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Treating the Core Features of Autism: Are We There Yet?

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A wide variety of nonestablished treatments have been proposed as "cures" for the core features of autism and are used frequently despite having largely escaped scientific scrutiny. In contrast, a growing body of empirical evidence supports the use of a few forms of theory-based and empirically validated treatment for some aspects of the core features of autism. These include behavioral/psychoeducational interventions and specific forms of medication treatment, which can produce significant improvements in communication, social interaction, and problem behaviors that both maintain over time and generalize across settings. While there is no doubt that treatment and educational services for persons with autism have improved over the past 6 decades, it also appears that significant issues remain with respect to (1) the routine application of validated treatments for the majority of cases with autism, (2) the resistance to even validated forms of treatment for a substantial minority of cases with autism, and (3) the extent to which validated treatments effectively treat the specific core features of autism that are most disabling for persons with autism and their families.
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As autism is characterized by deficits in language usage, impairments in social reciprocity, and the presence of behavioral rigidity, the primary goal of autism treatment should be the alleviation of these core features. Thus the pressing question when considering the body of treatment research studies in autism is–"*Do available treatments alleviate the core features of autism*?" This has been the central question in systematic reviews of autism and its treatment during the six decades which have now passed since Kanner's [1943] seminal work on the disorder [Eisenberg, 1956; Lockyer and Rutter, 1969; Kanner et al., 1972; Rutter, 1985; Bristol et al., 1996; Howlin et al., 2004]. Review of the large body of published autism treatment studies reveals two general areas with respect to the search for treatments for the core features of autism: (1) a variety of nonestablished treatments that frequently have been proposed as "cures" for the core features of autism but have largely escaped scientific validation and (2) the growing body of empirical evidence on a few forms of theory-based and empirically validated forms of treatment for the core features of autism. In this paper, I will outline the progress that has been made in each of these areas. In addition to reviewing evidence for the efficacy of treatments for autism, I will examine what I term the "depth of intervention effect" question in autism. Specifically, given the range of symptoms that are expressed in autism, how "deeply" do established treatments go in impacting the continuum of impairment within each domain area?

NONESTABLISHED TREATMENTS FOR AUTISM

Parents of children with autism find the disorder to be an unusually mysterious and perplexing condition in which symptoms and behaviors fluctuate with inexplicable rhythms. As such, causes and explanations of autistic behavior are occasionally glimpsed but never fully revealed. Add to this the fact that frequently children with autism demonstrate clear "islands of ability" amidst a sea of disabilities. This can leave parents with a powerful sense that maybe something can be done to "open the door." Parents' hopes for such "cures" are easily amplified by dramatic reporting of anecdotes on television, on the Internet, and in newspapers [Sandler and Bodfish, 2000].

Over the past several decades, many approaches have been serendipitously "discovered," each proposed as a "treatment," and some even boldly hailed as a "cure" for autism via sensational accounts in the media. These include holding therapy, megavitamins, music therapy, auditory integration therapy, facilitated communication, sensory diets, sensorimotor integration therapy, play therapy, Gentle Teaching, experimental brain surgery, immunosuppressant therapy, and secretin to name a few. Few of these were ever promising enough to even progress to rigorous scientific testing in controlled clinical trials despite initial popular media attention [Freeman, 1997]. Some were rigorously tested following parent demands to do so and were found to be ineffective [Sandler et al., 1999; Kern et al., 2004]. Over time these serendipitously discovered approaches to the treatment of autism have failed to achieve the consensus of clinicians or researchers as a legitimate way to alleviate the core features of autism or even to minimize the severity of autistic symptomatology [Campbell et al., 1996; Volkmar et al., 1999]. Although disappointing chapters in the history of autism treatment, the uptake and subsequent release of interest in most of these nonestablished treatment approaches has demonstrated that autism is a disorder that seems to be particularly "at risk" for unfounded claims of treatment [Sandler and Bodfish, 2000].

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Because there is no evidence from which individuals who promote treatments for autism can make claims of potential "cures" for autistic children, it is important for clinicians to counsel families to guard against either acting on such claims or increasing their hopes for change to this level.

Despite a lack of empirical evidence or clinical consensus to support their use, there is clear evidence that many parents of children with autism continue to be interested in the use of nonestablished or alternative therapies Aman, Lam, and Collier-Crespin [2003] found that there was considerable use of "alternative medicine" therapies along with standard psychotropic medications in the community treatment of children and adults with autism. In a survey of 121 parents who had enrolled their autistic children in intensive behavior analytic treatment programs ("ABA" treatment), Smith and Antolovich [2000] found that children in ABA treatment programs were also receiving an average of seven supplemental alternative treatment interventions. Interestingly, in the same study these authors reported that parents typically reported that these alternative therapies produced little or no apparent benefit for their autistic child. Although often viewed as benign, alternative therapies can be costly to families in terms of either time or money or both [Sandler and Bodfish, 2000], and those that are more invasive (e.g., alternative medicines, diets, surgeries) have the potential to have adverse effects.

As a part of the overall effort of researching treatments for autism, the examination of these alternative or nonestablished therapies has taken two forms. First, it is clear that research on established treatments now must involve attention to the potential concomitant use of alternative therapies given their popularity among parents [Smith and Antolovich, 2000]. Second, newly proposed alternative treatments are increasingly being subjected to more rigorous scientific evaluations of safety and efficacy. For example, secretin (a peptide hormone that stimulates pancreatic secretion) was proposed as a potential "cure" for autism following a single anecdotal report of its efficacy in 1998. This led to a tremendous amount of media exposure as a potential treatment for autism and considerable parent interest in its use for their children with autism. Within a year of this exposure the first randomized control trial of secretin effects in autism was published [Sandler et al., 1999] showing that secretin had no benefit above placebo on the core symptoms of autism when evaluated under blind conditions. Within the following 3 years, 16 well-controlled studies of secretin treatment in autism have been published, all demonstrating its lack of efficacy. Ironically, secretin is thus the single form of autism treatment that to date has been most rigorously investigated (from the standpoint of randomized clinical trials) and yet there is no rigorous scientific evidence of its efficacy. While it is unfortunate that this research effort did not lead to clues with regard to treatment of the core features of autism, these events demonstrate that the field of autism treatment research has progressed to the point where purported treatments can be rigorously investigated for clinical efficacy in a timely manner.

EMPIRICALLY VALIDATED TREATMENTS FOR AUTISM

In contrast to the disappointments of the various nonestablished treatment approaches, a few forms of treatment have been based in an established theory of autism and have achieved some measure of empirical support and clinical consensus as practical and safe ways to minimize the severity of autistic symptomatology [Bristol et al., 1996; Volkmar et al., 1999]. The two treatment approaches for autism that have amassed the most scientific and clinical support are behavioral/psychoeducational treatment approaches and biomedical treatment approaches. These two approaches evolved from different theoretical orientations to the deficits characteristic of autism. The focus on biomedical causes (i.e., genetic, neurological) lead naturally to a search for medical treatments. In contrast, the focus on abnormalities in behavioral, emotional, and cognitive development lead to an emphasis on psychological or behavioral interventions [Rutter, 1985]. However, although both theoretical approaches make claims with respect to putative etiological and pathophysiologic factors, the pathogenesis of autism has remained largely unknown. For this reason, existing empirically validated treatments for autism are largely symptomatic in nature. Thus, clear empirical validation exists for specific forms of behavioral and medical treatment for particular autistic symptoms within specific core deficit areas rather than as overall forms of treatment for all of the core deficits of autism.

Behavioral/Psychoeducational Treatments for Autism

Conceptual model

The first conceptualization of autism within a behavioral framework was made by Ferster [1961], who hypothesized that some of the acquired behavioral deficits seen in autism might develop due to a deficiency in acquired (i.e., social) reinforcers. Logically, children with social deficits of whatever origin would not naturally acquire adaptive behaviors that other children learn incidentally via natural social consequences. This was followed by empirical demonstrations that behaviors characteristic of each of the core domains of autism could be related in a lawful manner to certain explicit environmental changes [Ferster and DeMyer, 1961], a finding that has now been replicated in hundreds of published studies [Matson et al., 1996; Bregman, 1997]. Of importance in this approach is a clear distinction between the factors responsible for the etiology of autism (presumably genetic and neurobiological) and those factors responsible to for development of the abnormal behaviors associated with autism (presumably environmental and psychological) [Lovaas et al., 1973; Lovaas and Smith, 1989]. This conceptualization, based on the established scientific principles of learning theory, supported the application of learning-based intervention techniques as forms of treatment for both the deficit features of autism (e.g., cognitive, language, social) and the expressed behavioral features of autism (e.g., repetitive behaviors, problem behaviors) (Wolf et al., 1964; Lovaas et al., 1966].

The published behavioral treatment literature that has arisen based on the operant learning model involves the application of the standardized methods of behavioral science to examine and demonstrate treatment effects. Key features of this empirical approach are (1) operational definition of observable target behaviors, (2) definition of behavioral antecedents and consequents that make explicit the functional relationship between the treatment environment and the target behavior, (3) a task analysis that explicitly defines the treatment procedure, and (4) a measurement system for quantifying the acquisition, maintenance, and generalization of the target behavior [Rogers, 2000]. The goal of this methodology is to ensure that effective elements of a treatment procedure can be reliably identified by researchers, tested in replication studies by other researchers, and then reliably and practically ap-

plied by treatment agents (e.g., parents, teachers).

A key feature of the behavioral/psychoeducational approaches that have been developed to treat autism is an understanding of the unique ways that children with autism tend to interact with their environment and an appreciation of how they benefit from structured, planned, and predictable presentation of stimuli and events [Schopler et al., 1971, 1982]. Accordingly, several models of behavioral/educational treatment for autism have been established (e.g., TEACCH, ABA/Discrete Trial Training, Pivotal Response Training, Incidental Teaching) that incorporate elements of this structured learning approach. Other critical programmatic components of effective behavioral/educational models for treating autism that have been identified [Dawson and Osterling, 1991; Howlin, 1998; Wolery, 2000] include the use of a defined curriculum, attention to ensuring predictability and use of routines, the use of generalization strategies, the use of supportive transitions across programs, and high intensity of learning opportunities. Also, family involvement in the treatment planning and implementation process has been incorporated as an essential piece of effective behavioral/educational treatment programs [Schopler and Reicler, 1971].

Communication intervention studies

The treatment of verbal and nonverbal communication deficits has been one of the main areas of research on the behavioral/educational treatment of autism. Under typical conditions, approximately 50% of children diagnosed with autism remain nonverbal [Prizant, 1983]. In contrast to this, studies have indicated that as many as 90% of children with autism can learn to use verbal communication as a primary means of communicating with others when established behavioral/educational interventions designed for teaching language are used before age 5 [McEachin et al., 1993; McGee et al., 1994; Koegel, 1995; Smith et al., 1997; Kern-Koegel, 2000]. Initial behavioral interventions for treating language impairments in autism focused on a structured clinic-based or home-based discrete trial (or "drill") format. While clearly effective in both teaching language and promoting more typical patterns of adaptive behavioral development, the discrete-trial language intervention approach did not promote generalization of language use beyond training settings and it also proved difficult to implement with fidelity in routine settings [Volkmar et al., 1999; Koegel, 2000; Bibby et al., 2001]. In response to these limitations, approaches have been developed to teach language use more efficiently, more effectively, and more durably in naturally occurring settings (e.g., inclusive preschools and schools, routine home and community settings) [Koegel, 2000]. These natural language teaching approaches involve the inclusion of specific motivational procedures, a focus on following the child's lead, the provision of frequent opportunities for child-initiated expressive language in the natural environment throughout the child's day, and the inclusion of parents, teachers, and peers as therapists [Warren et al., 1984; Charlop et al., 1985; Koegel et al., 1987; Yoder et al., 1993; Koegel, 2000].

Researchers have referred to communication as a "pivotal" behavior that can significantly influence other features of autism. This is based on data that indicates effective language training can lead to generalized (i.e., nontargeted) improvements in social skills [Lovaas et al., 1973; Koegel and Frea, 1993; Dawson and Osterling, 1996; Rogers, 1998], repetitive behaviors [Lovaas et al., 1973], and nonspecific problem behaviors such as noncompliance; self-injury, and aggression [Lovaas et al., 1973; Carr and Durand, 1985; McEachin et al., 1993; Koegel et al., 1999].

A key feature of the language deficits characteristic of autism is that children with autism lack spontaneous verbal and nonverbal initiations even after successful language training has resulted in verbal language as the primary form of the child's communication. While pretreatment intelligence quotient (IQ) and the presence of functional speech before age 5 have long been purported to be the phenotypic characteristics associated with the most favorable outcomes following early intervention in autism [Freeman et al., 1985; Gillberg and Steffenburg, 1987], more recent research suggests that these features are correlates of the level of social-communicative initiations (e.g., initiated joint attention) that may be a more powerful prognostic indicator [Mundy and Crowson, 1997;Koegel et al., 1999; Koegel, 2000]. Accordingly, more recently researchers have developed treatments (1) to increase the generalized use of self-initiated protodeclaratives in prelinguistic children with pervasive developmental disorders [Yoder and Warren; 1999] and (2) to increase the social initiations and spontaneous verbalizations in verbal children with autism [Warren et al., 1984].

Research has also demonstrated that behavioral/educational interventions can be effective in teaching lower-functioning (i.e., IQ $<$ 50) nonverbal children with autism to communicate functionally using augmentative and alternative communication devices (AACs) such as sign language, photographs, communication books, computerized devices, and picture exchange systems [Carr and Kologinsky, 1983; Reichle et al., 1996; Bondy and Frost, 1998]. Although nonverbal children with autism can show substantial gains in prompted use of AACs, there is evidence that such use may not often generalize to untrained settings and that spontaneous communication continues to be a problem for these children [Mirenda and Mathy-Laikko, 1989; Udwin and Yule, 1990].

Social intervention studies

The social deficits of autism have also been the focus of many behavioral/educational research studies. A wide variety of social interventions for children and adults with autism have been developed and tested in controlled behavioral studies [Rogers, 2000]. Behavioral methods have been shown to be effective in teaching child–parent social interactions [Dawson and Galpert, 1990], child–other adult social interactions [Oke and Schreibman, 1990; Stahmer, 1995], and child–peer social interactions [Strain et al., 1979; Danko et al., 1998]. Social intervention studies have demonstrated that a variety of teaching methods effectively increase social skills (e.g., direct instruction, peer tutoring, video-modeling, social stories/games, scripted self-management) and that such methods are effective in both preschool and school-age children with autism [Rogers, 2000]. Although social intervention studies have included the full range of functioning present within the autism spectrum, relatively few studies have focused on improving social behaviors in lower functioning children or adults with autism [Rogers, 2000].

Paralleling trends in the language interventions studies, early social intervention approaches involved analog discrete-trial adult-directed instruction [Simpson et al., 1997] while more recent studies have focused on incidental teaching approaches that utilize naturally occurring social events with regular interaction partners in routine everyday settings. This shift in focus has brought with it concomitant gains in maintenance and generalization of the social skills that are taught for children and adults with autism [Lord and Hopkins, 1986; Koegel and Frea, 1993; Krantz and McClanna-

han, 1998]. Research has also indicated that social skills appear to be pivotal responses that, when trained, can lead to improvements in other nontargeted symptoms of autism, such as verbal and nonverbal communication [Krantz and McClannahan, 1993; Stahmer, 1995] and problematic behavior [Lee and Odom, 1996; Koegel et al., 1992].

Repetitive behavior intervention studies

Behavioral interventions have also been studied as forms of treatment for the repetitive behavior and associated features of autism [Matson et al., 1996; Horner et al., 2002]. In autism, this core area is characterized by a variety of overt behavioral symptoms, including stereotyped motor behaviors (e.g., hand-flapping, body-rocking, object spinning), rituals and routines (e.g., ordering items or events, insisting on sameness), obsessional restricted interests (e.g., nonfunctional consuming interest in train schedules), and also a more general characteristic of rigidity/inflexibility and poor response to novelty [Rutter, 1985; Lewis and Bodfish 1999; Bodfish et al., 2000]. To date, the treatment of the repetitive behavior core features of autism has received far less study than the treatment of the social and communication deficits of autism. Empirical support does exist for three behavioral approaches for treating repetitive behaviors in children and adults with autism: (1) teaching, occasioning, and reinforcing alternative adaptive behaviors (e.g., language/social interventions, differential reinforcement procedures) [Lee and Odom, 1996; Matson et al., 1996; Horner et al., 2002], (2) environmental arrangement or structuring [Schopler et al., 1971; Clark and Rutter, 1981; Goodall and Corbett, 1982], and (3) shaping or graded change [Rutter, 1985; Howlin, 1998].

In contrast to behavioral/educational intervention studies of the social and communication deficits of autism, studies on the treatment of repetitive behaviors have largely involved lower functioning individuals with autism and consequently little is known about treating this core feature in higher functioning persons with autism. Related to this point, the bulk of the literature on treating repetitive behaviors in autism has focused on treating the simple (and perhaps nonspecific) repetitive behaviors such as stereotyped behavior. Thus, at present, we know little about effective methods for the behavioral/educational treatment of the higher-order ritualistic repetitive behaviors and general rigidity/inflexibility that are most characteristic of autism [Lewis and Bodfish, 1999; Turner; 1999].

BIOMEDICAL TREATMENTS FOR AUTISM

Conceptual Model

Biomedical models of autism move beyond the acquired behavioral aspects of autism to focus more broadly on the potential links between the core features as expressed in manifest behavior and the putative neurobiologic systems involved in the etiology and pathogenisis of these core deficits. Basic behavioral research in autism has made it clear that the phenotype of autism is tremendously heterogeneous both between potential subtypes (e.g., Aspergers, high-functioning autism, low-functioning autism, PDD-NOS) and between individual cases within a subtype. Accordingly, neurobiological models of autism have expanded from models focusing on single brain areas of single neurotransmitter systems (e.g., serotonin, dopamine) to a collection of more modular accounts of putative neural circuits (e.g., fronto-striatal system, medial-temporal lobe), the functional integrity of which is presumed to underlie individual differences in patterns of expression of each of the core deficits.

While autism is undoubtedly a brain disorder, the neurobiological basis of autism remains to be identified. The bulk of available neurochemical evidence supports a role for dopamine (DA) systems in the pathogenesis of the stereotyped, repetitive behavior patterns characteristic of persons with autism [Leckman et al., 1980; Lewis and Baumeister, 1982; Gillberg and Svennerholm, 1987; Launay et al., 1987] and a role for serotonin (5HT) systems in the broader pathogenesis of autism [Schain and Freedman, 1961; Campbell et al., 1974; Hoshino et al., 1984; Anderson et al., 1987; McBride et al., 1989]. In both cases, pharmacological treatment studies have contributed significantly to the evidence suggesting involvement of these neurotransmitter systems in autism.

Medication Intervention Studies

There has been considerable interest in a wide range of medications for the treatment of autism. Of the medications suggested, several have been found to only be effective for nonspecific symptoms such as irritability, overactivity, aggression, and self-injurious behavior [King, 2000]. In contrast, dopaminergic and serotonergic agents have been demonstrated to have clinically significant effects on some aspects of the core features of autism when examined in randomized, controlled trials [Volkmar et al., 1999; Lewis and Bodfish, 1999]. This is consistent with the bulk of the existing neurobiological evidence, which suggests that aberrant behavior in autism is mediated in part by alterations in brain 5HT and DA systems [Lewis et al., 1996b; Racusin et al., 1999; Aman et al., 2000].

There is evidence that the older, "typical" antipsychotics and the nonselective serotonin reuptake medications are poorly tolerated by many individuals with autism [Gordon et al., 1993; Campbell et al., 1997]. For this reason, current psychopharmacology treatment research in autism has focused on the newer dopamine-blocking agents (referred to as "atypical" antipsychotics) and the newer serotonin reuptake inhibitors (referred to as selective serotonin reuptake inhibiting agents or SSRIs).

There is reasonable evidence supporting the use of the atypical antipsychotics risperidone and olanzapine in the treatment of some of the behavioral problems associated with autism. The evidence includes several open trials and two placebo-controlled trials of atypical antipsychotics in autism, all reporting significant improvements in at least half of the patients studied [Findling et al., 1997; Horrigan and Barnhill, 1997; McDougle et al., 1997, 1998b; Potenza et al., 1999; Posey et al., 1999b; Malone et al., 2001; McCracken et al., 2002]. However, in these studies most of the improvements were seen in such nonspecific behavioral problems as aggression, self-injurious behavior, irritability, and anxiety. With respect to the core features of autism, improvements were reported for some of the repetitive behavioral features of autism but not for the social or communication deficits. Further, while clearly significant with respect to improvements in behavioral problems in most cases, the atypical antipsychotics are also clearly associated with weight gain and sedation in at least a significant minority of cases treated and for some of whom such side effects become treatment limiting [Aman and Madrid, 1999]. Although atypical antipsychotics are known to produce fewer extrapyramidal side effects (e.g., dyskinesia, akathisia, parkinsonism) than typical antipsychotics (e.g., haloperidol, thioridazine), the acute nature of the majority of the atypical antipsychotic treatment studies in autism does not provide sufficient time to accurately evaluate potential long-term tardive effects (e.g., tardive dyskinesia).

There is also reasonable evidence supporting the use of serotonin reuptake inhibitors in the treatment of older individuals with autism. This evidence includes numerous positive case series and

open studies reporting improvements in autistic adults [Cook et al., 1992; Bodfish and Madison; 1993; Hellings et al., 1996; Brodkin et al., 1997; McDougle; 1998a; Posey et al., 1999a; Buchsbaum et al., 2001]. There also have been four positive double-blind, placebo-controlled trials with SRIs. The SRI clomipramine was shown to reduce repetitive behavior and abnormal social-communication symptoms to a significantly greater degree than the non-SRI comparator desipramine but clomipramine was also associated with significant side effects in several cases [Gordon et al., 1993]. McDougle et al. [1996] showed that fluvoxamine led to significant improvements in the overall functioning of 53% of the 16 people treated, while none of those in the placebo group responded. Fluvoxamine-related improvements were noted in repetitive thoughts and behaviors and maladaptive behaviors. In two additional placebo, double-blind studies, clomipramine produced clinically significant (>50%) reduction in a variety of repetitive behaviors in adults with PDD and mental retardation. Improvements were noted in repetitive behaviors (e.g., stereotyped motor behaviors, compulsions) as measured by both direct behavioral counts and clinical ratings scales [Lewis et al., 1995, 1996a].

The evidence of the effects of SRIs in children is more equivocal as there have been no randomized controlled trials published to date in children. Published open trial studies with the less selective medication clomipramine have shown inconsistent findings and some have indicated that younger children respond less well [Brasic et al., 1994; McDougle et al., 2000]. Significant improvements have been more consistently observed in open studies of the SSRIs [Steingard et al., 1997; DeLong et al., 1998], including improvements in both repetitive behavior and social-communication symptoms. DeLong and colleagues' study of the effects of fluoxetine in young autistic children is particularly provocative because of the gains in language skills that were reported for children who were receiving concommitant behavioral treatment for language. Improvements in social functioning and increased interest in the environment were reported in an open prospective study of fluoxetine treatment of six children between 4 and 8 years with autism [Peral et al., 1999]. However, these effects have not been replicated to date under blinded, placebo-controlled conditions and concerns have been raised about the tolerability of SSRIs in the pediatric populations [McDougle et al., 2000].

SOCIAL VALIDITY OF TREATMENTS FOR AUTISM

So far, evidence from treatment studies has been considered in support of the empirically validated forms of treatment for autism. Another way to gauge the effectiveness of the existing behavioral and medical interventions is to examine their effects in relation to what is known about the natural course of autism from childhood to adulthood. This provides a necessary degree of social validity to considerations of treatment effectiveness. Existing studies of the natural course of autism have identified the range of possible adult outcomes for persons with autism.

The earliest systematic studies followed adults (n = 37) who had been originally diagnosed in the 1950s and 1960s [Rutter and Lockyear, 1967; Lockyear and Rutter, 1969] and found that at follow-up few had acquired speech, almost all had shown declines in IQ, and 75% required institutionalization. In contrast to the early outcome studies, it is now clear that, when specific behavioral/psychoeducational treatments developed for autism are applied with fidelity, most children with autism acquire speech, most exhibit either no change or an improvement in IQ, and few regress to the point of requiring institutionalization [Volkmar et al., 1999]. With respect to medical treatments, as recently as 1985 it was noted that outcomes from medication interventions for autism were "generally disappointing" [Rutter, 1995] but more recently a wider variety of medications have become available and specific medications have been found to be safe and effective for the treatment of some of the behavioral sequelae of autism, including ritualistic repetitive behaviors and also nonspecific problematic behaviors [Aman and Madrid, 1999; Rascusin et al., 1999; King, 2000].

Despite the demonstrated promise of the empirically validated treatments for autism, it is also now clear that there can be a considerable gap between the magnitude of treatment outcomes in well-controlled treatment studies and those obtained as a result of typically available treatment services for persons with autism and their families. For example, in a more recent study of adult outcomes for children with autism (n = 68 children who grew up in 1980s and 1990s) Howlin et al. [2004] showed that only 22% achieved a "very good" or "good" outcome while the majority (58%) were rated as having "poor" (46%) or "very poor" (12%) outcomes.

While there is no doubt that treatment and educational services for persons with autism have improved over the past six decades, it also appears that significant issues remain with respect to both the routine application of validated treatments for the majority of cases with autism and the resistance to even validated forms of treatment for a substantial minority of cases with autism. To be sure, to some extent this gap between treatment study and routine service outcomes for persons with autism is related to problems in translating effective treatment procedures from highly controlled experimental settings to routine clinical settings (i.e., problems with treatment fidelity in the real world). However, it is also plausible that these interventions, while effective as treatments at some level, are not typically impacting autism at a deep enough level to produce the kind of socially valid outcomes that are being tracked in these studies of adult outcomes in autism.

DEPTH OF INTERVENTION EFFECTS IN AUTISM

As reviewed above, it is clear that ample experimental evidence exists that persons with autism can learn more appropriate ways of communicating, interacting, and behaving provided that effective behavioral/psychoeducational methods of treatment are used. Importantly, these skills appear to maintain and generalize provided that such behavioral/psychoeducational approaches are adapted to ensure that child-specific motivational procedures are used and learning in natural communication and social interaction settings takes place. Further, it is clear that specific medication treatments can also produce significant improvements in some of the specific behavioral difficulties associated with autism and also can significantly reduce nonspecific behavior and mood problems. However, it is important to consider what can be termed the "depth of intervention effect" question: Do these empirically established forms of behavioral and medication treatment for autism significantly impact those core features that are most characteristic and likewise most disabling for persons with autism?

Answering the "depth of intervention effect" question requires that we can distinguish between symptoms of each core domain that may be present but are not as specific to the autism impairment as other, more specific symptomatic expressions of the core domain. Advances

in behavioral studies of autism have shed light on the continuum of symptoms that can be impaired within each core area of autism and also which specific symptoms seem to be most characteristic of autistic impairment in general [Rutter, 1985; Tager-Flusberg, 1997; Turner, 1999; Constantino et al., 2000]. In autism, social and communication deficits are joint parts of one of the most characteristic and defining features of autism–social-pragmatics or the social uses of communication [Lord and Hopkins, 1986; Lord and Pickles, 1996; Tager-Flusberg, 1997]. Autistic children often lack empathy and the ability to share other people's feelings and can find it difficult to appreciate social cues and signals [Rutter, 1985; Lord and Magill-Evans, 1995; Bauminger and Kasari, 2000]. As a result of these key social-pragmatic deficits, persons with autism lack social reciprocity and responsiveness to others. In a similar way, features of the repetitive behavior core area of autism can be hierarchically arranged with respect to apparent specificity and resultant functional impact on overall adaptive behavioral development. Lower-order stereotyped behaviors are often present but do not seem to produce the kind of all-encompassing problems that the more general pattern of behavioral rigidity (e.g., inflexibility, resistance to change, need for sameness, restricted interests) seems to produce for persons with autism [Lewis and Bodfish, 1999; Turner, 1999; Bodfish et al., 2000].

Armed with a more complete knowledge of the range of behavioral impairments that exists within the core domains of autism, a more critical appraisal of the effects of empirically validated treatments can be considered. Viewed in this light, key issues in the treatment of the core deficits of autism are whether the effects of existing empirically supported interventions (1) extend beyond discrete aspects of communication behavior (phonological, syntactic, and semantic abilities) to include the functional social use of language, (2) extend beyond simply increasing the frequency of social interactions to affect the more complex social–emotional deficits that are the defining feature of autistic social impairments, and (3) extend beyond simple stereotyped behaviors to include the more complex, higher-order forms of behavioral rigidity that are characteristic of autism. However, as reviewed above, a critical appraisal of findings from both behavioral/educational and medical intervention studies with respect to those core features of autism that seem to be most characteristic of the disorder suggests that these treatments seem to be most effective in treating relatively simple aspects of the core features of autism (e.g., speech, social interaction, stereotyped behavior) while leaving the more complex phenotypic features untreated in the majority of cases. Consequently, it is not clear whether these aspects of the core features of autism are appreciably improved by the existing empirically validated interventions for autism [Bristol et al., 1996; Koegel, 2000; Rogers, 2000]. Simply put: treatments may bring about less flapping, more words, and more interactions when flexibility, meaning, and friends are what is needed.

Coming full circle to return to the issue of nonestablished "alternative" treatments, one wonders whether to some extent some parents of children with autism sense both the practical limitations of the existing empirically validated interventions and their "shallowness" of effect with respect to the core features of autism. If so, this would at least go partway in helping to explain parents' continued interest in and use of alternative invalidated treatments. To be sure, many parents are satisfied with the effects that the empirically validated behavioral and medication treatments have produced for their children. However, the fact that most parents remain interested in presumably ineffective treatments [Smith and Antolovich, 2000] should humble the research community. It seems reasonable to assume that this reflects several things. First, a deep desire to improve their child's quality of life (and not just to reduce symptom severity). Second, a recognition of the disruptive effects that autism can have on family life in general. And, third, a lack of satisfaction with either the existing treatment options or their availability and typical application in routine practice. To the extent that these reflections are true, it is important to consider these weaknesses of the existing validated forms of treatment as a basis for directing future research designed to discover improved forms of treatment for the core features of autism.

FUTURE DIRECTIONS FOR AUTISM TREATMENT RESEARCH

How can studies of autism treatment move beyond demonstrations of changes in lower-level features of the autistic phenotype to begin addressing mechanisms for producing more meaningful changes in those features of autism that are most disabling? Answers to this question are likely to involve a combination of both continued study of the existing validated forms of autism treatment and novel lines of treatment research aimed at discovering novel treatment approaches.

Many others have noted the urgent need for more scientifically rigorous studies of the existing forms of autism treatment [Rutter, 1985; Bristol et al., 1996; Lewis and Bodfish, 1999; Lord, 2000]. Most of the research findings in the area of medication interventions are based on open trials with small to modest heterogeneous sample sizes, and most of the research findings in the area of behavioral/educational interventions are based on single-subject designs typically replicated across a small number of poorly characterized cases. To rectify this lack of scientific rigor, methodological improvements that need to be included in future studies are (1) the use of well-chosen and well-specified autism groups based on validated assessment and diagnosis procedures; (2) the inclusion of appropriate control groups and/or control conditions; (3) random assignment to treatment groups/conditions; (4) the use of psychometrically sound standardized outcome measures that have established validity as measures of the core features of autism; (5) the assessment of generality of treatment effects across settings, including those that tend to be problematic for persons with autism; (6) the assessment of the maintenance of treatment effects beyond acute treatment periods; and (7) the use of measures of treatment acceptability (i.e., to families) and cost. In addition, for most of the areas of autism treatment, evidence is lacking on treatments for lower functioning persons. Thus, treatment research focusing on persons with autism and comorbid mental retardation is urgently needed as this subgroup represents up to 70% of the autistic population. The dearth of rigorous treatment studies is beginning to be addressed within the existing network of NIH-funded RUPP (Research Units of Pediatric Psychopharmacology), CPEA (Centers for Programs of Excellence in Autism), and STAART (Studies To Advance Autism Research and Treatment) autism research centers where a variety of well-controlled multicenter behavioral and biomedical intervention studies are currently ongoing.

Along with more rigorous methodologies, there is also a need to address the depth of intervention effect question to begin to determine whether interventions are producing changes in core deficits that are driving symptom expression. This will involve expanding the repertoire of treatment outcome measures from straightforward symptom invento-

ries to more precise measures of core deficits. This could involve using established measures from autism "mechanism" studies (e.g., neurocognitive performance, fMRI, neurochemical markers, behavioral mechanisms) as outcome measures in treatment studies. This would permit within treatment group analyses to determine whether treatment-related symptom changes are associated with changes in outcomes at the level of putative mechanisms. This would provide information on which treatments are simply changing symptom severity and which are more deeply altering core mechanisms.

Novel approaches for treating the core features of autism may lie in efforts to link emerging basic studies of the early development and early identification of autism with existing early intervention approaches. Existing studies of behavioral/educational treatment have shown that early and sustained intervention appears particularly important. Currently, timing of early intervention for autism has been restricted to late infancy/early childhood (e.g., 3–6 years of age) due limitations in clinicians' ability to reliably diagnose autism in early infancy. Work on the accurate early identification of autism is closing this gap between the point in time when the first behavioral and developmental abnormalities are apparent and the clinical diagnosis of autism is made [Stone et al., 1994; Baranek, 1999]. This will permit earlier initiation of the validated forms of autism treatment, with the hope that effective early intervention may impact positively the trajectory of brain and behavioral development during a critical period of development. Also, specific interventions can be designed to directly impact the behavioral features that prove to accurately distinguish infants with autism at an early age (e.g., initiated joint attention). If so, correction of these deficits early on may preclude the development of more abnormal autism-specific patterns of behavior.

Increased integration of behavioral and biological approaches to understanding and treating autism is also likely to yield new insights into autism treatment. One unfortunate side effect of the fact that the two general areas of validated treatments for autism (behavioral, biomedical) emerged from distinct conceptual models and their associated distinct academic disciplines (psychology/education, medicine) is that clinically this conceptual distinction has often lead to a false dichotomy of "pills" versus "skills." It is important that researchers and practitioners alike abandon this false dichotomy of "brain" or "behavior" to develop a more integrated approach to understand autism. Clinical practice suggests that medication treatment rarely works in a vacuum and instead is likely optimized when integrated with behavioral/educational, environmental, and family approaches [Volkmar et al., 1999]. Similarly, those forms of medication treatment that have been shown to be effective in treating some of the features of autism may work synergistically with behavioral/educational interventions to more deeply impact the core features of autism. This could include early intervention efforts as there is preliminary evidence that those medications that are effective in treating older children and adults with autism appear to be safe and effective for the treatment of preschool age children with autism [DeLong et al., 1998; Masi et al., 2003; Namerow et al., 2003]. The interaction between treatment and neurobiology may in fact be bidirectional, with medical treatments potentially impacting behavioral treatments and also behavioral treatments potentially impacting early brain development.

The discovery and development of improved treatments for autism is also more likely to occur by focusing treatment research efforts on specific desirable outcomes for children with autism [Wolery, 2000]. What is desired is children who spontaneously demonstrate more varied, sustained, and generative ways of interacting with their environments and with others. Armed with such experiences such children are more likely to lead more independent and socially integrated lifestyles as adults. Development of interventions that promote characteristics like spontaneity, flexibility, and social understanding is likely to depend on our knowledge of the basic behavioral and neurocognitive processes that give rise to and support such personal characteristics. Thus, basic behavioral studies are needed to identify the patterns of interacting with the social and physical environment that lead autistic children to develop the symptoms we recognize as the phenotype of autism. This will permit a shift from the symptomatic treatment of autism toward a focus on the causal factors that, when untreated, lead to the autistic symptoms.

The science of the treatment of persons with autism has come a long way in the last several decades. It has progressed to the point where much is now known about how to effectively manage many of the devastating symptoms associated with the disorder and about how persons with autism can be helped to learn new skills. The hope is that future developments in this area will include not only better studies of existing forms of treatment but also an integration of basic and treatment research studies in an effort to develop novel treatment approaches that more deeply impact the core features of the disorder. ■

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