted for IQ scores, there was no prominent difference in scores between the RL group and LRL group at Intake or Year 1. As well, the multiple regression indicated that there was no significant predictive relationship between early learning rate and IQ scores at Year 1.

In terms of limitations, first, given that the inclusion criteria specified that participants only needed one outcome score at Year 1, there was a substantial amount of data missing for at least two of the outcome measures. This resulted in differing sample sizes used for comparing, both across and within, each outcome measure with early learning rate. These uneven sample sizes may have skewed the results of the descriptive analyses and may have contributed to the non-significant results found with the multiple regression. Future researchers could modify the inclusion criteria to ensure equal sample sizes for all measures.

A second limitation involves the nature of the assessments that were chosen for this study. Both the PDDBI and the SIB-R involve completion of an inventory or checklist by the child's parents or legal guardians. Generally, parents will report what they observe in terms of behaviours, however, they may not be familiar with their child's behaviours in other environments (e.g., daycare or school). Future research could address this limitation by conducting direct assessments with the child's daycare or school staff, as well as their parents, to produce a more representative result for each child.

A third limitation concerns the use of archived data. Although using archived data may allow for a larger sample, specific details concerning a child's treatment program may not be discernable such as the number of teaching programs in place at one time, or the presence of any aberrant behaviours that may disrupt teaching sessions. This should be taken into consideration when interpreting these findings. Future research may consider acquiring skills databases directly

from the service providers to evaluate both the number of programs and variety of skills being taught to each child.

Overall, this study contributes to the current research by examining early learning rate as a predictor of outcomes for children enrolled in an EIBI program. Results demonstrated that early learning rate significantly predicts autism severity, adaptive behaviour, and change in adaptive behaviour outcomes after one year of treatment. If clinicians are able to evaluate and consider a child's learning rate, amongst other predictor variables, they may be better able to estimate the child's outcomes and program accordingly to ensure optimal progress.

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Key Messages From This Article

People with disabilities: It is important that services and treatments that you receive are suited to your individual needs and abilities, to encourage increased learning and opportunities for success.

Professionals: You have a responsibility to design skills training programs that are personalized to the individuals you serve. It is important to recognize when training programs are not beneficial to the individual and to be flexible with program decisions, to provide the individual with the opportunity to learn skills at a desired pace to foster improved outcomes.

Policy makers: You have a responsibility to implement policy change to accommodate the best service model based on current research. It is important to acknowledge that policies need to reflect evidence-based practices in order to increase positive outcomes for the individuals that receive such services.

Messages clés de cet article

Personnes ayant une incapacité : Il est important que les services et les interventions que vous recevez soient adaptés à vos besoins et capacités individuels afin d'encourager un apprentissage et des opportunités de réussite accrus.

Professionnels : Vous avez la responsabilité de concevoir des programmes de formation personnalisés pour les personnes que vous desservez. Il est important de reconnaître quand ces programmes ne sont pas bénéfiques pour l'individu et de faire preuve de flexibilité dans les décisions relatives aux programmes afin de fournir à la personne la possibilité d'acquérir des compétences au taux souhaité et de favoriser de meilleurs résultats.

Décideurs : Vous avez la responsabilité de mettre en œuvre un changement de politique pour tenir compte du meilleur modèle de services basé sur la recherche actuelle. Il est important de reconnaître que les politiques doivent refléter des pratiques fondées sur des données probantes afin d'accroître les résultats positifs pour les personnes qui reçoivent de tels services.

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