YALE JOURNAL OF BIOLOGY AND MEDICINE 88 (2015), pp.37-44.

Toward Optimal Outcome Following Pivotal Response Treatment: A Case Series

Pamela E. Ventola*, Devon R. Oosting, Cara M. Keifer, and Hannah E. Friedman

Yale Child Study Center, New Haven, Connecticut

There is a growing literature on children with autism spectrum disorder (ASD†) who respond favorably to behavioral treatment, which is often termed "optimal outcome." Rates and definitions of optimal outcome vary widely. The current case series describes an empirically validated behavioral treatment approach called Pivotal Response Treatment (PRT). We present two preschool-aged children who received an intensive course of PRT and seem to be on a trajectory toward potential optimal outcome. Understanding response to treatment and predictors of response is crucial, not necessarily to predict who may succeed, but to individualize medicine and match children with customized treatment programs that will be best tailored to their unique and varied needs.

Historically, autism spectrum disorder (ASD) has been considered a pervasive condition with difficulties in social communication and restrictive and repetitive behaviors persisting into adulthood [1]. Given the heterogeneity of the disorder, it is not surprising that the outcomes for individuals with ASD are highly variable and can range from serious impairment to nearly typical functioning in adolescence and adulthood [1-5]. While improvements of varying degrees have been observed longitudinally in affected individuals, reports of individuals losing their diagnosis later in life are rare, and the literature supporting such outcomes is sparse [5,6-10].

Lovaas initially introduced the term "best outcome" when describing the 47 percent of his initial cohort of children with ASD who, after intense intervention, were mainstreamed in school and had IQs in the typical range [11]. Subsequent studies have yielded inconsistent support for Lovaas's rate of best outcome [7,8,12,13]. In the past 2 decades, reported rates of best, or optimal, outcomes in individuals with ASD have ranged from 2 to 25 percent of affected individuals, drastically lower than the 47 percent reported by Lovaas [5,6,9,10,14,15]. One contributing factor to the discrepancy of reported optimal outcome rates is that the term optimal outcome (OO) has not yet been uniformly defined. While Lovaas referred to individuals with average IQ and mainstream classroom placement as best outcome, other researchers have used more stringent criteria for membership in the OO group (i.e., remediation of all ASD symptoms and typical social and communicative functioning) [2,11,16-19].

Recent work by Fein et al. [4] investigated the existence of OO in a group of 34 individuals who once held a diagnosis of ASD but no longer meet diagnostic criteria. Fein et al. clarified the definition of OO by operationalizing it as no longer meeting criteria for ASD, remediation of symptoms of ASD, and achieving social, communicative, and adaptive functioning in the typical range [4]. The characterization of these individuals confirms that OO is a possibility in ASD.

Research investigating potential predictors of optimal outcome in individuals with ASD has consistently demonstrated that average or above average cognitive abilities in early childhood predict better outcomes later in life [3,13,18,20,21]. Other factors likely to predict OO include early diagnosis, early intervention, strengths in receptive language, and an initial diagnosis of Pervasive

*To whom all correspondence should be addressed: Pamela Ventola, Yale Child Study Center, 230 South Frontage Road, New Haven, CT 06520; Tele: 203-785-5657; Email: pamela.ventola@yale.edu.

†Abbreviations: ASD, autism spectrum disorder; OO, optimal outcome; PDD-NOS, Pervasive Developmental Disorder Not Otherwise Specified; ABA, Applied Behavioral Analysis; PRT, Pivotal Response Treatment; DAS-II, Differential Abilities Scales-Second Edition; CELF-P-2, Clinical Evaluation of Language Fundamentals-Preschool, Second Edition; ADI-R, Autism Diagnostic Interview-Revised; ADOS, Autism Diagnostic Observation Schedule.

Keywords: autism, pivotal response treatment, outcome

Author contributions: All authors contributed to writing the manuscript and data collection. Dr. Ventola is also the Principal Investigator of the project and oversaw its completion.

Developmental Disorder Not Otherwise Specified (PDD-NOS) or Asperger's syndrome [2,5,22,23]. Anderson et al. [2] conducted a prospective study of individuals diagnosed with ASD at 2 years old with follow-up assessments at 3 and 19 years of age. Results indicated that 9 percent of the sample achieved OO by 19. Importantly, at 2 years old, the OO group did not differ phenotypically from cognitively able participants who maintained their ASD diagnosis at 19. This study supports the notion that strengths in cognitive and communication abilities are not sufficient in predicting optimal outcome. While these characteristics likely contribute to optimal outcome in individuals with ASD, they do not sufficiently account for the emergence of social competency, independence, and remediation of autistic symptomatology present in the rare optimal outcome cases [14,20,24-27].

More research is needed to elucidate the rate of OO in ASD as well as the factors that meaningfully contribute to it. Furthermore, there is currently a limited understanding of the weaknesses that persist in OO cases in terms of social communication and adaptive skills as well as other comorbidities. A more nuanced understanding of OO in ASD will have meaningful implications for treatment development and implementation.

OVERVIEW OF PIVOTAL RESPONSE TREATMENT (PRT)

One of the treatments used to address the core symptomatology of ASD is Pivotal Response Treatment (PRT) [28,29]. PRT is an empirically validated behavioral treatment model with foundations in the principles of Applied Behavioral Analysis (ABA) [30]. However, unlike ABA, which uses extrinsic reinforcement and rote skill learning toward the goal of generating specific responses (such as matching shapes or colors), PRT utilizes the motivations unique to each child to provide opportunities for skill acquisition within naturalistic play-based interactions [29,31,32]. By employing techniques such as child choice in activities, interspersion of novel demands with ones already mastered, presentation of clear opportunities for skill demonstration, and rewarding full and attempted productions with contingent, context-appropriate reinforcement, PRT seeks to improve social communication skills by addressing the deficits in social motivation (i.e., *pivotal responses*) that likely underlie many core symptoms of ASD [29]. It is thought that gains in these specific skills will stimulate improvements in the broader "pivotal areas" of functioning they represent, a hypothesis supported by a growing body of literature [29,33,34].

The inherent flexibility of this treatment modality is one of its greatest advantages. Importantly, while the overarching treatment goals for each child are similar and address the core deficits associated with ASD, the approach to these goals is individualized for each child based on his/her skillset. A session may begin by offering the child a choice between coloring, making a book, or playing a game. Each of these activities offers opportunities to elicit a variety of skills. A tower-building game like Jenga can be modified to require the child to ask a question of his or her play partner every time he or she chooses a block and to then build a short conversation around the answer, and structured board games such as Candy Land emphasize turn-taking and reciprocity in play. Narrative language and sequencing skills (i.e., the ability to describe an experience step-by-step) can be addressed by assembling pictures of a child's trip to the zoo or the beach into a book. Less structured activities such as craft projects provide abundant opportunities for requests, question and comment initiations (e.g., "What are you making?" or "I made a pink star!"), and can also help encourage conversational ability.

PRT was initially developed as a way to foster language acquisition in minimally verbal children with autism; however, it has since expanded to include a focus on appropriate social behavior, symbolic play, and higher-order social communication skills such as conversation and self-initiated queries [28,33-36]. Additionally, a more recent emphasis on parent training as a critically important component of treatment has demonstrated the effectiveness of further practice of target skills during naturally occurring situations in the home and community [37-40]. PRT has been implemented successfully with individuals across the lifespan, from infants to adults, and has repeatedly been illustrated as effective in improving social and communication skills in those with ASD [41-43]. Importantly, many of the children in these studies maintained therapeutic gains in target skills at long-term follow-up and were able to generalize those skills to nonclinical settings [28,31,32,44]. This focus on generalizability and maintenance of acquired skills is a hallmark of PRT and is arguably one of the most crucial facets of the approach.

The number of children diagnosed with ASD has risen rapidly in the past few decades, highlighting the necessity of adequate treatment provision [45,46]. Research has suggested the existence of a sensitive period of intervention effectiveness, during which time treatment approaches such as PRT can maximize social, communicative, and adaptive skill gains [47,48]. Accordingly, as detailed above, some children attain an "optimal outcome," in which they no longer meet criteria for an ASD diagnosis after substantial improvements in the social, communicative, and behavioral symptom domains associated with autism. In what follows, we describe two case studies in which preschool-aged children with ASD seem to be on a trajectory toward possible optimal outcome, or are faring quite well, following an intensive treatment course. For this purpose, we define optimal outcome as children who no longer exhibit clinically significant social communication deficits and do not meet criteria for a diagnosis of ASD on standardized measures. Importantly, here we are not conceptualizing the children as falling into the optimal outcome classification per se, as the treatment duration was brief, and we have not followed the children long-term yet. We are making the case, though, that these children may be

on a trajectory toward a solid classification of optimal outcome. The case presentations are chosen from children who participated in a research study on PRT. The study examined the efficacy of 16 weeks of PRT on social-communicative abilities in high-functioning preschool-aged children with ASD. Children eligible for the study were high-functioning children between ages 4 and 6 and had a full-scale IQ of over 70. All children entered the study with a prior diagnosis of ASD, and the diagnosis was confirmed by a highly experienced licensed clinical psychologist using "gold-standard" diagnostic procedures. Diagnostic impressions were informed by the Autism Diagnostic Observation Schedule-Module 3 (ADOS) [49] and the Autism Diagnostic Interview-Revised (ADI-R) [50].

CLINICAL CASE PRESENTATIONS

Subject CHILD 1

CHILD 1's parents first became concerned about his development soon after birth, as he was very fussy, difficult to console, and slept only 2 hours at a time. They became further concerned at 15 months of age because he had no words. They sought an evaluation from a clinical psychologist at a medical center specializing in autism spectrum disorders at 1 year, 9 months of age. At this time, he was diagnosed with Pervasive Developmental Disorder, Not Otherwise Specified (PDD-NOS). He then qualified for early intervention services. He received 20 hours per week of intervention using Applied Behavioral Analysis as well as speech and language therapy. His first words emerged at about 2 years of age, and he spoke in short phrases at 2½ years. At 3 years of age, he transitioned into his local school district. He entered an integrated preschool program where he received speech and language and occupational therapy. In kindergarten, he participated in a mainstream classroom, and he received speech and language therapy and participated in a social skills group.

At age 5 years, he was re-evaluated by his school district. As assessed by the Brigance Inventory of Early Development-II, CHILD 1's gross motor, fine motor, self-help, general knowledge, and social-emotional skills were judged to be within age expectations [51]. His language skills, however, were delayed. A report from his speech-language pathologist indicated that his core receptive and expressive language skills were within the level expected for his age, although he demonstrated weaknesses with narrative language and pragmatic language. Specifically, he had difficulty re-telling his experiences with appropriate context, and he frequently made off-topic remarks. He also rarely made eye contact. With peers, he needed support to engage. He was not able to read others' nonverbal communication or emotional expressions. He also frequently used scripted language with peers.

At 5 years, 5 months of age, CHILD 1 was evaluated as part of his participation in the current study. Cognitive functioning was assessed using the Differential Abilities Scales-Second Edition (DAS-II) [52], and his scores ranged from the average to the very high range (GCA = 132; Verbal = 147; Nonverbal Reasoning = 107; Spatial = 123). Language functioning was assessed using the Clinical Evaluation of Language Fundamentals-Preschool, Second Edition (CELF-P-2) [53], and his scores were in the above average range (Core Language = 123; Receptive Language = 119; Expressive Language = 123; Language Content = 131; Language Structure = 116). His adaptive functioning, as measured by the Vineland Adaptive Behavior Scales-Second Edition (Vineland-II) [54], was average but lower than his cognitive abilities (Standard scores: Communication = 106; Daily Living Skills = 111; Socialization = 90). Pragmatic language skills were assessed using the Clinical Evaluation of Language Fundamentals-4 Pragmatic Profile (CELF-4) [55]. The Pragmatic Profile subtest uses criterion-based scoring, with a cut-off point for scores falling in the impaired/typical range. His score on his measure fell within the impaired range. Diagnosis of ASD was informed by parent-report using the Autism Diagnostic Interview-Revised (ADI-R) [50] and direct clinical interactions using the Autism Diagnostic Observation Schedule (ADOS) [49]. Final diagnosis was confirmed by clinical judgment. In this evaluation, it was noted that CHILD 1 enjoyed interactions, but he had trouble maintaining conversations. He also had highly notable difficulty recalling any past personal event. His eye contact was inconsistent, and his insight and understanding of social relationships were poor. For example, he said that he had many friends, but he was unable to list their names or any shared activity. Lastly, his play skills were quite weak. He was not able to engage in appropriate play with any of the toys presented. He preferred to observe the clinician play.

Upon the initiation of the treatment program, goals were identified for CHILD 1. Goals included: 1) respond to comments with on-topic remarks; 2) initiate on-topic comments and questions; 3) improve reciprocity within the context of play and conversation; and 4) develop narrative skills.

At the start of treatment, clinicians played structured games (e.g., board games) and engaged in less structured activities (e.g., tossing water balloons) to work on reciprocity and turn-taking. As he became more adept, clinicians initiated spontaneous conversations around motivating topics, such as *Star Wars*. At the start, CHILD 1 required significant prompting in order to engage. He was able to answer direct questions, but he did not respond to comments. With indirect prompting, such as, "I said that I like to play with *Star Wars* Lego. What can you say?" and with direct modeling of comments, he became more responsive to verbal bids, but his language was often repetitive. For instance, he repeated, "Wow, that's cool" in response to many conversational bids. As treatment progressed, the clinicians modeled more flexible responses, and if his language became repetitive, he was prompted to say the phrase/sentence differently or with more detail.

Table 1. CHILD 1's ADOS, Vineland-II, and CELF-Pragmatics Profile scores before and after 4-month treatment course.

	Pre treatment	Post treatment
ADOS Module 3 total score	12	6
ADOS Module 3 CSS*	7	3
VABS-II Communication SS	106	104
Receptive AE	78	90
Expressive AE	66	53
Written AE	73	83
VABS-II Daily Living Skills SS	111	107
Personal AE	90	78
Domestic AE	66	91
Community AE	74	71
VABS-II Socialization SS	90	92
Interpersonal AE	54	31
Play and Leisure AE	70	78
Coping AE	27	55
CELF-4 Pragmatics Profile raw score	86	132

*ADOS CSS: Calibrated Severity Score

With this instruction and encouragement, his language became more flexible. CHILD 1 was still highly motivated to participate in such conversational exchanges as the clinicians introduced motivating topics and followed his lead on topics of interest to him, all within the context of preferred activities.

With regard to narrative language skills, at the start of treatment, CHILD 1 had significant difficulty with narratives; he was unable to describe past personal experiences with detail. When asked, he said nothing or responded with a brief detail but no context or gestalt explanation. To work on the development of this skill, the clinicians first focused on CHILD 1 relaying information with a high level of visual supports. For example, they created schedules of the activities completed during the treatment sessions, which he then used to retell his experiences about his session that day. They talked very explicitly about the sequence of the activities (first, second, last). As he became more adept, his mother took pictures of family outings and events outside of session. CHILD 1 and his clinicians made photo books. With these books as visual supports, he was able to see the pictures and then describe the events he completed (e.g., a trip to the zoo, birthday party, etc.). Over time, CHILD 1 relied less on the visuals, and the clinicians naturally faded them out.

CHILD 1 was highly motivated to tell narratives. He received great pleasure in being able to retell his experiences, and he then became interested in fictional stories. Therefore, the clinicians worked with CHILD 1 on developing fictional narratives. To this end, they started by painting or drawing a picture and creating a (brief and simple) story about that character. To structure the story, the clinician provided the context. They then each took turns adding one detail, to create a joint story. As CHILD 1 became more skilled, he took over adding more of the details independently, and he learned how to structure the background/context for the story as well. Toward the end of treatment, CHILD 1 created short, simple books with his clinician that they illustrated and wrote together using the shared story-telling approach.

CHILD 1 made exceptional progress during treatment. At the conclusion of treatment, a clinician otherwise not involved in the study evaluated him again (the clinician was not blind to treatment status, but otherwise was uninvolved in the study). As part of this evaluation, he completed the ADOS. The clinician noted that he made consistent and well-modulated eye contact, was able to appropriately engage in reciprocal conversations about a range of topics, and was able to tell about past experiences in clear and sequential narratives with appropriate detail and context. As illustrated in Table 1, following treatment, CHILD 1 no longer met criteria for autism spectrum on the ADOS. Additionally, his pragmatic language skills were re-assessed using the CELF-4 Pragmatic Profile. His score on his measure fell within the expected (non-impaired) range following treatment. He made dramatic improvements in his adaptive skills as well; improvements in adaptive skills are defined as increases in score from pre- to post-treatment. He showed increases on his age equivalent scores in the following subdomains: Receptive, Written, Domestic, Play and Leisure Time, and Coping Skills, all of which increased to a greater degree than expected based on chronological development, with an average increase of 16.4 months (meaning the equivalent of 16.4 months of gains on average, based on age equivalent scores) over a 4-month period. His scores on Expressive,

Personal, and Interpersonal Relationship subdomains were lower after treatment. His Community score remained stable. A decrease in score from pre- to post-treatment may be a function of the parent-training component of the intervention; after treatment, parents may be more aware of the child's deficits. His mother also, though, reported that he was engaging more consistently with peers and developing friendships. This was corroborated by reports from his school. The clinical impression at this post-treatment evaluation was that he did not meet criteria for an ASD. About a year later, at the end of first grade, his school indicated that he no longer met criteria for special education services. About 2 years later, in a clinical interview with his mother (CHILD 1 at age 8½), she reported that he was still not receiving special education services. He had friends and was doing quite well socially. He changed schools given a family move, and his family did not share with his new school (of about 1 year at the time), that he had a prior diagnosis of ASD.

Subject CHILD 2

CHILD 2's parents noticed that as an infant she let only her mother hold her, cried almost constantly, and was very difficult to soothe. Her speech was delayed; her first word emerged at about 20 months of age, and she spoke in short phrases starting just after 2 years. At 3 years of age, her parents noted that she did not play with other children, was often unresponsive to others, was quite upset by changes in her routine, and was highly regimented. When CHILD 2 was 4 years, 3 months of age, her parents sought an evaluation from a developmental-behavioral pediatrician. At this time, she was given a diagnosis of an ASD. Shortly after diagnosis, CHILD 2 entered an integrated preschool program where she received speech and language therapy. In kindergarten, CHILD 2 was in a mainstream classroom and received special education services, including speech language therapy, social skills instruction, and support from a special education teacher.

At 5 years of age, CHILD 2 was evaluated as part of her participation in the current study. Assessment of CHILD 2's cognitive abilities, using the DAS-II [52], revealed a discrepant cognitive profile. Her scores ranged from the below average range to the very high range (Standard scores: GCA = 110; Verbal = 107; Nonverbal Reasoning = 136; Spatial = 83). Her language functioning was assessed using the CELF-P-2 [53]; her scores were in the average to above average range (Standard scores: Core Language = 118; Receptive Language = 113; Expressive Language = 119; Language Content = 109; Language Structure = 121). CHILD 2's adaptive functioning was below average as measured by the Vineland-II [54] (Standard scores: Communication = 78; Daily Living Skills = 79; Socialization = 81). Her mother also was interviewed using the ADI-R [50], and CHILD 2 completed the ADOS Module 3 [49]. Based on the results from these two assessments, it was noted that CHILD 2 did not yet engage in reciprocal play with peers and preferred to play alone or watch other children play. She generally avoided social interactions, particularly in larger social situations such as at recess, and had limited insight into friendships/social relationships. Although her play skills were emerging, she did not engage in complex make-believe scenarios with other people, and her play routines were limited and repetitive. With regard to her communication skills, CHILD 2 spoke in complex sentences and used her language for a variety of purposes; however, her speech was often not directed at other people and was not communicative in nature. She had trouble maintaining conversations, as she tended to shift rapidly between topics and was often off-topic. CHILD 2 also had difficulty recalling and retelling past personal experiences. She would often provide a single detail that was not salient to the experience and leave out all contextually relevant information. Finally, her eye contact was inconsistent. She met criteria for autism on both the ADI-R and ADOS. Overall clinical judgment was consistent with a diagnosis of an autism spectrum disorder as well.

At the start of treatment, CHILD 2's goals included: 1) respond to comments with on-topic remarks; 2) initiate on-topic comments and questions; 3) improve reciprocity within the context of play and conversation; and 4) develop narrative skills.

Upon treatment inception, CHILD 2 was highly self-directed and minimally engaged with others. While she was fairly responsive to comments made by adults, she did not consistently respond to questions directly posed to her. Additionally, she rarely initiated social interaction, and her eye contact was not coordinated with her speech. Thus, clinicians engaged in structured activities that focused on requesting with eye contact, responding to questions and comments with on-topic remarks, and the basics of reciprocity. For example, while making an art project, the clinicians maintained control of the materials and waited for CHILD 2 to ask which color paint each person in the room wanted. Clinicians then briefly stopped the activity to ask her a question about what she was making, and if she answered with an on-topic comment, she was able to continue the activity. Initially, CHILD 2 consistently required a high level of prompting. For example, if she did not answer a question directly posed to her, the clinician followed up with, "I asked what you are painting. What can you say?" In addition to this type of indirect prompt, CHILD 2 also needed direct modeling of appropriate responses such as, "CHILD 2, you could say, I am making an elephant."

As treatment progressed, CHILD 2 became more engaged in play with her clinicians, responded appropriately to posed questions and comments more often, and verbally initiated with much greater social intention than at baseline. As a result of this improvement, clinicians increased the complexity of CHILD 2's social communication goals to target reciprocal conversation and narrative skills. CHILD 2 had difficulty continuing conversations past one question and one response. With prompting, though, she

Table 2. CHILD 2's ADOS and Vineland-II scores before and after 4-month treatment course.

	Pre treatment	Post treatment
ADOS Module 3 total score	11	4
ADOS Module 3 CSS*	6	2
VABS-II Communication SS	78	81
Receptive AE	21	21
Expressive AE	41	53
Written AE	61	68
VABS-II Daily Living Skills SS	79	89
Personal AE	38	62
Domestic AE	54	47
Community AE	43	58
VABS-II Socialization SS	81	83
Interpersonal AE	28	31
Play and Leisure AE	48	64
Coping AE	36	34

Note: Due to changes in study protocol, CELF-4 Pragmatics Profile was not administered to CHILD 2.
*ADOS CSS: Calibrated Severity Score

learned to ask follow-up questions and make comments that built upon previous comments made in the conversation. For example, when talking about motivating topics and ones of interest to CHILD 2, her clinicians asked her, "What else can you say?" or modeled appropriate ways to continue the exchange, such as, "You can say [additional detail about topic]." With this, CHILD 2 gained more robust and fluid conversational skills.

In addition to conversation skills, CHILD 2's narrative language skills also improved greatly. At the beginning of treatment, she often reported on small details from her experiences rather than focusing on contextually salient information, such as who was with her and what they did. In order to foster narrative skill development, CHILD 2's clinicians worked on her relaying sequenced information, such as the directions for a craft project with clear steps. CHILD 2 and her therapists also created picture schedules for each treatment session that provided an opportunity for her to learn how to sequence activities explicitly. CHILD 2 then would relay, using the visual schedule, the activities that she was going to complete (at the beginning of the session) and then completed (at the conclusion of the session). As CHILD 2 became more adept, she and her clinicians made books about family outings and events that happened outside of treatment. CHILD 2 used the pictures as visual supports to describe her experiences (e.g., a trip to the library, birthday party, etc.). After creating several of these books, CHILD 2 learned to recognize the salient information in her photographs and provide appropriate context. As CHILD 2 became more skilled, she independently added appropriate details into the experiences she shared.

As described, CHILD 2 made remarkable gains in her social communication skills throughout treatment. At the conclusion of treatment, a clinician who was not blind to treatment but otherwise not involved in the study evaluated her again. The clinician noted that during the ADOS, CHILD 2 made coordinated and consistent eye contact, was able to engage in reciprocal interactions using verbal and nonverbal behaviors, and was able to provide appropriate information about past personal experiences. As evidenced by her post treatment Vineland-II scores, CHILD 2 made great improvements in her adaptive skills; improvements in adaptive skills are defined as increases in score from pre- to post-treatment. She showed increases on her age equivalent scores in the following subdomains: Expressive Language, Written Language, Personal, Community, Interpersonal Relationships, and Play and Leisure Time; scores increased by an average of 12.8 months (meaning the equivalent of 12.8 months of gains on average, based on age equivalent scores) over a 4-month period. Her scores on Domestic and Coping Skills were lower after treatment. Her Receptive Language score remained constant. In the same regard as CHILD 1, decreases in scores after treatment may be a reflection of CHILD 2's parents being more aware of her deficits. These changes are illustrated in Table 2. At the end of treatment, CHILD 2 no longer met criteria for autism spectrum disorder as measured by the ADOS and post-treatment clinical impression was that she did not meet criteria for an ASD. CHILD 2 continues to receive special education services at school to foster a more robust social communication skill set and to provide facilitated interaction with same-age peers.

At follow-up 4 months after the conclusion of treatment, CHILD 2's mother reported that she is doing very well. She has friends at school and is independently initiating social interactions with them. She is able to sustain a reciprocal conversation and play interaction, and she is able to relay her experiences clearly and with appropriate

detail and context. Her services at school include social skills support and are largely focused on solidifying and maintaining the gains that she has achieved with peers.

With regard to future directions, we plan to continue to follow these children and track their trajectory over time. Additionally, we will also obtain collateral information from teachers, parents, and clinicians to obtain continued measures (both standardized and qualitative) of their development of social communication, behavioral, and adaptive skills.

CONCLUSION

PRT is an effective behaviorally based treatment for teaching social communication skills in individuals with ASD. It is becoming more widely employed as parents and providers seek naturalistic, empirically supported treatments. The two case studies presented and corresponding broader research project [33] importantly illustrate that PRT can be effective in a short-duration treatment model. These two cases also exemplify a growing interest and literature on children who have a highly favorable response to treatment, or children with optimal outcome. Estimates of optimal outcome vary widely, from 2 to 25 percent, but it is becoming clear that some children may benefit from effective intervention to the point that their social communication symptoms are ameliorated [2,4-6,9,10,14,15]. Not all of these children are without any difficulties, as attentional and executive functioning vulnerabilities, in particular, may persist. Although a subset of children with ASD do reach optimal outcome, the vast majority continue to struggle with social communication deficits and maintain their diagnosis. As a field, we do not yet know predictors of outcome. For example, at the outset, the two children discussed here were not phenotypically distinct from other children in this study who also made progress but did not achieve the same magnitude of response. Therefore, this work is crucial, not to predict who may succeed necessarily, but to individualize medicine and match children with customized treatment programs that will be best tailored to their unique and varied needs.

Acknowledgments: We would like to thank the Deitz Family for funding this research and acknowledge additional support from Allied World and the Autism Science Foundation. We wish to thank the families of the children included in this study for their time and participation. We also wish to thank our colleagues Avery Voos, Jonathan Tirrell, and Julie Wolf for their contributions to the treatment work and clinical characterization of the sample.

REFERENCES

1. Piven J, Harper J, Palmer P, Arndt S. Course of behavioral change in autism: a retrospective study of high-IQ adolescents and adults. J Am Acad Child Adolesc Psychiatry. 1996;35(4):523-9.
2. Anderson DK, Liang JW, Lord C. Predicting young adult outcome among more and less cognitively able individuals with autism spectrum disorders. J Child Psychol Psychiatry. 2014;55(5):485-94.
3. Eaves LC, Ho HH. Young adult outcome of autism spectrum disorders. J Autism Dev Disord. 2008;38(4):739-47.
4. Fein D, Barton M, Eigsti IM, Kelley E, Naigles L, Schultz RT, et al. Optimal outcome in individuals with a history of autism. J Child Psychol Psychiatry. 2013;54(2):195-205.
5. Helt M, Kelley E, Kinsbourne M, Pandey J, Boorstein H, Herbert M, et al. Can children with autism recover? If so, how? Neuropsychol Rev. 2008;18(4):339-66.
6. Billstedt E, Gillberg IC, Gillberg C. Autism after adolescence: population-based 13- to 22-year follow-up study of 120 individuals with autism diagnosed in childhood. J Autism Dev Disord. 2000;35(5):351-60.
7. Cohen H, Amerine-Dickens M, Smith T. Early intensive behavioral treatment: replication of the UCLA model in a community setting. J Dev Behav Pediatr. 2006;27(2):S145-55.
8. Eikeseth S, Smith T, Jahr E, Eldevik S. Outcome for children with autism who began intensive behavioral treatment between ages 4 and 7: a comparison controlled study. Behav Modif. 2007;31(3):264-78.
9. McGovern CW, Sigman M. Continuity and change from early childhood to adolescence in autism. J Child Psychol Psychiatry. 2004;46(4):401-8.
10. Rutter M. Autistic children: infancy to adulthood. Semin Psychiatry. 1970;2(4):435-50.
11. Lovaas OI. Behavioral treatment and normal educational and intellectual functioning in young autistic children. J Consult Clin Psychol. 1987;55(1):3-9.
12. Howard JS, Sparkman CR, Cohen HG, Green G, Stanislaw H. A comparison of intensive behavior analytic and eclectic treatments for young children with autism. Res Dev Disabil. 2005;26(4):359-83.
13. Sallows GO, Graupner TD. Intensive behavioral treatment for children with autism: four-year outcome and predictors. Am J Ment Retard. 2005;110(6):417-38.
14. Farley MA, McMahon WM, Fombonne E, Jenson WR, Miller J, Gardner M, et al. Twenty-year outcome for individuals with autism and average or near-average cognitive abilities. Autism Res. 2009;2(2):109-18.
15. Sigman M, Ruskin E, Arbeile S, Corona R, Dissanayake C, Espinosa M, et al. Continuity and change in the social competence of children with autism, Down syndrome, and developmental delays. Monogr Soc Res Child Dev. 1999;64(1):1-114.
16. Fein D, Dixon P, Paul J, Levin H. Brief report: pervasive developmental disorder can evolve into ADHD: case illustrations. J Autism Dev Disord. 2005;35(4):525-34.
17. Kelley E, Paul JJ, Fein D, Naigles LR. Residual language deficits in optimal outcome children with a history of autism. J Autism Dev Disord. 2006;36(6):807-28.
18. Sutera S, Pandey J, Esser EL, Rosenthal MA, Wilson LB, Barton M, et al. Predictors of optimal outcome in toddlers diagnosed with autism spectrum disorders. J Autism Dev Disord. 2007;37(1):98-107.
19. Turner LM, Stone WL. Variability in outcome for children with an ASD diagnosis at age 2. J Child Psychol Psychiatry. 2007;48(8):793-802.
20. Howlin P, Goode S, Hutton J, Rutter M. Adult outcome for children with autism. J Child Psychol Psychiatry. 2004;45(2):212-29.
21. Szatmari P, Bartolucci G, Bremner R. Asperger's syndrome and autism: comparison of early history and outcome. Dev Med Child Neurol. 1989;31(6):709-20.
22. Cederlund M, Hagberg B, Billstedt E, Gillberg IC, Gillberg C. Asperger syndrome and autism: a comparative longitudinal follow-up study more than 5 years after original diagnosis. J Autism Dev Disord. 2008;38(1):72-85.
23. Pellicano E. Do autistic symptoms persist across time? Evidence of substantial change in symptomatology over a 3-year period in cognitively able children with autism. Am J Intellect Dev Disabil. 2012;117(2):156-66.
24. Fountain C, Winter AS, Bearman PS. Six developmental trajectories characterize children with autism. Pediatrics. 2012;129(5):e1112-20.

25. Gillberg C, Steffenburg S. Outcome and prognostic factors in infantile autism and similar conditions: a population-based study of 46 cases followed through puberty. J Autism Dev Disord. 1987;17(2):273-87.
26. Howlin P, Mawhood L, Rutter M. Autism and developmental receptive language disorder--a follow-up comparison in early adult life. II: Social, behavioural, and psychiatric outcomes. J Child Psychol Psychiatry. 2000;41(5):561-78.
27. Seltzer MM, Shattuck P, Abbeduto L, Greenberg JS. Trajectory of development in adolescents and adults with autism. Ment Retard Dev Disabil Res Rev. 2004;19(4):234-47.
28. Koegel RL, O'Dell MC, Koegel LK. A natural language teaching paradigm for nonverbal autistic children. J Autism Dev Disord. 1987;17(2):187-200.
29. Koegel RL, Koegel LK. The PRT pocket guide. Baltimore: Brookes; 2012. 216 p.
30. Lovaas OI, Koegel R, Simmons JQ, Long JS. Some generalization and follow up measures on autistic children in behavior therapy. J Appl Behav Anal. 2013;6(1):131-65.
31. Koegel LK, Koegel RL, Harrower JK, Carter CM. Pivotal response intervention I: Overview of approach. Res Pract Persons Severe Disabl. 1999;24(3):174-85.
32. Koegel LK, Koegel RL, Shoshan Y, McNerney E. Pivotal response intervention II: Preliminary long-term outcome data. Res Pract Persons Severe Disabl. 1999;24(3):186-98.
33. Ventola P, Friedman HE, Anderson LC, Wolf JM, Oosting D, Foss-Feig J, et al. Improvements in Social and Adaptive Functioning Following Short-Duration PRT Program: A Clinical Replication. J Autism Dev Disord. 2014;44(11):2862-70.
34. Voos AC, Pelphrey KA, Tirrell J, Bolling DZ, Vander Wyk B, Kaiser MD, et al. Neural mechanisms of improvements in social motivation after pivotal response treatment: two case studies. J Autism Dev Disord. 2012;43(1):1-10.
35. Koegel RL, Frea WD. Treatment of social behavior in autism through the modification of pivotal social skills. J Appl Behav Anal. 1993;26(3):369-77.
36. Koegel RL, Koegel LK, Brookman LI. Chapter 19. Empirically supported pivotal response interventions for children with autism. In: Evidence-based Psychotherapies for Children and Adolescents. New York: Guilford Press; 2003. p. 341-57.
37. Bryson SE, Koegel LK, Koegel RL, Openden D, Smith IM, Nefdt N. Large scale dissemination and community implementation of pivotal response treatment: Program description and preliminary data. Res Pract Persons Severe Disabl. 2007;32(2):142-53.
38. Coolican J, Smith IM, Bryson SE. Brief parent training in pivotal response treatment for preschoolers with autism. J Child Psychol Psychiatry. 2010;51(12):1321-30.
39. Laski KE, Charlop MH, Schreibman L. Training parents to use the natural language paradigm to increase their autistic children's speech. J Appl Behav Anal. 1988;21(4):391-400.
40. Minjarez MB, Williams SE, Mercier EM, Hardan AY. Pivotal response group treatment program for parents of children with autism. J Autism Dev Disord. 2011;41(1):92-101.
41. Doggett RA, Krasno AM, Koegel LK, Koegel RL. Acquisition of Multiple Questions in the Context of Social Conversation in Children with Autism. J Autism Dev Disord. 2013;43(9):1-11.
42. LeBlanc LA, Geiger KB, Sautter RA, Sidener TM. Using the Natural Language Paradigm (NLP) to increase vocalizations of older adults with cognitive impairments. Res Dev Disabil. 2007;28(4):437-44.
43. Steiner AM, Gengoux GW, Klin A, Chawarska K. Pivotal response treatment for infants at-risk for autism spectrum disorders: A pilot study. J Autism Dev Disord. 2013;43(1):91-102.
44. Stahmer AC. Teaching symbolic play skills to children with autism using pivotal response training. J Autism Dev Disord. 1995;25(2):123-141.
45. Facts about ASD. Centers for Disease Control and Prevention [Internet]. 2014 [cited 2014 Nov 7]. Available from: http://www.cdc.gov/ncbddd/autism/facts.html.
46. Blumberg SJ, Bramlett MD, Kogan MD, Schieve LA, Jones JR, Lu MC. Changes in prevalence of parent-reported autism spectrum disorder in school-aged US children: 2007 to 2011-2012. Natl Health Stat Report. 2013;65:1-7.
47. Dawson G. Early behavioral intervention, brain plasticity, and the prevention of autism spectrum disorder. Dev Psychopathol. 2008;20(3):775-803.
48. Princiotta D, Goldstein S. Part II, Early Start Denver Model. In: Interventions for Autism Spectrum Disorders. New York: Springer; 2013. p. 59-73.
49. Lord C, Rutter M, DiLavore PC, Risi S. Autism Diagnostic Observation Schedule—Second Edition (ADOS-2). Los Angeles: Western Psychological Services; 2012.
50. Rutter M, Le Couter A, Lord C. ADI-R: Autism Diagnostic Interview-Revised. Los Angeles: Western Psychological Services; 2003.
51. Brigance A. Brigance Diagnostic Inventory of Early Development, Revised. North Billerica: Curriculum Associates, Inc; 1991.
52. Elliott CD. Differential Ability Scales—Second Edition (DAS-II). 2nd ed. San Antonio: Psychological Corporation; 2006.
53. Semel EM, Wiig EH, Secord W. CELF Preschool 2: Clinical Evaluation of Language Fundamentals Preschool. Pearson/PsychCorp; 2004.
54. Sparrow SS, Balla DA, Cicchetti DV. Vineland Adaptive Behavior Scales. 2nd ed. Circle Pines: American Guidance Service; 2005.
55. Semel E, Wiig E, Secord WA. Clinical Evaluation of Language Fundamentals 4th Edition (CELF-4). San Antonio: The Psychological Corporation; 2003.