

## *Mechanisms of change in psychosocial interventions for autism spectrum disorders*

*Matthew D. Lerner, MA, PhD; Susan W. White, PhD;  
James C. McPartland, PhD*



### Introduction

**A**utism spectrum disorders (ASDs) are characterized by pervasive deficits in social interaction and communicative behavior, along with restricted and repetitive behavior patterns,<sup>1</sup> that impact multiple domains of functioning throughout the lifespan.<sup>2</sup> Deficits in complex<sup>3,4</sup> social-communicative (or social functioning) outcomes are often considered “core,” and

*Research into psychosocial interventions (particularly cognitive-behavior therapies and social skills training) for social-communication deficits among individuals with autism spectrum disorder (ASD) has proliferated over the past decade. While this research has provided some empirical support for the efficacy of these interventions, little work has begun to elucidate therapeutic mechanisms—the when, why, how, for whom, and under what conditions an intervention may produce change. Identification of mechanisms underlying these effects should help advance ASD intervention research. This article describes methods for assessing such mechanisms (ie, mediators and moderators) and presents promising candidates for common mechanisms impacting treatment response: behavior modification, therapeutic relationship, social knowledge, social motivation, social information processing, executive functioning, and internalizing comorbidities. Finally, future directions are discussed as a program of psychosocial intervention research designed to identify predictors of individual differences in treatment response (including biomarkers), isolate active therapeutic ingredients, and promote dissemination of optimized interventions.*

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**Address for correspondence:** Matthew D. Lerner, 102 Gilmer Hall Box 400400, Charlottesville, VA, 22904-4400, USA  
(e-mail: mdl6e@virginia.edu)

**Author affiliations:** Department of Psychology, University of Virginia; Department of Psychiatry and Behavioral Neuroscience, University of Chicago Medical Center (Matthew D. Lerner); Department of Psychology, Virginia Polytechnic Institute and State University (Susan W. White); Child Study Center, Yale University (James C. McPartland)

# Clinical research

are the primary target of cognitive and psychosocial interventions.<sup>5,6</sup> Considerable research, much of it conducted over the last 10 years, has begun to identify evidence-based interventions for ASD.<sup>7</sup> However, as the body of literature on such interventions evolves, the operative question begins to move beyond “what works,” towards the more nuanced questions of “why and how does it work, for whom, under what conditions,”<sup>8–10</sup> as well as “when” (ie, at what stage of cognitive and psychosocial development). Treatment research related to ASD has barely begun to explore the common and unique processes by which these interventions “work,” the conditions under which they “work best,” and for whom each type of treatment might be optimal. Such research is crucial towards moving the field beyond the initial treatment package efficacy trials<sup>11</sup> characteristic of the early stages of treatment research, and towards a more mature phase in which cognitive and psychosocial interventions may be customized and optimized.

In this paper, we first review the most prominent types of psychosocial interventions for “core” social-communicative deficits in ASD. Then, we identify an array of promising and emerging theoretically and empirically derived mechanisms that may underlie these interventions—that is, the “why and how” of them.<sup>12</sup> (Throughout this manuscript, the reference to “mechanism” is primarily associated with *mechanisms of change* [ie, active treatment ingredients or therapeutic processes], as it is used in the intervention research literature. However, on occasion such reference may also indicate *neural mechanisms*, as is more often the case in the neuroscience literature). Finally, we provide future directions to accelerate the evolution of psychosocial intervention research for ASD by exploring and capitalizing upon these mechanisms.

Throughout this review, we focus on school-aged children, adolescents, and young adults with ASD. We do this for two reasons. First, this age group represents a gap in the established review literature, with much greater coverage of evidence-based strategies<sup>5,7,13</sup> and mechanisms<sup>14</sup> already extended to younger populations. Second, psychosocial interventions, which are the topic of this review, are primarily applicable to age groups beyond early childhood. That said, we note that the mechanistic principles described herein are not exclusively relevant to psychosocial interventions, and may be applicable to other age ranges and strategies.

## Psychosocial interventions for autism spectrum disorders

### Cognitive-behavior therapy

Cognitive-behavior therapy (CBT) is among the most widely used psychosocial interventions for all populations, and has obtained empirically supported status (ie, replicated results in well-controlled trials) for many disorders.<sup>15</sup> CBT is based on the theory that maladaptive thoughts, feelings, and behaviors interrelate to sustain psychopathological or maladaptive symptoms and behaviors. Thus, CBT interventions typically focus on more accessible domains (eg, changing thought or behavior patterns) to address subtler sources of deficit (eg, emotional responses to challenging situations). CBT interventions are often delivered in a 1:1 format and use discrete modules (eg, fear hierarchies) and tasks (eg, homework) to create realistic goals and comprehensible feedback on progress to patients. Interventions that are CBT-based tend to be fairly time-limited (often fewer than 16 sessions), focus on a collaborative and problem-solving relationship between therapist and patient, and emphasize thinking in more logical or helpful ways.<sup>16</sup>

Recently, CBT has begun to be applied to treat people with ASD as a method to ameliorate social-communication deficits.<sup>17–21</sup> Such applications typically focus on uncovering thought processes (eg, black-and-white thinking) and identifying behavior patterns (eg, lack of social initiation) that prevent the development of fruitful social interactions. Notably, CBT has exclusively been examined in individuals with ASD who have at least average cognitive ability, with most work focusing on school-aged and adolescent populations.<sup>17,20,21</sup>

### Social skills training

Social skills training (SST) is likely the most widely used intervention approach to improve social functioning in older children and young adults with ASD. Often delivered in a group setting, SST is based on the premise that structured learning of specific prosocial behaviors, coupled with in-session opportunities for practice and out-of-session generalization strategies, is ideal for engendering generalized improvements in appropriate social behavior.<sup>22–25</sup> Length of time in SSTs varies, from as few as 4 weeks to several years.<sup>25</sup> Although qualitative and

quantitative reviews on the efficacy of SST programs for young people with ASD have not consistently yielded favorable results<sup>26</sup> more recent published reviews suggest that SSTs may broadly be considered to be empirically supported for ASD populations,<sup>27,28</sup> though the ages and developmental levels for which this is the case are limited. Although such group-based programs have dominated this literature, in practice these interventions include a broad array of approaches such as Social Stories,<sup>29</sup> peer-mediated training and intervention,<sup>30</sup> video modeling of appropriate skills,<sup>29</sup> and Pivotal Response Training.<sup>31</sup>

### Others

Several other psychosocial intervention approaches are also being explored to address social-communication deficits in ASD. For instance, there exist programs to teach emotion regulation strategies<sup>32,33</sup> through experiential and cognitive means. These approaches are based on models that implicate poor executive functioning or emotion regulation in the complex social deficits of ASD.<sup>34,35</sup> A related approach uses mindfulness-based interventions to help youth with ASD experience greater awareness of themselves and their behaviors during difficult interactions.<sup>36</sup> Such an approach suggests that individuals with ASD may suffer from a lack of awareness of their own behavior and internal states during social interactions, and so may benefit from increased attention to their subjective experience.

A small subset of interventions has used a simple support group model for youth with ASD.<sup>37</sup> Such interventions suggest that simply discussing shared experiences while seeing that they are not alone may be a useful way for youth with ASD to manage their social challenges. While these approaches are not well-represented in the literature, a recent review suggests that they may represent a common theme among efficacious interventions for youth with ASD.<sup>25</sup> Finally, some approaches employ parent training to either augment or supplant direct social-communicative interventions with youth.<sup>38-40</sup> These interventions suggest that parents are often the main drivers of peer relationships with children,<sup>41,42</sup> especially among those with developmental disorders.<sup>40,43</sup> While a full exploration of these promising approaches is beyond the scope of the current review, we note that many of the treatment mechanisms mentioned below cut across the

specific treatment modalities, and we highlight such applications below.

### Potential mechanisms

Based on available research, we delineate several potential mechanisms by which psychosocial interventions for ASD may produce change in social-communicative functioning. Before we do so, however, it is important to distinguish several key terms as they pertain to psychotherapy research.<sup>10,12</sup> A *mechanism* is a process or specific therapeutic “ingredient” that can be said to be reliably responsible—perhaps causally so—for the effects of a given intervention.<sup>10</sup> However, it is extremely difficult to directly test for mechanisms, especially across disparate interventions and diverse samples. Thus, studies generally examine *moderators* and *mediators* as a way to point to *mechanisms*.

A *moderator* is a generally stable (ie, not meant to change in response to treatment) variable that may affect the strength and/or direction of the relationship between treatment assignment and outcomes. For instance, gender has been found to moderate the effects of group-based treatments for post-traumatic stress disorder such that it appears more efficacious for females than males.<sup>44</sup> This moderation effect suggests that such treatments may involve a different *process* by which such treatments work for females, thus suggesting (though not directly testing) a different treatment mechanism for each gender. Thus, moderator analyses are valuable for beginning to unearth treatment mechanisms.

A *mediator* is a variable that generally is influenced *during treatment* and directly by the treatment that may statistically account for the influence of the independent variable (ie, treatment assignment), at least partially, on change in a given outcome. For instance, in a large multi-site study of treatments for attention deficit-hyperactivity disorder (ADHD), reductions in negative parenting practices have been shown to mediate improvements in school-based social skills among children who received behavioral and psychopharmacological intervention.<sup>45</sup> This mediation suggests that such improvements in parenting were at least partly responsible for the improvements in social skills. However, a mediator may not itself always be a causal mechanism, but may instead point more directly to such mechanisms. For instance, decreased negative parenting practices may have led to

# Clinical research

less daily child frustration or increased behavioral compliance (both potential mechanisms that, themselves, could be tested via mediation) which, in turn, could have led to improvements in social skills. Thus, mediation analyses may either directly test potential mechanisms, or provide fruitful direction for their subsequent exploration.

Finally, mechanisms may be either *common* or *unique* among interventions. For instance, while the effect of exposure may be common across diverse interventions for anxiety,<sup>46</sup> the effect of changed interpretation of feared stimuli may be somewhat *unique* to cognitive bias modification.<sup>47</sup> As the current literature on psychosocial interventions for ASD is yet nascent, few well-designed studies examining moderators, mediators, or uniqueness (ie, specificity) of effects have been conducted. Thus, we next present several theoretically and empirically promising mechanisms (behavior modification, therapeutic relationships, social knowledge, social motivation, social information processing, executive functioning, and internalizing comorbidities), and provide suggestions for closer examination via the aforementioned approaches.

## Behavior modification

A key ingredient in many psychosocial interventions for ASD is behavior management, or the application of behavioral principles (eg, contingent reinforcement) to increase or reduce the frequency or severity of specific behaviors. Behavior management is often used for the treatment of externalizing problems such as aggression, outbursts, and other disruptive behaviors. Indeed, such behaviors are not uncommon among youth with ASD<sup>48</sup> and are often a key reason that youth with ASD are referred for psychiatric treatment.<sup>49</sup>

Across child populations, it is well established that externalizing behaviors are negatively related to social skills and peer relations.<sup>50</sup> For youth with ASD, such behaviors may be especially problematic as they predict parental stress,<sup>51</sup> can be quite severe,<sup>52</sup> and may be less well-understood by peers.<sup>53</sup> Thus, interventions to improve social-communicative functioning may valuably include behavior management approaches to do so.

Psychosocial interventions for social-communication problems are often constructed, either structurally or adjunctively, to mitigate disruptive behaviors either within treatment settings (ie, in SST groups) or in the real world<sup>38,54</sup> (ie, in classrooms). Little research has yet

examined the degree to which management of these behaviors may be responsible for increases in social functioning, though some results are promising. For instance, a small study of Social Stories© (brief comics designed to be used as part of psychosocial interventions to aid and prepare youth with ASD for new social interactions) suggests that reducing problem behaviors may be helpful in increasing prosocial behavior.<sup>55</sup> Some SSTs have found concurrent improvements in social skills and problem behaviors,<sup>56-59</sup> though concurrent measurement precludes analysis of the direction of effects. Additionally, applied behavior analytic treatments have been shown to be successful in treating aggression in youth with ASD, principles of which are sometimes included in SST and CBT interventions.<sup>22</sup> Initial results and research with other populations, then, suggests that improved behavior management may be a pathway for improvement of social functioning among youth with ASD. Thus, examination of the role of decreased behavioral problems as a potential common treatment mechanism across psychosocial interventions is warranted.

## Therapeutic relationship

Therapeutic relationship refers to the interpersonal process dynamic that emerges between therapist and patient in the context of a psychosocial intervention.<sup>60</sup> Such relationships are complex and multifaceted, though a fairly large body of literature suggests that they represent a common treatment factor accounting for a modest but significant amount of variance across individual,<sup>61</sup> group,<sup>62</sup> family,<sup>63</sup> and child-focused<sup>64,65</sup> therapeutic modalities. The most well-researched therapeutic relationship is the *therapeutic alliance*, or the perceived or observed concordance between patient and therapist on therapeutic goals, tasks, and a sense of bond.<sup>61,66</sup> Meta-analytic work, not specific to ASD, suggests that the alliance may be the most important common factor across psychotherapies.<sup>67</sup>

Recent work suggests that the alliance may be effective in improving social-communicative function in youth with nonspecific behavior problems<sup>68</sup> and ADHD.<sup>69</sup> However, almost no research has considered the therapeutic alliance among youth with ASD, with some suggesting that it may even be counterproductive in effectively addressing treatment goals with this population.<sup>70,71</sup> Meanwhile, some psychosocial interventions theoretically posit the importance of developing a warm, col-

laborative relationship with youth with ASD as a component of the treatment process,<sup>72,73</sup> and some authors have begun to consider its utility in CBT for adults with ASD.<sup>74</sup> However, no published research has examined this impact of relationship empirically. In an initial promising unpublished study, Lerner and Anthony<sup>75</sup> demonstrated that self-reported alliance early in a group-based SST predicted significant improvements in blinded peer nominations of reciprocated friendships. Thus, there is both ample literature from other populations—as well as preliminary theoretical and empirical literature with ASD populations—to suggest that the alliance should be explored as a common mechanism in psychosocial interventions for ASD. In particular, research should first consider ASD populations (eg, higher-functioning teens and young adults) and contexts (eg, individual psychotherapy treatment) in which traditional self- and observer-report measures of alliance<sup>65</sup> may be most validly and effectively implemented. Likewise, as many interventions (eg, SSTs) are delivered in group formats, group processes such as group cohesion<sup>62</sup> should be explored as well. As it is indeed likely that the process of establishing and defining rapport may differ for populations with social-communication difficulties,<sup>74</sup> future research should carefully consider the construct validity of alliance in this population.

### **Social knowledge**

Social knowledge refers to the awareness of the appropriate range of responses in a given social situation. In lay, clinical, and research arenas, it has long been presumed that a deficit in social knowledge is central to problems with social functioning in ASD.<sup>20,76</sup> That is, youth with ASD are uniquely thought to “not know what to do” in social situations, even if they have otherwise intact cognitive ability. Because of this presumption, the majority of psychosocial interventions for ASD (especially SSTs) tend to include modules designed to increase social knowledge.<sup>22,23,38</sup> The strength of this presumption is, again, fairly unique in the ASD literature, as social knowledge-training interventions for other populations are generally found to increase self-reported social knowledge with little effect on social behavior.<sup>77</sup> Indeed, in nonclinical populations, the ability to develop skilled performance of complex domains of behavior tends to develop more directly through experience rather than acquisition of knowledge.<sup>78</sup>

Such findings, however, reflect clear mechanistic processes of skill development in other populations. Thus, they present a fruitful avenue for direct consideration of the mechanism of social knowledge training in the development of social functioning in ASD populations. Indeed, because knowledge-training components of interventions are fairly modular, they lend themselves quite naturally to a “dismantling” approach to exploring potential mechanisms.<sup>79</sup> Dismantling studies “take apart” components of existing intervention packages, such as exposure and behavioral experiments for anxiety disorders,<sup>80</sup> and randomly assign participants to receive them independently to assess their relative contribution to the overall efficacy of the package. In a recent study, Lerner and Mikami<sup>81</sup> used a dismantling approach to explore trajectories of change in peer interaction between knowledge-training and experience-based SST conditions. This preliminary study found faster rates of friendship-making and peer interaction in the experience condition, but comparable change overall between conditions. These differences implicate unique, discrete mechanisms in each condition, which bear further investigation in subsequent research.

### **Social motivation**

The ability of social information and prosocial interaction to uniquely capture and sustain interest and attention, or social motivation, is thought to be a fundamental building block of typical human development and a crucial element of human eusociality.<sup>82</sup> Indeed, in typically developing (TD) individuals, the neural processes that facilitate social motivation may permit attending-to and learning in social scenarios.<sup>83</sup> Social amotivation may be pathognomonic in ASD populations, and may underlie deficits in social functioning.<sup>84,85</sup> Indeed, neuroanatomical evidence suggests that impaired social motivation in ASD populations may affect social learning.<sup>86</sup> This suggests that social motivation may be a necessary (if not sufficient) condition for engagement in successful social behavior.

Basic behavioral interventions for ASD, such as pivotal response training, have long posited that increasing social motivation may be a crucial element of increasing social behavior in this population.<sup>31,85,87</sup> However, only recently have psychosocial interventions, such as SSTs, begun to consider the inclusion of components to address social motivation (such as pairing social interaction with intrinsically motivating activities) as treat-

# Clinical research

ment ingredients.<sup>88,89</sup> While these SST studies have presented promising findings in terms of long-term outcomes, no research has yet explored the degree to which increasing motivation may be responsible for such results. This is, in part, due to the difficulty in accurately measuring this subtle construct. Future research, then, would be well-served to begin to use more precise indices of social motivation (eg, potential biomarkers<sup>84</sup>), and thus explore individual differences in social motivation as a possible predictor of response to psychosocial interventions.

## Social information processing

Beyond being *motivated* to attend to social information, it is also thought that the ability to efficiently and accurately *process* such information is crucial for social development. This includes the ability to rapidly discriminate subtle emotions in nonverbal behavior (eg, facial displays and vocal intonation), which typically develops consistently throughout youth, and is thought to underlie social perception and functioning.<sup>90</sup> Such *social information processing* has been identified as a common area of deficit in ASD populations.<sup>91</sup> Most notably, both behavioral<sup>91,92</sup> and electrophysiological<sup>93-95</sup> measures suggest that such information processing is slowed. Promisingly, recent computer-based intervention modules have begun to demonstrate that it is possible to modify the speed, efficiency, and accuracy of emotion processing (primarily facial emotion recognition) in individuals with ASD as evinced in both behavioral<sup>96</sup> and electrophysiological<sup>97</sup> outcomes. However, only preliminary work has examined biomarkers of change or outcomes in “real-world” social behavior, and no studies have adjunctively included these modules in existing CBT- or SST-based psychosocial interventions. Such inclusion among a sample of intervention participants would represent a straightforward way to test the degree to which social information processing speed may be a mechanism of change in social functioning.

## Executive functioning and self-regulation

Youth with ASD have long been known to have difficulty with executive functions including self-regulation and attention management.<sup>98</sup> These challenges can manifest as difficulties regulating emotional states.<sup>99</sup>

Heightened negative affect and difficulties with achieving and maintaining an optimum state of arousal (ie, emotional dysregulation), which impede one’s ability to react appropriately in social discourse, have been well-documented in ASD.<sup>100</sup> Similar to difficulties with behavior management, executive function deficits may underlie externalized behaviors ranging from odd and stereotyped behaviors to aggression.<sup>99</sup> However, they may also have internalizing components that, downstream of social information processing, impede the ability to orient to social cues and express social behavior in a timely manner.<sup>101</sup>

Difficulties with executive functioning can also manifest via poor attentional control in ASD.<sup>35,102</sup> Indeed, the frequency with which symptoms of ADHD co-occur in people with ASD suggests that such difficulties may be a cardinal challenge for many youth carrying the ASD diagnosis.<sup>103</sup> Deficient executive functioning has been implicated in social skills problems for many child clinical populations.<sup>104,105</sup> Indeed, youth with ADHD are known to have peer problems comparably intractable to those of youth with ASD.<sup>106</sup> As pertains to psychosocial interventions, unfortunately, there are few empirically supported treatments for peer problems in ADHD and related disorders implicating executive functioning.<sup>107</sup> Crucially, however, there are empirically supported treatments to aid development of executive functioning that may also be appropriate settings to address social skills.<sup>108</sup> These interventions, often delivered in school settings, may be readily combined with adjuvant SST or CBT interventions. There is fruitful work that may be done to directly examine the effects of such training on improved social functioning in this population, implicating a fairly easily testable change mechanism.

## Internalizing comorbidities

Youth with ASD are also known to experience high rates of internalizing comorbidities, especially clinically significant elevations in anxiety and depressive disorders.<sup>103,109</sup> Importantly, associations have been found between anxiety and social deficits in this population.<sup>110,111</sup> Clinical and anecdotal observations suggest it may specifically be the awareness of social difficulties that enhances anxiety in adolescents with ASD.<sup>112</sup> Additionally, research has implicated a relationship between greater cognitive and verbal abilities, and greater ASD severity, and elevated risk of depression.<sup>113</sup>

This emerging descriptive research suggests that internalizing disorders may play a role in predicting social dysfunction in this population.

Promising interventions to specifically address anxiety using CBT in this population have recently proliferated.<sup>114,115</sup> Most of this clinical work has adapted CBT programs to primarily target anxiety reduction<sup>114,116–118</sup> in children under the age of 14. Collectively, this body of research suggests that internalizing processes may be amenable to intervention in ASD. However, they do not explicitly examine the potential role of anxiety (or other internalizing problems, such as depression) as a mechanism of change in improving core ASD deficits. In a crucial recent step towards testing the possible mechanistic nature of anxiety in social dysfunction in ASD, White and colleagues<sup>119</sup> produced and tested a manualized intervention to treat both of these deficits in this population. Further exploration of this intervention will be essential in teasing out the degree to which decreasing anxiety may act as a mechanism of change in addressing social functioning in ASD.

### Other potential mechanisms

As the consideration of common and unique mechanisms of change in psychosocial interventions for ASD is fairly new, we have focused above only on those that are most promising based on the available literature. We note, however, that there may be several more that are worthy of consideration, whose comprehensive exploration is beyond the scope of this overview. First, while we have noted the importance of social knowledge, it may be that such prescriptive application of social responses is only a piece of the puzzle. For instance, it may be that generation of novel, flexible responses to social scenarios,<sup>120</sup> or social creativity,<sup>121</sup> is a necessary element of developing social competence in this population. Indeed, while this ability appears impaired in ASD populations due to more rigid cognitive styles,<sup>120</sup> initial work suggests that social creativity is related to higher social competence and popularity among TD youth.<sup>121</sup> Thus, psychosocial interventions that highlight the improvement of social creativity<sup>73</sup> may be ideal venues for exploration of the role of this novel construct.

Second, as a clinical population, those with ASD have traditionally faced stigma and related poor self-perception,<sup>122</sup> which may in turn affect their social functioning and status with peers.<sup>123</sup> Thus, addressing a sense of

understanding, self-acceptance, and ownership over the “ASD” diagnosis and label may be an important pathway by which those with ASD begin to develop more confident, assertive, and effective peer interactions. In TD populations, such a sense of group membership and collective identity has been shown to relate to more positive self-esteem,<sup>124</sup> as well as relationship satisfaction and success.<sup>125</sup> Preliminary work suggests that this sense of group belonging may be emerging in online communities of individuals with ASD,<sup>126</sup> though almost no rigorous empirical research has examined these environments in detail, nor has work yet been done on the role of a focus on building such identities as a component of psychosocial intervention.

Relatedly, integration of individuals with ASD into their existing communities may also be a crucial mechanism by which those with ASD may experience more social success. Such integration may aid in decreases in stigma, increased peer acceptance, and adaptive outcomes among youth and adults. For instance, recent research suggests that adults with ASD who participate in community-based supported employment rather than substantially separated sheltered workshops achieve better vocational outcomes.<sup>127</sup> Most promisingly, Kasari et al<sup>128</sup> found that training TD peers in regular classrooms to be more inclusive and accepting of those with differences produced superior outcomes on measures of social skills, peer friendships, and peer interaction relative to simply training youth with ASD to improve their behaviors. This elegant study, capitalizing on the “dismantling” approach described above, provides initial support for the possible mechanistic role of peer acceptance and an inclusive community in producing positive social functioning and peer relations outcomes for youth with ASD.

### Directions for psychosocial intervention research

As research on psychosocial interventions for individuals with ASD matures, a focus on common and unique mechanisms by which such treatments evince change becomes increasingly crucial. Above, we have enumerated several promising mechanisms that may cut across psychosocial treatment modalities (especially CBT and SST). Herein, we specify a program of study for intervention researchers to pursue that may aid in accelerating the empirical specification of mechanisms of change in these interventions.

# Clinical research

First, using the wide range of existing interventions and with newly developed interventions that show promise, we suggest that clinical scientists in this field begin to focus on identifying *predictors of individual difference* in response (ie, moderators) to these treatments. Such predictors may include factors such as gender, age, cognitive ability,<sup>129</sup> or level of comorbid psychopathology. Such research would have implications for both future intervention research and immediate practice. It would permit the specification of models to empirically identify more promising mechanisms of response across treatments (eg, if more cognitively able youth respond better to CBT interventions, it may suggest that cognitive processing of intervention strategies may be a pathway through which these interventions “work”). Just as importantly, though, it would directly aid in the development of markers to inform treatment selection for individual patients among the already-large and ever-growing body of putatively “evidence-based” psychosocial interventions. Such markers will be essential during the intermediate period, as the field begins to narrow down and optimize interventions based on developing research. Finally, it may be argued that answering “for whom” (see refs 8–10) any given treatment is likely to be most effective is particularly imperative in treatment research for ASD, given the heterogeneity of this clinical population.<sup>3,9,25,130</sup>

Relatedly, as the field begins to specify more precisely the neuroanatomical<sup>131</sup> and electrophysiological<sup>93,94</sup> processes underlying social dysfunction in ASD, it is crucial that such processes be included in this first phase. Notably, biomarkers such as a delayed N170 ERP component in response to faces<sup>95</sup> may be used to begin to differentiate participants’ response to existing interventions based on theoretically sound principles. For instance, individual differences in N170 response may be used to determine whether or not processing deficits should be directly targeted in some participants and not others, in a treatment program seeking to improve social competence. Additionally, such biomarkers may be used to index change in neural processes in response to intervention,<sup>97</sup> providing concrete measures of more systematic (and potentially enduring) change, as well as supporting the possibility of plasticity in neuropathological processes previously thought to be intractable.<sup>132</sup>

Second, we recommend the careful testing of proximal effects of these theorized mechanisms in lab-based set-

tings. For instance, if it is found that social motivation is a promising mechanism of change in CBT, one may develop a brief lab procedure in which maladaptive cognitions are targeted with and without a motivation-enhancement component. This, along with comprehensive pre- and post-testing of behavioral, cognitive, and neurobiological outcomes thought to be associated with the mechanism of motivation, would allow for the between-subjects isolation of the specific role that social motivation may play in producing change among individuals with ASD. Such research would aid in uncovering the possible mechanistic role of social motivation in engendering change in social behavior, and in assessing the centrality of the social motivation hypothesis in explaining deficits in ASD. While this approach may run counter to the belief that whole “treatment packages” are necessary to produce change (and, indeed, this may be so for *macro-level* change), it provides a venue in which to carefully specify the processes by which each component of intervention produces specific changes in social-communicative outcomes. Moreover, it is consonant with the emerging framework of lifelong neuroplastic change that may subtend change across domains of human neurocognitive and behavioral functioning.<sup>132</sup>

Third, having carefully isolated a potential mechanism and its proximal neurocognitive effects, lab-based efficacy studies of interventions built around these mechanisms should be conducted using multi-trait, multi-method assessment and well-defined and -controlled populations. While such studies have been criticized for lacking ecological validity,<sup>133</sup> they are nonetheless valuable for addressing important considerations such as dose-response curves associated with minimal and maximal treatment response, additive versus multiplicative effects of concurrent mechanisms, and effects on auxiliary outcomes. Related to this, use of more sophisticated methodological approaches, such as dismantling studies, and statistical procedures, such as multilevel modeling,<sup>88</sup> will allow us to make direct comparisons of active treatments and understand the time-course of change across identified mechanisms and their outcomes. Additionally, these studies could also be applied to TD populations with familial risk of ASD or to those evincing some level of ASD psychopathology (ie, the broader autism phenotype<sup>134</sup>). Such studies would be useful in identifying the degree to which identified mechanisms of change are somewhat “unique” to ASD, or are representative of extreme version of more normative



social psychopathological processes (ie, transdiagnostic treatment processes).

Finally, efficacious interventions based on well-defined mechanisms should be “scaled up” to “real-world” effectiveness studies. These studies should be implemented in community-based clinics recruiting representative samples of clinically referred populations with ASD. Such studies not only provide a test of ecological validity, but also allow for the use of existing practice as a “natural laboratory” to test questions that defy examination in controlled settings.<sup>133</sup> For example, it may be that otherwise efficacious interventions lead to higher rates of dropout or family dissatisfaction when brought “to scale.” Such information is crucial, as it suggests that potentially iatrogenic mechanisms (eg, frustration with treatment progress; demands on family time) may be introduced when interventions are introduced in the real world. Of course, rather than posing an intractable problem, such findings provide fertile ground for further mechanistic intervention research to identify, specify, isolate, and modify these newly found mechanisms.

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## Conclusion

This provides, then, a window into the future of psychosocial intervention research for ASD. It is an environment in which basic research and applied practice are reciprocally informed. It is a setting where basic questions of mechanism and process may be used to build progressively more targeted, optimized, and responsively-designed treatments. Most importantly, it is a world where families and individuals with ASD may find hope for rapid and effective treatment of social-communicative deficits among a rich array of individually tailored, empirically supported, ever-evolving psychosocial interventions which are tethered to specific and measureable mechanisms affecting the sought change. □

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# Clinical research

## **Los mecanismos de los cambios las intervenciones psicosociales para los trastornos del espectro autista**

*En la última década ha proliferado la investigación acerca de las intervenciones psicosociales (particularmente terapias cognitivo-conductuales y entrenamiento en claves sociales) para el déficit social y de comunicación en los individuos con trastornos del espectro autista (TEA). Aunque la investigación ha aportado algún soporte empírico para la eficacia de estas intervenciones, es poco el trabajo que se ha iniciado para aclarar los mecanismos terapéuticos –el cuándo, por qué, cómo, para quién y bajo qué condiciones una intervención puede producir cambios. La identificación de los mecanismos que están a la base de estos efectos debería ayudar al progreso de la investigación acerca de las intervenciones en los TEA. Este artículo describe los métodos para evaluar tales mecanismos (por ej. mediadores y moderadores) y presenta prometedores candidatos para los mecanismos comunes que influyen en la respuesta terapéutica: modificación conductual, relación terapéutica, conocimiento social, motivación social, procesamiento de la información social, funcionamiento ejecutivo y las comorbilidades de trastornos internalizados. Para finalizar se discuten perspectivas futuras como es un programa de investigación de la intervención psicosocial diseñado para identificar predictores de las diferencias individuales en la respuesta terapéutica (incluyendo biomarcadores), aislar elementos terapéuticos activos y fomentar la divulgación de las intervenciones optimizadas.*

## **Mécanismes des changements dans les interventions psychosociales pour les troubles autistiques**

*Ces dix dernières années ont vu progresser la recherche dans les interventions psychosociales (surtout les thérapies cognitivo-comportementales et les entraînements aux capacités sociales) pour les déficits de communication sociale chez les personnes souffrant de troubles autistiques (TA). Ces recherches ont fourni un support empirique à l'efficacité de ces interventions mais peu de travaux ont concerné les mécanismes thérapeutiques - les quand, pourquoi, comment, pour qui et sous quelles conditions une action peut induire un changement - qui nécessiteraient d'être identifiés. Les méthodes d'évaluation de ces mécanismes (par exemple, les médiateurs, les modérateurs) sont décrites ici et l'article présente ceux susceptibles d'être des mécanismes communs influant sur la réponse au traitement : modification du comportement, relations thérapeutiques, connaissance sociale, motivation sociale, processus d'information sociale, fonctionnement exécutif et comorbidités internalisées. Enfin, sont analysées les futures directions comme un programme de recherche d'action psychosociale élaboré pour identifier les prédicteurs de différences individuelles de réponse au traitement (y compris les biomarqueurs), isoler les agents thérapeutiques actifs et diffuser des interventions optimisées.*

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# Clinical research

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