Knowledge or Performance - Why Youth with Autism Experience Social Problems

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Abstract

Youth with high-functioning autism spectrum disorders (HFASDs) exhibit average cognitive ability, but social deficits manifested in their ability to understand another's perspective (Theory of Mind), decipher feelings from nonverbal cues (emotion recognition), and display prosocial behavior. Most treatments consider these deficits in terms of social knowledge (lacking knowledge of correct social behaviors) and provide training accordingly. Some research suggests that the primary deficit may exist in terms of social performance (failing to enact known behaviors because of confounding factors) and should be remediated differently. Across three studies, I assessed social knowledge versus performance deficits, and brief intervention response, among adolescents with HFASDs.

Forty-one youth with HFASD (33 male; M_{age} = 12.01, SD_{age} = 2.07) attended two laboratory visits in which they completed measures of social knowledge and performance-related variables (social creativity, motivation, and social information processing speed [SIPS]). They were randomly assigned, in dyads, to brief knowledge- or performance-training sessions, during which peer social interactions were observed; they were also assessed in terms of Theory of Mind, emotion recognition, and unstructured social interaction.

Study 1 focused on construct validity of SIPS due to the novelty of using event-related potentials (ERPs) to measure social functioning. Results indicated that SIPS is a stronger predictor than evaluative ERPs in predicting emotion recognition.

Study 2 examined social knowledge and performance-related factors in predicting social outcomes. While social knowledge demonstrated no main effects, it interacted with SIPS and motivation to predict emotion recognition and interaction quality. SIPS and motivation each predicted emotion recognition. Results question the primacy of social knowledge in social functioning.

Study 3 examined effects of brief social knowledge- and performance-training sessions on change in social functioning outcomes. Participants' interaction decreased during session, although this decrease was less for those in performance-training. Social performance-related factors predicted changes regardless of condition. Social knowledge and creativity demonstrated differences by condition.

This investigation suggests that a complex interplay of perceptual and social-cognitive factors characterize social functioning, and that these factors can be meaningfully isolated and used to predict intervention response. Implications for models of social functioning and intervention among ASD and typically-developing populations are discussed.

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The international rise in incidence of autism spectrum disorders (ASDs; Baron-Cohen et al., 2009; Grether, Rosen, Smith, & Croen, 2009; Hertz-Picciotto & Delwiche, 2009) has sparked increased focus on their core features and optimal treatments (Strategic Objectives 1 & 3; National Institute of Mental Health, 2009a). While ASDs are characterized by three diagnostic features (social deficits, communication impairment, repetitive stereotyped behaviors; American Psychiatric Association, DSM-IV-TR, 2000), difficulties in the social domain are considered a pathognomonic feature of the population, particularly among individuals who are considered high functioning (HFASDs; Carter et al., 2005). Individuals with HFASDs exhibit otherwise preserved cognitive functioning (i.e. IQ in the average to above average range), yet experience social deficits that pervasively impact their academic, social, and emotional functioning and development (Rao, Beidel, & Murray, 2008). Social difficulties in this population are pervasive across the lifespan (Baxter, 1997), may increase with age (Howlin, Mawhood, & Rutter, 2000), are often related to emotional and behavioral problems but not verbal ability (Attwood, 2007; Green, Gilchrist, Burton, & Cox, 2000), and are largely treatment-refractory (Koenig, De Los Reyes, Cicchetti, Scahill, & Klin, 2009).

Critically, social difficulties in this population do not remediate naturally via exposure to typically-developing (TD) peers (Gresham, 1984; Stainback & Stainback, 1987), leading to efforts to develop psychosocial treatments that may be effective for the HFASD population (Matson, Matson, & Rivet, 2007; White, Keonig, & Scahill, 2007). Calls for these treatments have been especially pronounced with respect to adolescents

with HFASD. Adolescents with HFASDs may evince increased psychiatric comorbidities -- relative to children with HFASDs -- concomitant with their social deficits in the face of increased social demands (Green et al., 2000). Likewise, there exists a dearth of evidence-supported interventions for adolescents with HFASDs (Reichow & Volkmar, 2009).

A number of factors have been considered to be indicators these deficits (see the social-emotional learning [SEL] framework and socio-cognitive integration of abilities model [SOCIAL]; Beauchamp & Anderson, 2010; Lipton & Nowicki, 2009; McKown, Gumbiner, Russo, & Lipton, 2009), such as impaired nonverbal emotion recognition (Hobson, Ouston, & Lee, 1988; Howlin, 1998, 2008; Semrud-Clikeman, Walkowiak, Wilkinson, & Minne, 2010) difficulty with Theory of Mind (Baron-Cohen, 1990; Baron-Cohen & Glidden, 2001), and prosocial behavior (Bauminger, 2002; Bauminger & Kasari, 2000; Beauchamp & Anderson, 2010; Carter et al., 2005). However, mechanistic predictors of these deficits in social competence remain unknown. Several models suggest underlying deficits in arousal-related (e.g. social motivation; Dawson, Webb, & McPartland, 2005) or basic perceptual factors (e.g. basic processing of social or emotional input; Happé, 2005; Klin, Jones, Schultz, & Volkmar, 2003; Klin, Jones, Schultz, & Volkmar, 2005; Mundy, Henderson, Inge, & Coman, 2007), often as indicated by abnormalities in the neural correlates of these abilities (Dawson, Meltzoff, Osterling, & Rinaldi, 1998; Jeste & Nelson, 2009; Kleinhans et al., 2009). However, these models are often highly speculative, and are insufficiently parsimonious given the lack of converging data at multiple levels of analysis. An alternative, more straightforward

model, suggests that indicators of social competence may be clinically impaired due to a lack of knowledge of appropriate social behaviors (social knowledge deficit), an inability to perform otherwise known social behaviors (social performance deficit), or both.

Knowledge versus Performance Deficit

Gresham (1997) provided a social learning taxonomy of why some children fail to engage in appropriate reciprocal social behavior. He distinguished between social acquisition deficits (referred to here and elsewhere as *social knowledge deficits*), in which children lack knowledge of the social behaviors they should perform, and *social performance deficits*, in which children know the social behaviors that they should perform, yet fail to do so. Thus, while Gresham (1997) considered both knowledge and performance to be necessary for competent social functioning, researchers have only recently begun to explore whether social problems present in HFASDs derive from impairments in social knowledge or social performance (Lerner, Hileman, & Britton, in press; Matson et al., 2007).

Understanding whether social problems in a given individual are derived from a social knowledge or a social performance deficit has direct implications for the etiology of the dysfunction (why do they not know what to do versus why do they not do what they know). It also provides direction for intervention content (providing social information that is lacking versus determining the factors that prevent appropriate enactment of the known behavior). Indeed, if children do not possess reliable social knowledge deficits, then delivery of social knowledge-oriented interventions may be inappropriate and potentially ineffective (Nixon, 2001).

While the clinical and theoretical importance of distinguishing between social knowledge- and performance-based deficits has been acknowledged for some time in the Attention Deficit/Hyperactivity Disorder literature (e.g., Maedgen & Carlson, 2000; Wheeler & Carlson, 1994), it has scarcely been explored in HFASD populations (Koenig et al., 2009; Lerner, Hileman, et al., in press). In fact, the prevailing presumption for more than 20 years has been that social deficits among all individuals with ASDs, as well as deficits in concurrent multi-method indicators of social functioning such as Theory of Mind and emotion recognition (Beauchamp & Anderson, 2010; Koenig et al., 2009), derive from an inability to acquire social skills (i.e., a knowledge deficit; see Mesibov, 1984). Such limitations in skills are thought to yield impoverished social behaviors (i.e. in brief structured and unstructured interactions), which, in turn, beget fewer rich peer interactions (Ridgers, Carter, Stratton, & McKenzie, 2011), as well as poorer emotion recognition and Theory of Mind (Peterson, Wellman, & Liu, 2005; Wellman, Fang, & Peterson, 2011). Figure 1 provides an illustration of this theoretical model.

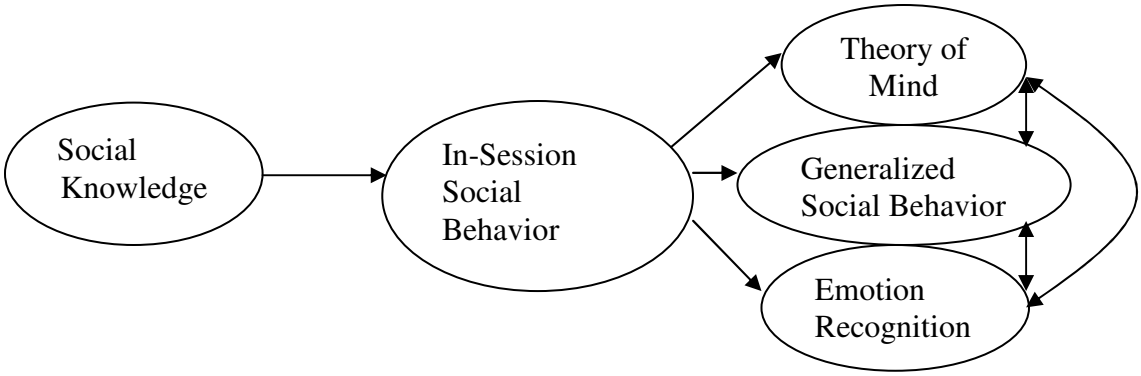

Figure 1. A social knowledge-based model of social deficits.

This model emerged from findings that individuals with ASDs tend to be especially systematic (i.e. rules-bound) in their cognitive processes (Baron-Cohen & Belmonte, 2005; Qian & Lipkin, 2011), especially with reference to social information (Hoyt, Kang, & Swain, 2006; Kransny, Williams, Provencal, & Ozonoff, 2003; Laugeson, Frankel, Mogil, & Dillon, 2009; Matson et al., 2007). Thus, it is presumed that lack of knowledge of specific social rules will lead to impoverished enactment of social behavior. This presumption has persisted despite substantial work showing that children with ASDs, particularly those with HFASDs, do appear to possess greater social knowledge than would be expected from their deficient behaviors if their deficits were purely knowledge-based (Happe, 1995; Laugeson et al., 2009; Rump, Giovannelli, Minshew, & Strauss, 2009). Indeed, it has recently been suggested that individuals with HFASDs may possess "latent social skills" that are suppressed by inaccurate processing of social and emotional information (Andari et al., 2010), directly indicating the presence of a performance deficit. Nonetheless, the question of whether social deficits in individuals with HFASDs are primarily knowledge- or performance-based has never been directly tested.

Social performance deficits. A number of theoretical models of HFASD social pathology have posited a performance deficit; that is, they have suggested that the acquisition of specific social knowledge may be minimally related to the social problems experienced by children with HFASDs (Greenspan & Wieder, 1998; Gutstein, Burgess, & Montfort, 2007; Lerner, Hileman, et al., in press; Lerner & Levine, 2007). Rather, they posit that an array of factors common to HFASDs may play an equally-important (if not

more important) role in predicting social deficits. For instance, in ADHD populations, impulsivity (de Boo & Prins, 2007) and working memory deficits (Kofler et al., 2011) have been shown to represent social performance-related factors. For youth with HFASDs, three key factors that are common across many non-knowledge-based models of social deficits are impairments in social motivation (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012; Dawson et al., 1998), social creativity (Hobson, Lee, & Hobson, 2009), and social information processing (Lerner, White, & McPartland, in press; McPartland & Pelphrey, in press; McPartland et al., 2011; Rump et al., 2009). As these factors exist independently of social knowledge but may still directly affect an individual's ability to perform known social skills (Gresham, 1997; Nixon, 2001), they may be considered to represent *social performance deficits*. However, these models have yet to be tested empirically.

Impaired social motivation, or a limitation in one's engagement with social input, has been hypothesized to be a fundamental deficit in children with HFASDs that may underlie concurrent deficits in social mechanisms (e.g., emotion recognition and Theory of Mind) and social behavior (Chevallier et al., 2012). Recent neural evidence reveals that individuals with HFASDs may possess an impairment in social motivation, and that this may directly impair social learning (Scott-Van Zeeland, Dapretto, Ghahremani, Poldrack, & Bookheimer, 2010). This is consistent with recent findings that brain regions associated with reward are neuroanatomically identical to those mediating subjective social orienting and preferences, even in the absence of explicit reward (Behrens, Hunt, & Rushworth, 2009); that is, the same processes that facilitate motivation to interact with

others may permit attention to and learning in social scenarios. This suggests that social motivation may be a necessary (if not sufficient) condition for engagement in successful social behavior. Thus, impaired social motivation may interfere with the performance of prosocial behavior irrespective of social knowledge.

Impaired social creativity, or a difficulty with flexibly responding to social situations (Fischer, Giaccardi, Eden, Sugimoto, & Ye, 2005; Mouchiroud & Bernoussi, 2008), has also been cited as a core underlying feature of all ASDs (Gutstein et al., 2007; Herbert, 2005; Rapin, 2002). Social creativity has been defined as the application of collective imagination to solving a problem (Fischer, 2000; Fischer et al., 2005) and as the use of original solutions to solve a social problem (Mouchiroud & Bernoussi, 2008; Mouchiroud & Lubart, 2002). A central feature of all definitions of social creativity, however, is the ability to adaptively and creatively engage in a social environment *without* the use of pre-defined, prescribed behaviors (i.e., engage a peer fluidly and successfully; Koenig et al., 2009). Crucially, social creativity so defined has been shown to be linked to social competence and peer acceptance (Mouchiroud & Bernoussi, 2008). Hobson et al. (2009) suggest that lack of social creativity in individuals with ASDs, and consequent social deficits, may result from extended lack of experience engaging in successful peer interactions.

Inefficient processing of social stimuli (e.g., faces) has also been cited as a unique and key area of deficit in ASD populations (Rump et al., 2009). Such processing underlies the ability to rapidly discriminate increasingly subtle emotions, an ability which typically develops at a consistent pace throughout childhood and early adolescence

(McKone, Kanwisher, & Duchaine, 2007). This processing is thought to undergird social perception and functioning by permitting rapid interpretation of cues crucial for appropriate responding (McKone et al.). It also appears uniquely slower in youth with ASDs as measured by both behavioral (Bal et al., 2010; Rump et al., 2009) and electrophysiological measures (McPartland & Pelphrey, in press; McPartland et al., 2011). For instance, the N170 is an event-related potential (ERP) component whose latency is thought to index speed of automatic, obligatory (i.e. prior to voluntary or effortful) processing (but not subsequent cognitive, more prefrontal evaluation) of configural information (Bentin, Allison, Puce, Perez, & et al., 1996) in faces. The N170 is modulated by emotional information (Blau, Maurer, Tottenham, & McCandliss, 2007) and tends to respond increasingly quickly through development in childhood (Batty & Taylor, 2006). This component, however, has consistently been shown to respond abnormally to social and emotional information in ASD populations across the lifespan (Batty, Meaux, Wittemeyer, Roge, & Taylor, 2011; Dawson et al., 2002; Dawson, Webb, Carver, Panagiotides, & McPartland, 2004; Dawson et al., 2005; McPartland, Dawson, Webb, Panagiotides, & Carver, 2004; O'Connor, Hamm, & Kirk, 2005, 2007; Webb, Dawson, Bernier, & Panagiotides, 2006), and to be especially delayed in ASD populations (McPartland & Pelphrey, in press; McPartland et al., 2011). Notably, this delay does not appear to index generally slowed information processing, evincing a deficit that is unique to social information. However, little work has yet examined its relation to downstream social functioning outcomes in this population.

Thus, while social knowledge deficit models posit that knowledge of prescriptive steps is necessary for solving the social problem of peer engagement, social performance deficit models suggest that such knowledge may already be present; instead, they suggest that experience of social successes, rapid processing of social information, and generation of creative solutions to the same problem may be necessary for performance of adaptive social behavior. Figure 2 provides an illustration of the model underlying theorized social performance deficits. Notably, such models do not suggest that social knowledge is unrelated to social performance; rather, they suggest that social knowledge may be a necessary, but not sufficient, condition for performance of successful social behavior (i.e. it may interact with performance-related variables).

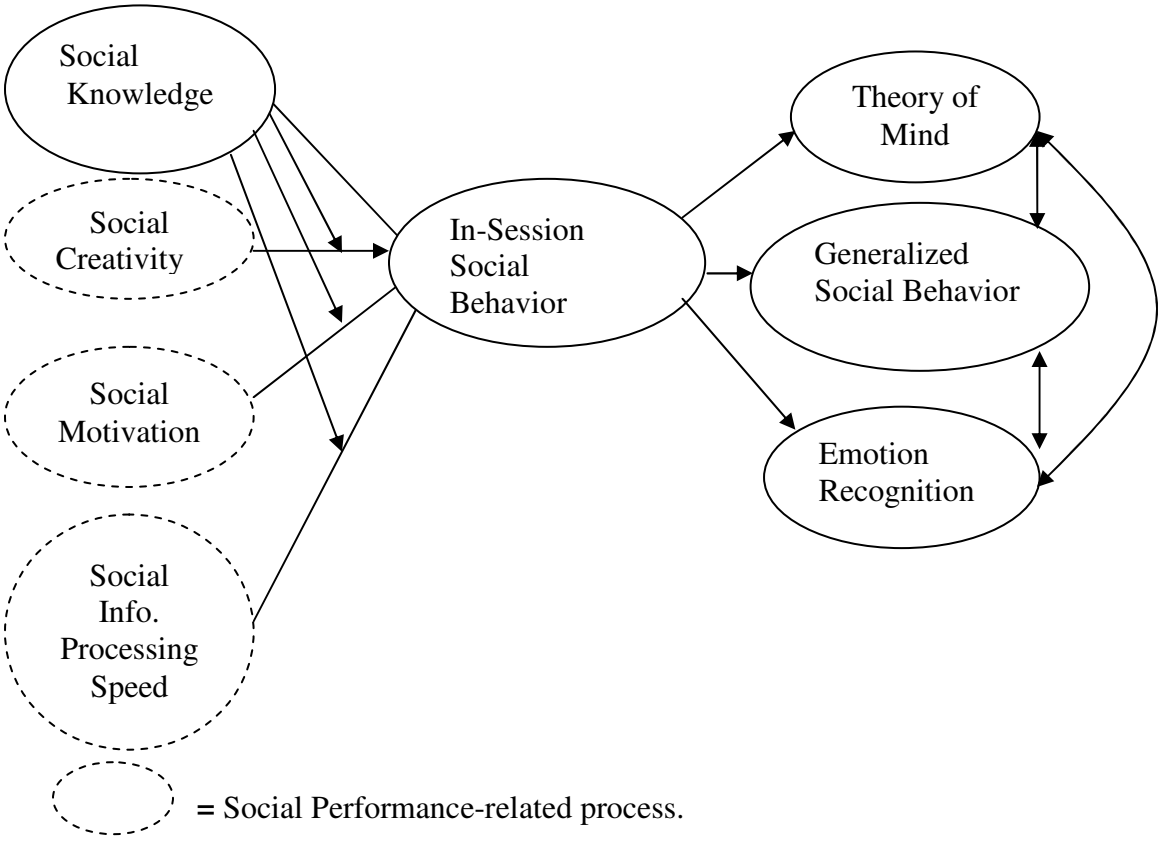

Figure 2. A social performance-based model of social deficits

Social Skills Interventions for HFASDs

Social skills interventions targeted at remediating social deficits in individuals with ASDs have existed for more than 20 years (Mesibov, 1984). Roughly 15 years ago, their status was questionable, with one meta-analysis concluding that they were ineffective (Kavale, Mathur, Forness, Rutherford, & Quinn, 1997). Recently, there has been a significant increase in research on these interventions (Lerner, Hileman, et al., in press; Matson et al., 2007; Rao et al., 2008; Schreiber, 2011; White et al., 2007), with reviews yielding heterogeneous and inconclusive results (Koenig et al., 2009). Effect sizes have varied widely (from extremely small to large on standardized metrics) between studies, target outcomes (i.e., Theory of Mind, prosocial behavior, emotion recognition), populations (i.e., school- versus community-based, all ASDs versus HFASDs, across age groups), modalities (i.e., group versus individual), and methodologies (i.e. cognitive-behavioral, role play, peer modeling). While social skills interventions for school-age children with ASDs have recently been deemed "evidence-supported" (Reichow & Volkmar, 2009), the specific techniques, approaches, and theories that may be optimal, particularly for individuals with HFASDs, remain unknown (Schreiber, 2011).

Critically, addressing these questions will require ensuring that the theory of the mechanisms sustaining social deficits within the given population is both accurate and consonant with chosen intervention strategies. Intervention strategies consonant with social knowledge deficits focus on directly teaching social knowledge by *didactically* providing information on appropriate actions (e.g., when to make eye contact, how to initiate a conversation), while intervention strategies consonant with social performance

deficits focus on providing a context in which socially skilled behaviors may be effectively enacted by mitigating those factors that prevent an individual from such enactment. These factors may differ by population, however, leading to differences in whether a given strategy constitutes knowledge- or performance-training. For instance, among youth with ADHD, didactic lessons on appropriate social behaviors on a playgroup constitute knowledge-training. However, providing reminders of those social behaviors prior to recess offers a context that mitigates their poorer working memory (Kofler et al., 2011), leading such reminders to act as performance-training modules.

Conversely, youth with ASDs are much less likely to experience such working memory deficits (Ozonoff & Strayer, 2001), and more likely to focus on social rules (i.e. knowledge). Thus, the same behavioral reminder would operate as an extension of the original knowledge-training module in youth with ASD by explicitly reinforcing preferred skills. Such knowledge-training strategies in this population focus on the didactic provision of *a priori* determined knowledge about social interaction strategies, and the contingent reinforcement of successful implementation of such strategies in session. They specify the importance of having social instruction activities mirror "real life" social interaction *as closely as possible* (A. P. Goldstein & McGinnis, 1997). As such, the goal is to ensure that a child *knows* specific behavioral steps to enact in a given setting, and then to train that child such that he or she *knows* to use those behaviors in analogous situations outside the intervention group setting. Hence, such strategies posit that the optimal pathway for achieving in-session and generalized competent social

behavior among participants exists via the mechanism of increased knowledge and use of specific appropriate social behaviors.

In contrast, interventions based on social performance-training principles posit that, due to the same proclivity towards a systematic, rules-based approach to social interactions, reinforcement of specific scripts may yield increased rigidity of social behavior, and thus poorer social competence and learning (Greenspan & Wieder, 1998; Gutstein et al., 2007). Rather, social performance-training strategies for youth with ASDs posit that impoverished *social creativity* (Mouchiroud & Bernoussi, 2008) and *motivation* (Scott-Van Zeeland et al., 2010), as well as slowed *social information processing speed* (SIPS; McPartland & Pelphrey, in press; McPartland et al., 2011) are key factors that may block expression of skilled behavior, even if the individual already possesses the knowledge about what behavior to perform. Therefore, mitigating deficits in each of these areas is thought to be necessary in treatments for eliciting in-session and generalized prosocial behavior (Guli, Wilkinson, & Semrud-Clikeman, 2008; Lerner & Levine, 2007).

First, poor social creativity may lead to a limited and inflexible social behavioral repertoire that may leave the individual ill-prepared for the complexity of *in vivo* peer interactions (Hobson et al., 2009). Strategies to enhance social creativity, then, aim to promote generation of a wide and varied set of novel responses to (realistic or outlandish) social scenarios, regardless of their practical feasibility (Guli et al., 2008) to enhance preparedness for and responsiveness to unstructured interaction (Guli, 2005; Guli, Semrud-Clikeman, Lerner, & Britton, under review). Likewise such strategies, by

providing a broad sample of social behaviors and responses, may aid participants in considering novel social perspectives, thus promoting perspective-taking abilities such as Theory of Mind and emotion recognition (T. R. Goldstein & Winner, in press). Crucially, such strategies aim to promote the spontaneous generation and execution of social responses without pre-specification of what such behaviors might look like (i.e. without specifically highlighting rules of "correct" social behavior), to preclude employment of the rigid, rules-based cognitive processing style.

Second, poor social motivation may lead to limitations in initiation and maintenance of social interactions, as well as impoverished social experiences that preclude the development of Theory of Mind and emotion recognition ability (Chevallier et al., 2012; Koegel & Mentis, 1985). Strategies to enhance social motivation aim to increase such reciprocal social behaviors in structured and unstructured settings (as well as consequent social cognitive skills) by making social interactions themselves more motivating; they do so by embedding topics or activities participants already find engaging within these interactions (Koegel & Mentis, 1985; Koegel, Vernon, & Koegel, 2009; Lerner & Levine, 2007).

Finally, slower SIPS may lead participants to fail to "catch" social information when it happens (McPartland et al., 2011), leaving youth with ASD a fraction of a second behind in peer interactions. This may lead them to struggle to keep up in fluid peer settings, leading to downstream effects on prosocial behavior, encoding of social information (see Study 1), and perspective-taking. Strategies to enhance SIPS have participants quickly and repeatedly identify (Lerner, Mikami, & Levine, 2011) or

discriminate between (Faja et al., 2012) social and emotional stimuli (e.g., faces), in hopes that this will accelerate their ability to automatically do so in social settings.

While strategies to remediate each of these factors may be considered atomistically, naturalistic social performance-training interventions aim to incorporate them in tandem during structured and unstructured games (Guli et al., 2008; Lerner & Levine, 2007). Additionally, social performance-training interventions do not require intervention activities to closely mirror "real life" social interactions, as they tend to prioritize motivated interactions and creative, rapid response over the use of accurate social scripts.

Notably, both social knowledge- and social performance-training interventions for youth with ASDs may employ reinforcement of skilled social behavior. However, social knowledge interventions do so after specifying (nomothetic) target behaviors, while social performance interventions aim to do so through the use of activities that may (ideographically) lead participants to engage, without prompting (i.e. rapidly, spontaneously, and creatively), in social behaviors they find to be reinforcing or successful, and to obtain greater naturalistic social reinforcement (through peers).

To date, despite a purported emphasis on both social knowledge and performance (e.g., Stichter et al., 2010), most social skills interventions for HFASDs have aimed to capitalize on the rules-based learning style of youth with HFASDs (A. P. Goldstein & McGinnis, 1997; Hoyt et al., 2006; Kransny et al., 2003), and have consequently focused on training social knowledge via strategies such as social scripts, structured teaching, and reinforcement of *specific* desired behaviors (see Laugeson et al., 2009; Matson et al.,

2007; White et al., 2007). Most existing interventions are thus consonant with the prevailing social knowledge-deficit model of social problems in HFASDs. This focus runs somewhat contrary to known limitations of social knowledge-training-focused programs in changing skilled social behaviors displayed in- and out-of-session, despite their ability to affect self-reported social knowledge in other youth populations (e.g., McMahon, Washburn, Felix, Yakin, & Childrey, 2000). Nonetheless, such interventions are widely used for individuals with HFASDs to train social behavior (Barry et al., 2003; Matson et al., 2007), and related outcomes such as Theory of Mind and emotion recognition (Rao et al., 2008) for which there exists a theoretical rationale for their inclusion in social skills interventions (Spence, 2003). Some have argued, however, that use of alternative strategies such as social performance-training may produce superior social skills intervention outcomes (Gutstein et al., 2007).

Social performance-training. Many social skills interventions have included components of social performance-training such as errorless teaching (promoting social creativity, shaping behaviors without identifying certain actions as "wrong"), developing a positive environment (such that socialization is intrinsically reinforcing), and orchestrating peer involvement (such that peer interactions are additionally reinforcing; White et al., 2007). However, such inclusion has not allowed for the identification of those strategies that may be therapeutically optimal, nor has it facilitated differentiation of the role of social performance versus knowledge deficits in the etiology of social problems among individuals with HFASDs.

There has recently been greater examination of largely social performance-based approaches for promoting social skills (Corbett et al., 2011; Doyle, 2001; Guli et al., under review; Guli et al., 2008; Gutstein et al., 2007; LeGoff, 2004; Lerner & Levine, 2007; Lerner & Mikami, in press; Lerner et al., 2011) and social play (Lerner & Mikami, in press; Luckett, Bundy, & Roberts, 2007; Sherratt & Peter, 2002). For instance, in studies where youth with ASDs were assigned to a condition to increase social motivation (a performance-related variable) or a control condition, those who received the manipulation to enhance motivation displayed increased quantity and quality of social interactions during and after training activities (Koegel & Mentis, 1985; Koegel et al., 2009). Other studies have found that increased musical imitation (Stephens, 2008), social initiation and response to peers (Gena, 2006), and responsiveness to video modeling and social stories (Sansosti & Powell-Smith, 2008) among children with ASDs were only evident in the presence of social reinforcement. These findings support the prioritization, found in social performance-training models, of pairing motivation with social interaction.

Studies including activities priming creative generation of responses to social scenarios (i.e. social creativity) have yielded promising results among individuals with HFASDs. One study found generalization and maintenance of skills relative to a matched clinical comparison group in multiple domains of social functioning that endured at 3 and 6 weeks post-treatment (Lerner et al., 2011). Others have demonstrated significant improvements in observed peer interaction, emotion recognition, and Theory of Mind as a result of social performance-training (Corbett et al., 2011; Guli et al., under review).

Still others have demonstrated significant improvements in generalized (out-of-session) social skills among youth receiving creativity-focused social performance-training compared to matched controls engaging in social knowledge-training interventions after 3 years of continuous intervention in both groups (Legoff & Sherman, 2006). Likewise, creativity-focused social performance approaches have preliminarily demonstrated results in terms of improvements in social anxiety (Lerner, Calhoun, & Mikami, 2009; Lerner, Calhoun, Mikami, & De Los Reyes, in press) and autistic impairment in social settings (Lerner, Spies, Jordan, & Mikami, 2009). They have also shown more rapid (though comparable in magnitude) improvements in social play and social preference relative to performance-training approaches (Lerner & Mikami, in press). Related approaches have been shown to improve Theory of Mind in TD children and adolescents (T. R. Goldstein & Winner, in press).

Little work has yet considered the role of accelerating SIPS as a component of intervention (Lerner, White, et al., in press). However, theoretical accounts have begun to identify it as a process that may respond to fast-paced, engaging *in vivo* social activities in performance-training interventions (Lerner & Levine, 2007; Lerner et al., 2011). Crucially, recent behavioral (Golan et al., 2010; Hopkins et al., 2011; Tanaka et al., 2010) and electrophysiological (Faja et al., 2012) evidence suggests that some indices of SIPS may be amenable to change via targeted interventions. Thus, while preliminary, these findings converge on the notion that SIPS may also be effectively targeted in social performance-training.

Overall, while the above findings reveal compelling emerging results for interventions consonant with social performance-training, comparable results have been lacking in knowledge-training treatment models (e.g., McMahon et al., 2000; White et al., 2007). However, most contemporary social skills interventions incorporate elements of both knowledge- and performance-training (Laugeson et al., 2009; Stichter et al., 2010; Tse, Strulovitch, Tagalakis, Meng, & Fombonne, 2007), making it difficult to directly assess unique effects of either element. As such, there exists support for closer examination of the difference between these models.

This differentiation has a precedent in the psychotherapy dismantling literature, which seeks to identify the active ingredients of existing evidence-based therapies (Kiesler, 2004). This literature has focused on identifying the "micro interventions" that exist within broader psychotherapeutic packages, elucidating the theory of change that underlies each one and determining the contribution of each of these components to treatment efficacy. This approach has been applied to widely-used treatments including cognitive-behavioral therapy (CBT) for anxiety disorders (Holtforth, Castonguay, & Borkovec, 2004; McMillan & Lee, 2010) and dialectical behavior therapy for borderline personality disorder (Dewe & Krawitz, 2007). As social skills intervention for HFASDs, broadly defined, has recently been identified as an evidence-supported treatment with presently undifferentiated and unidentified active ingredients (Reichow & Volkmar, 2009), it represents precisely the sort of intervention that may be a candidate for investigation into its active components.

Dismantling studies have often differentiated between psychoeducational components, which focus on teaching clients specific rules or frameworks thought to improve the way they think about a maladaptive behavior or stimulus (e.g., teaching clients about the cognitive-behavioral triad; Freeman, Davis, Bellack, Hersen, & Kazdin, 1990; Miklowitz, Goodwin, Bauer, & Geddes, 2008), and behavioral components, which focus on providing controlled *in vivo* exposure to a stimulus for clients to practice responding appropriately (e.g., systematic desensitization via exposure therapy; Bermudes, Wright, Casey, & Gabbard, 2009; Hamblen, Schnurr, Rosenberg, & Eftekhari, 2009). Indeed, recent reviews have pointed to discrete treatment effects associated with cognition-oriented and behavioral components of empirically-supported treatments (Longmore & Worrell, 2007; McMillan & Lee, 2010). Analogously, social knowledge-training focuses on teaching clients correct rules of social behavior, while social performance-training aims to provide active, in vivo practice of complex social behaviors in a controlled condition to promote social motivation and creativity. This analogy highlights the importance of exploring the differential effects of knowledge- and performance-training on social competence, with the suggestion that there may be valuable effects unique to each.

Additionally, dismantling studies can be useful for exploring "Aptitude x Treatment interactions," in which baseline client characteristics reveal deficit mechanisms and predict response to specific treatment conditions (Norcross & Wampold, 2011; Simon & Perlis, 2010; Vlaeyen & Morley, 2005). For instance, in the CBT literature, it is suggested that both maladaptive cognitions around the ability to change

behavior and challenges accepting difficult experiences may be mechanisms sustaining anxiety and depression (Forman, Herbert, Moitra, Yeomans, & Geller, 2007). Cognitive Therapy (CT) and Acceptance and Commitment Therapy (ACT) are similarly-effective CBT interventions (Forman et al.) thought to reduce internalizing symptoms via different mechanisms (decreasing maladaptive cognitions versus increasing acceptance of experiences, respectively). Recent research suggests that, as hypothesized, effects of CT are mediated via use of strategies to decrease maladaptive cognitions (but not to increase acceptance of difficulties), and effects of ACT are mediated via strategies to increase acceptance (but not to decrease maladaptive cognitions; Forman et al., 2012). Thus, it is plausible that an individual with relatively greater pre-treatment deficits in terms of maladaptive cognitions would benefit more from CT, while someone with greater deficits in terms of acceptance would benefit more from ACT (i.e. greater deficit in the targeted domain would predict a "match" to treatment condition). Analogously, in social knowledge- or performance-training, poorer functioning in the relevant domain (i.e. poorer social knowledge) might predict a "match" to the consonant intervention (i.e. knowledge-training). Conversely, relative strength in a given domain may reflect an individuals' preferred social learning style (i.e. someone with greater social knowledge might simply have an easier time learning social information concretely). In this case greater functioning in the relevant domain might predict a "match," as the consonant treatment condition may tap into the learning approach that works best for the given individual. As this question has never been explored in social skills interventions, both explanations are plausible. Either way, however, this Aptitude x Treatment approach

provides a way to relate heterogeneity in mechanisms of social deficit in ASD to targeted intervention procedures.

One small-scale study has used a dismantling methodology to assess differences in social performance and knowledge-training approaches. Lerner and Mikami (in press) randomly assigned 13 youth with HFASDs to four, once-weekly brief sessions of either knowledge- or performance-training. While not demonstrating generalized effects on parent-report, both groups displayed group leader-reported increases in social skills and within-group peer-reported increases in reciprocated friendship-making. While these results point to comparable efficacy for these conditions, results on additional sociometric and observed interaction outcomes augment this story. Specifically, children in the performance-training condition befriended each other *faster* and interacted *more* after a single session relative to knowledge-training. However, those in knowledge-training "caught up" over the course of the four sessions. This suggests, then, that the comparable overall outcome effects emerged via different *mechanisms* of peer interaction, which operate at different *rates*. That these effects were measureable over such a brief intervention (some differences were evident after a single session) suggests that these mechanisms might be operating quite quickly, and may be evident in single well-differentiated knowledge- and performance-training sessions. Thus, identification of social knowledge- and performance-training mechanisms via examination of proximal effects on social behavior of brief, "pure" sessions that differ by these conditions (Holtforth et al., 2004) is plausible.

Although no study to date has investigated whether such brief training activities will yield changes on social-cognitive processes such as Theory of Mind and emotion recognition, I speculate this may occur. First, there is evidence that longer (e.g., summer or school-year), more diffuse (i.e. less concentrated doses of intervention content) performance-training interventions demonstrate large effects on Theory of Mind and emotion recognition (T. R. Goldstein & Winner, in press; Lerner et al., 2011), while comparable knowledge-training interventions may not (Barnhill, Cook, Tebbenkamp, & Myles, 2002; Solomon, Goodlin-Jones, & Anders, 2004; White et al., 2007). It is possible that intensely applied, pure performance-training sessions can be examined as a test of "micro interventions" (Kiesler, 2004), which are useful in identifying the minimum *dose* of a treatment condition necessary to produce change (Kazdin, 2007; Lerner, White, et al., in press). As a dose-response analysis has not yet been conducted in the social skills intervention literature, identifying potential minimum dosages can be useful for ensuring that future studies do not fail to detect effects due to clinically underpowered interventions. Conversely, if changes in behavior or social-cognitive processes are evident in short periods of time, this would indicate that social skills training mechanisms may operate rapidly, and provide support for the proposed processes as mechanistic in longer training periods (Lerner & Mikami, in press; Lerner, White, et al., in press). Finally, as these conditions appear dissociable, exploration of participant "match" to condition via the Aptitude x Treatment principle is warranted (Smith & Sechrest, 1991).

Additional considerations.

Individual interests. A discussion of social motivation in interventions for HFASDs would not be complete without contending with the construct of *individual interests* (Hidi, Renninger, & Krapp, 2004). A very common feature of children with HFASDs is a tendency to perseveratively fixate on a specialized interest (Szatmari et al., 2006). It has recently been suggested that incorporation of these interests into all interventions for children with HFASDs would valuably increase their motivation to participate (MacKenzie, 2008). Recent experimental findings support this claim (Vismara & Lyons, 2007). Focus on individual interest in this way is thought to facilitate desire for re-engagement in the given activity and activation of cognitive and affective circuits underlying intrinsic motivation in TD children (Hidi et al., 2004; Renninger, Hidi, & Krapp, 1992). As such, both social knowledge- and social performance-training interventions would do well to incorporate a child's specialized interest (e.g., SpongeBob SquarePants) into their intervention content. However, social performance-training models do not posit *a priori* content for training activities (e.g., they do not explicitly specify how a given skill must be learned or when it must be used), and instead focus *primarily* on incorporating individual interests into the enactment of social scenarios (e.g., by allowing a given social performance activity to focus on SpongeBob SquarePants, even if it precludes the enactment of pre-determined social scripts involving more realistic scenarios; Lerner & Levine, 2007). Thus, while both training models may include a focus on individual interests, social performance-training interventions may do so more easily, because this can occur without otherwise manipulating theoretically core intervention content.

Neuroplastic learning. A useful model for conceptualizing performance deficits and performance-training exists in the neuroplastic therapies literature, which posits the reshaping of cortical pathways as the optimal approach for remediating some neuropsychological deficits (Bryck & Fisher, 2012; Lillard & Erisir, 2011; Pascual-Leone, Amedi, Fregni, & Merabet, 2005). Robertson and Murre (1999) put forward core principles for effective neuroplastic treatment. They note that such therapies must incorporate both top-down (increasing prefrontal processes such as attention and motivation) and bottom-up, (focused activities that do not require conscious -- and instead permit more automatic, obligatory -- engagement with the core deficit area) deficit-relevant stimulation (i.e. use of the affected limb in stroke patients or engagement in social behavior for individuals with HFASDs). The use of these neural control mechanisms, so defined, is thought to produce unique and sustained guided recovery via neuroplastic mechanisms (Robertson & Murre). They also suggest that a nonspecific enriched environment (see Rosenzweig, 2007) containing substantial quantities of the stimulus in the deficient domain (e.g., opportunities for physical activity after stroke) may be required. These three components are included in social performance-training models, as they include top-down (attentionally-focusing, socially-motivated, and cognitively-involved activities) and bottom-up (activities targeted towards the specific deficit areas that restrict competing information and do not provide didactic or deliberative information regarding said deficit) inputs, and socially-enriched environments. Similarly, the putative performance-related processes noted here represent both bottom-up (basic perceptual SIPS) and top-down modulatory (more cognitively-

involved social creativity and motivation) processes, indicating further consonance with this model.

This approach is most similar to constraint-induced (CI) therapy for aphasic patients (Pulvermuller et al., 2001), which uses therapeutic language games and constraints introduced through the game content, game rules, and individualized reinforcement contingencies. If neuroplastic social learning takes place in the presence of performance-training interventions, then, crucially, one would expect it to involve a two-step process: first, short-term change in neural pathways (immediate unmasking), followed by long-term structural change (e.g., dendritic arborization; Pascual-Leone et al., 2005). Pascual-Leone, Peris, Tormos, Pascal, & Catala (1996) showed that such short-term change is evident as soon as 20 minutes after a single 2-hour motor task training session. If a different form of learning takes place in the presence of knowledge-training models, one would not expect to see this process. Thus, a brief dismantling study aimed at identifying whether neuroplastic processes differentially underlie knowledge- and performance-training models would be well-served to examine differences in response after randomization to single, brief training sessions.

Indicators of Social Deficits in HFASDs

Recent integrative theoretical work (e.g., SOCIAL; Beauchamp & Anderson, 2010) has posited that effective social skills development requires the integration of a psychological component (e.g., social cognition such as Theory of Mind) and a social component (e.g., effective reading of social cues) in producing social behavior. Likewise, it is posited that social dysfunction in HFASDs is a complex, multi-faceted construct

requiring concurrent multimethod assessment across each of these domains (Koenig et al., 2009). Herein, I review key findings in each of these domains, as well as the relationship of these findings to the knowledge versus performance deficit distinction.

Theory of Mind. Theory of Mind has been theorized to be a core deficit indexing social problems in all ASDs (Baron-Cohen & Glidden, 2001; Spence, 2003). As such, it must be addressed when considering the nature of (and change in) social deficits in individuals with ASDs (Ruffman, 2000). Critically, deficits in Theory of Mind have been shown to be correlated with social behavior in TD children (Watson, Nixon, Wilson, & Capage, 1999) and in ASD populations (Tager-Flusberg, 2003). As such, these deficits are often targets of intervention for social problems (e.g., Fisher & Happe, 2005; Wellman et al., 2002), particularly for older children with HFASDs (Howlin, 2008).

Interestingly, although children with HFASDs are widely acknowledged to have Theory of Mind deficits, they pass basic Theory of Mind tests at a higher rate than one might expect (Ruffman, 2000). This finding has led to the Hacking Hypothesis of Theory of Mind in children with HFASDs (Bowler, 1992; Dissanayake & Macintosh, 2003; Frith, Morton, & Leslie, 1991), which suggests that, while TD children intuit correct responses to Theory of Mind tasks, individuals with HFASDs have "hacked together" a deliberative Theory of Mind through conscious observation and inference. Thus, TD children are able to fluidly (often automatically) understand the perspectives of others and apply this understanding to respond appropriately. Meanwhile, those with HFASDs may use a more deliberative understanding of others' perspectives, apply it less efficiently, and therefore respond less appropriately.

As pertains to the present taxonomy of social deficits, the Hacking Hypothesis is analogous to a social performance deficit, as individuals with HFASDs may appear to know specific social information (i.e. about the perspective of another person in a given situation), but do not evince such knowledge when interacting with peers. The possibility of this Hypothesis is supported by findings of more consistent deficits in spontaneous as opposed to verbal Theory of Mind in individuals with HFASDs (Ruffman, 2000; Senju, Southgate, White, & Frith, 2009), as well as the discovery of distinct neural pathways associated with intuitive versus deliberative social interaction in the human brain (Kuo, Sjöström, Chen, Wang, & Huang, 2009). The Hacking Hypothesis, then, would predict an over-reliance on deliberative neural pathways during social interaction and cognition by individuals with HFASDs that thereby slows social processing and generates inappropriate social response and inference. With regard to intervention strategies, social knowledge-training would be designed to reinforce the use of the deliberative system (i.e., by teaching more rules with which to consider social interactions), while social performance-training would reinforce (perhaps by an unmasking process; see Xerri, 2008) the use of the intact, but underutilized, automatic, obligatory (posterior) intuitive system in the HFASD brain. As such, examining the role of Theory of Mind in distinguishing between social performance and social knowledge deficits in this population would help to elaborate upon the Hacking Hypothesis of Theory of Mind and elucidate appropriate directions for improved intervention.

Emotion recognition. Another area of critical deficit related to social functioning in individuals with HFASDs that has likewise been a target of intervention

(e.g., LaCava, Golan, Baron-Cohen, & Myles, 2007) is the ability to recognize non-verbal emotion in faces and voices (Blacher, Kraemer, & Schalow, 2003; Wishart, Cebula, Willis, & Pitcairn, 2007). These deficits have been proposed to be the basis for Theory of Mind deficits (Solomon et al., 2004), and may relate to social deficits in all children with ASDs (Dawson et al., 1998; Dawson et al., 2004; Semrud-Clikeman et al., 2010).

As with Theory of Mind, however, results of tests of emotion recognition have been often yielded contradictory results, especially among older children with HFASDs (Rump et al., 2009). Recent studies have uncovered a possible source of these inconsistencies. It appears that speed and valence of stimulus presentation may affect performance of individuals with HFASDs on tests of emotion recognition, with more quickly presented and lower-valence (i.e., less intense emotions) stimuli revealing the greatest deficits relative to controls (Rump et al., 2009; Speer, Cook, McMahon, & Clark, 2007), and slower and higher-valence stimuli revealing improved performance (Tardif, Laina, Rodriguez, & Gepner, 2007). Thus, while TD youth are able to rapidly attend to, accurately assess, and respond to nonverbal information, those with HFASDs may require more time or stimulus intensity to assess and respond to such information. Because of this requirement, “real life” social interaction may be too fast and subtle for HFASD youth to be able to “catch” what is going on, leading them to respond improperly.

It has been proposed that emotion recognition deficits in this population, then, may be primarily attentional deficits (Jeste & Nelson, 2009). This finding is partially

supported in the face domain by the finding that slower amygdala downregulation after face presentation relative to controls may mediate performance on emotion recognition tasks in individuals with HFASDs (Kleinhans et al., 2009). Specifically, this suggests that prolonged amygdala activity may interfere with the ability of individuals with HFASDs to attend quickly to nuanced facial emotion information. Such attentional processes do not appear to be readily remediated by knowledge-training interventions (see Robertson & Murre, 1999), but may be responsive to more performance-based neuroplastic learning (Merzenich, 2001). If this is indeed the case, then the focus on teaching specific non-verbal information (rather than attempting to increase SIPS) may explain the disappointing results of knowledge-training interventions on emotion recognition (Lopata, Thomeer, Volker, Nida, & Lee, 2008; Lopata et al., 2010), and the promising initial findings from a performance-training intervention in this domain (Lerner et al., 2011). Intriguingly, a knowledge-training intervention that incorporated a performance-training component (a motor activity focusing on emotion understanding through motivated play) also demonstrated promising results in improving emotion recognition (Solomon et al., 2004). Thus, examining emotion recognition in social performance and social knowledge deficits in this population would elaborate on the hypothesized attentional deficit in emotion recognition and further aid in improving intervention activities.

Neural mechanisms of emotion processing. Recent efforts have begun to reveal the neural mechanisms underlying the etiology and treatment of various symptoms of developmental disorders, such that it has become a priority at NIMH to employ methods

such as using electroencephalography (EEG) to measure event-related potentials (ERP), to elucidate processes underlying disorders and intervention effects (National Institute of Mental Health, 2009b). Such methods have shown promise for uncovering the processes underlying emotion recognition deficits, and their potential links to other social deficits in ASD.

Jeste and Nelson (2009) recently reviewed the current literature using ERP and concluded that smaller P1, N2, P3, and N4 ERP components were associated with voice perception in individuals with HFASDs (see Whitehouse & Bishop, 2008), and that this indicates a selective attentional deficit to voices. Likewise with emotional face perception, they reported delayed N170 latencies, which may relate to slower amygdala downregulation (Kleinhans et al., 2009) and have been shown to correlate with face-selective brain regions in the temporal lobe and superior temporal sulcus (Sadeh, Podlipsky, Zhdanov, & Yovel, 2010), in the presence of faces (see O'Connor et al., 2007). Slower and smaller N300 latencies have also been reported during viewing of fearful and angry faces by individuals with HFASDs (Dawson et al., 2004). Again, these findings reflect the attention-mediated delays in face processing discussed above, and may be directly related to degree of social impairment (see Dawson et al.).

The relationship of neural processes underlying emotion recognition in HFASDs to social deficits has only preliminarily been explored, and it has not yet been examined differentially between possible models of social impairment (e.g., performance- versus knowledge-based). Thus, in trying to uncover whether knowledge or performance deficits underlie social functioning (and differentiate treatment conditions) in ASD populations,

special attention must be paid to further clarifying the construct validity and role of neurophysiological processes (i.e. ERPs) in indexing markers of deficits in social processing and behavior.

Overview

This investigation was designed to advance understanding of social deficits in HFASDs and their underlying processes in several ways. First, it directly assessed the presence of social knowledge versus social performance deficits in this population. This was accomplished using explicit measures of social knowledge, social motivation, social creativity, and social information processing, as well as multi-method assessment of behavioral (observed social interaction) and social cognitive (Theory of Mind and emotion recognition) outcomes. These measures were collected concurrently with biological, psychological, and social indicators of social skills impairment (Beauchamp & Anderson, 2010). This was done to aid in understanding the relationship of social knowledge and social performance to theorized indices of social deficits (Theory of Mind, emotion recognition, social behavior), as well as in illuminating the primary type of social deficit that is present in individuals with HFASDs.

Second, this investigation was designed help to elaborate upon current models of underlying deficits in social impairment in HFASDs. Specifically, it provides evidence with which to further evaluate the Hacking Hypothesis of Theory of Mind deficits (Dissanayake & Macintosh, 2003) and the attentional impairment hypothesis of emotion recognition difficulties (see Jeste & Nelson, 2009; Rump et al., 2009). It also represents the one of the first studies to measure multiple components of the SOCIAL model

(Beauchamp & Anderson, 2010) and the SEL framework (Lipton & Nowicki, 2009; McKown et al., 2009) concurrently, thus providing a context in which to assess two leading developmental psychopathological conceptualizations of the emergence and maintenance of social skills deficits. It also provides a window through which to consider other leading models of social deficits in ASD such as the social motivation (Chevallier et al., 2012) and Enactive Mind (Klin et al., 2003; Klin et al., 2005) models. Likewise, in assessing the neural correlates of some of these processes, it aids in understanding the degree of flexibility (plasticity; McPartland & Pelphrey, in press; Pascual-Leone et al., 2005) in neural mechanisms underlying these deficits. Such an understanding provides direction for future explorations of the biological basis of social deficits in HFASDs as well as other populations who struggle with social problems.

Finally, this investigation included a brief dismantling study drawing from existing models of social knowledge- and performance-training. Thus, it is designed to help disentangle the current complex intervention packages which may include both components to understand the mechanisms by which either one – or both – may function. Thus, results may also suggest prescriptive information on the presence of the differential effects of type of social skills training for individuals with HFASDs, thus providing direction for improved interventions.

Studies

This investigation is comprised of three smaller studies, each drawing from the same sample, that examine a group of related hypotheses. I have divided these three studies into separate manuscripts. I have already submitted Studies 1 and 2 for

publication, and am preparing Study 3 to be a third submission as a separate manuscript. Below, I provide an overview of the conceptual linkage between the studies and then explain the overall dataset, procedures, and measures. I have next inserted all three manuscripts in this document, and concluded with a discussion that unifies the three manuscripts again.

Study 1. In Study 1, I examined the relationship of ERPs collected during the emotional voice with those collected during the face recognition assessment, as well as with performance on those assessments, to provide a richer understanding of their role in predicting such recognition. Specifically, I examined the degree to which a cluster of face- and voice-responsive ERPs predicted concurrent emotion recognition performance within-modality. Then, to assess whether these correlations represented a unified multimodal construct (e.g., SIPS rather than simply *facial* emotion processing speed), I examined correlations across modalities. Finally, I considered whether such a construct could be used to distinguish between subgroups of ASDs with impaired and intact emotion recognition ability, thereby parsing heterogeneity in this outcome in the population.

This study was important as a foundation for the following two. First, it provides a neurophysiological grounding for subsequent behavioral assessment. Second, it links such grounding to concurrent performance on a key indicator of social functioning, and is among the first investigations to do so. Finally, it provides a deeper assessment of the empirical construct validity of SIPS, which is necessary for its inclusion in the subsequent studies.

Study 2. In Study 2, I considered the cross-sectional relationship between social knowledge, social performance-related factors (social creativity, social motivation, SIPS) and target outcomes (observed social behavior, Theory of Mind, emotion recognition). Building on the robust finding of SIPS from Study 1, I hypothesized that social performance-related factors would independently predict -- or would interact with social knowledge to predict – these outcomes. If such main effects or statistical interactions existed, they would reject a primary knowledge deficit model of social skills deficits in HFASDs, as they would demonstrate that factors besides social knowledge are primarily responsible for observed social performance and social mechanisms. While this finding would not conclusively support a social performance deficit alternative, it is nonetheless necessary to rule out the possibility of a pure social knowledge deficit to assess the relative contribution of other factors to social behavior. As represented in Figure 3, this hypothesis states that line 1 would not be the only significant predictor of prosocial behavior; rather either line 2, line 3, or both will also be significant predictors of social performance and mechanisms.

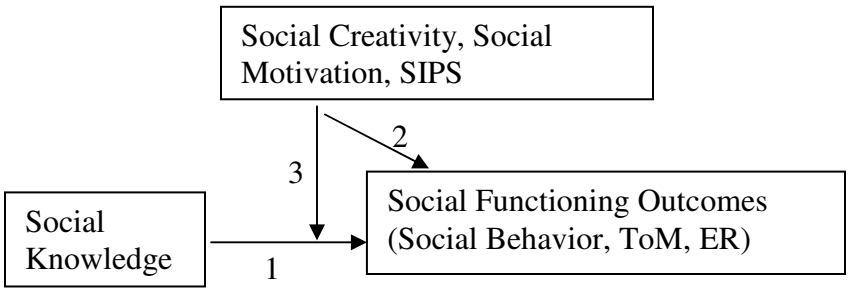

Figure 3. Graphical representation of Study 2 hypotheses. SIPS = Social information processing speed, ToM = Theory of Mind, ER = emotion recognition.

Study 3. In Study 3, I conducted a dismantling study examining the proximal effects of brief knowledge- and performance-training conditions on social outcome

variables, as well as their relation to pre-test social knowledge- and performance-related factors. I hypothesized that participation in social performance-training activities would predict a greater increase in outcomes (observed in-session and generalized prosocial behavior, Theory of Mind, and emotion recognition) relative to knowledge-training activities. Such a finding would support the presence of a primary social performance deficit in the ASD population through the Aptitude x Treatment principle (Smith & Sechrest, 1991). Additionally, it would suggest that differences found in longer intervention trials (Lerner & Mikami, in press) may begin early during interventions. Finally, it would highlight that social skills interventions for ASD youth are generally dissociable according to the knowledge-performance divide in terms of general efficacy and putative mechanisms. This hypothesis is represented by line a in Figure 4.

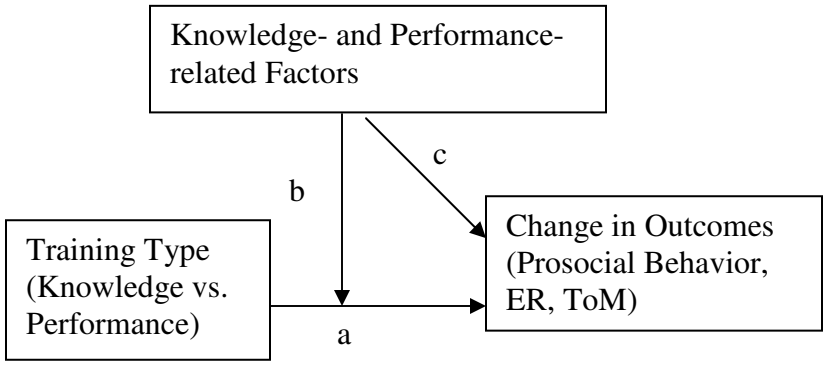

Figure 4. Graphical representation of Study 3 hypotheses. ToM = Theory of Mind, ER = emotion recognition.

Building on Study 2, I also hypothesized that individual differences in mechanisms of social deficit (i.e. primarily knowledge- or performance-based) may predict differential response regardless of treatment condition. Specifically, across a short time span, higher levels of social performance-related factors (social motivation,

creativity, and information processing speed), but not social knowledge, may yield greater responsiveness (in terms of change on social outcome measures) to opportunities to engage in interactions with peers (Guli et al., 2008; Lerner & Levine, 2007). This would further support a social performance-related deficit, as it would indicate a stronger relation between change in social outcomes and performance-related factors in the presence of peer interaction (i.e. that performance-related variables promote a social "snowballing" effect). It would also provide a picture of which youth might be most likely to respond to social skills interventions *as currently delivered*.

Finally, again capitalizing on the Aptitude x Treatment principle (Smith & Sechrest, 1991), I hypothesized that individual differences in pre-test levels of knowledge- or performance-related variables would predict response by condition. As this was an exploratory hypothesis, I posited that either deficient "aptitudes" would predict response in the consonant condition (such that those with poorer social knowledge would show greater change during knowledge-training, and likewise with social performance and performance-training), or that conditions may tap into latent learning style differences (such that those with greater social knowledge would show greater change during knowledge-training, and likewise with social performance and performance-training). Either way, results would indicate that, while there may be heterogeneity in mechanisms of social functioning in HFASD, this heterogeneity can be used to "match" participants to treatment conditions (Norcross & Wampold, 2011; Simon & Perlis, 2010; Smith & Sechrest, 1991). Moreover, it would support the knowledge-

performance distinction as an effective way to characterize individual differences predicting such a "match" (Gresham, 1997; Nixon, 2001).

Method

Participants

Participants were 41 adolescents (33 male; M_{age} = 12.01, SD_{age} = 2.07) with ASD. This age group was recruited for three reasons: 1) their greater awareness of their social deficits relative to younger children (Tse et al., 2007) was thought to facilitate their willingness to participate in social training activities; 2) they were more likely to be able to complete the time-intensive paradigm described above due to increased capacity for sustained attention relative to lower-functioning and younger children (Anderson, Jacobs, & Anderson, 2008); and 3) this age group has demonstrated responsiveness to performance-based interventions in previous research (Guli et al., under review; Lerner et al., 2011).

Participants were recruited via contacts with local schools, service providers, and agencies, as well as the contact list developed by the UVA Autism Research Group (i.e. via participation in local conferences and organizations for individuals with ASD and their parents and service providers). Parents who expressed interest were provided a Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2005) as a screening measure, and those who provided a score above the recommended cutoff were asked to proceed to the diagnostic confirmation stage; they and their parents also provided informed consent and assent at this stage (see Appendix A). At this stage, 45-minute individual child visits were conducted to administer the Autism Diagnostic Observational

System (ADOS; Lord, Rutter, DiLavore, & Risi, 1999) Module 3 or 4, the gold standard for adolescent ASD diagnosis in research settings (de Bildt et al., 2004), for diagnostic confirmation and to ensure adequate verbal ability. SCQ scores have been shown to have the highest sensitivity for accurate detection of ASDs (when compared to gold standard instruments) in older children (Corsello et al., 2007) and so I expected few children screened by the SCQ to fail to meet diagnostic cutoffs on the ADOS; indeed, only two adolescents who were screened in via the SCQ failed to meet ADOS criteria, and so were excluded. Children also completed a two-subtest short form of the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV; Wechsler, 2003) at this visit to ensure they meet IQ requirements for HFASD (FSIQ > 70); two adolescents failed to meet WISC cutoffs, and so were also excluded. WISC-IV scores were also used to match groups assigned to social performance- or knowledge-training conditions. Participants who scored above diagnostic cutoffs on the ADOS and above 70 on the WISC-IV proceeded to the final stage, were randomly assigned to performance-training or knowledge-training conditions, and were scheduled for 2-hour child dyad visits. During these visits, children completed the procedure described below (see Design & General Procedure section). See Figure 5 for CONSORT flow diagram for the full sample of participants.

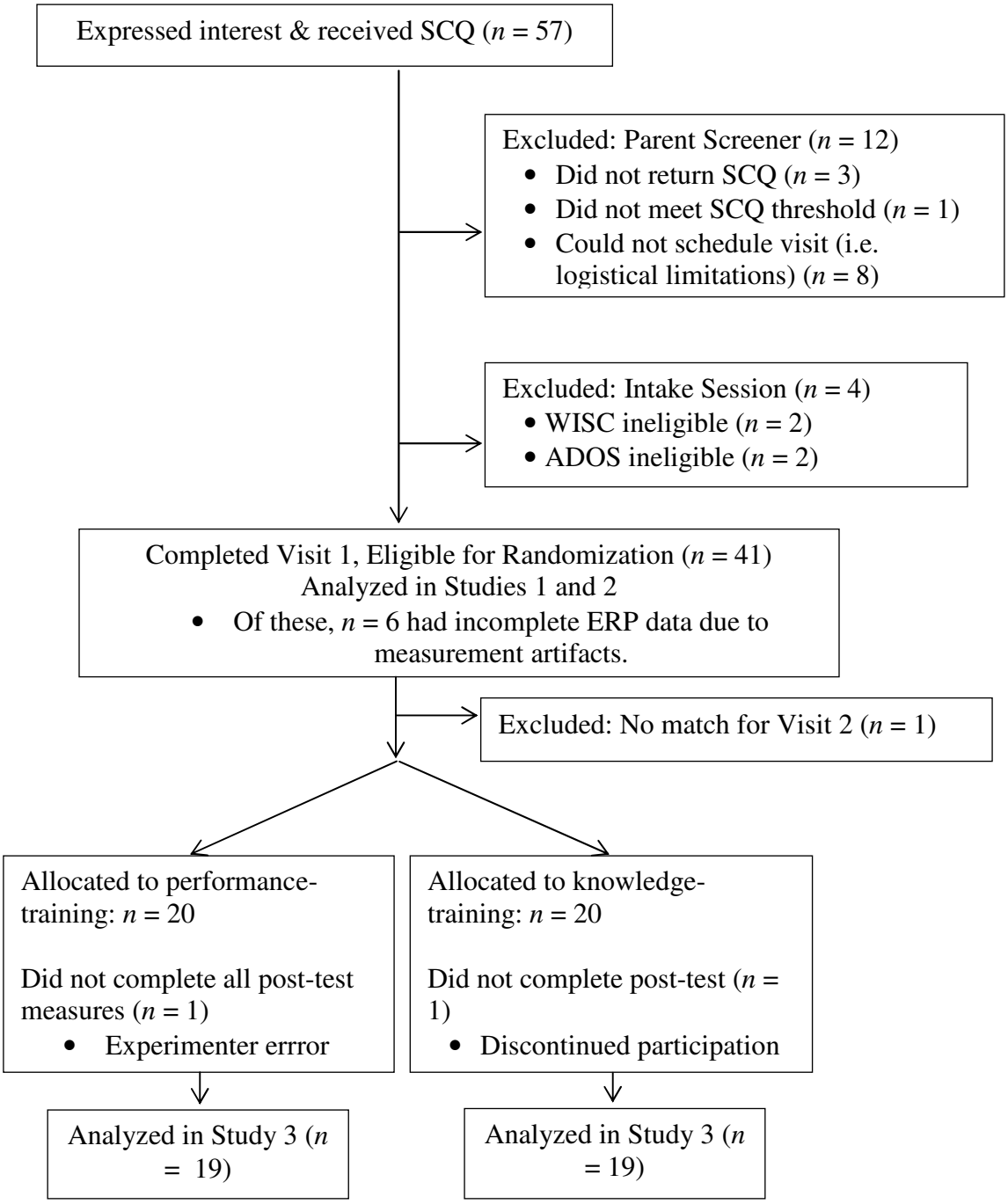

Figure 5. CONSORT flow diagram for the sample. Of the $n = 57$ families who expressed interest, $n = 41$ were eligible for enrollment following screeners and intake session. These participants were included in analyses for Studies 1 and 2. Of these, $n = 40$ were randomized to and participated in Visit 2 in either the performance-training or knowledge-training condition. One child's data was lost in each condition, yielding $n = 38$ analyzed in Study 3.

Design and General Procedures

This study involved three steps. In the first step, I surveyed existing treatment manuals to identify and isolate approximately one dozen largely performance-training activities and one dozen knowledge-training activities. These activities were then reviewed with the Committee Chair (A.Y. Mikami) iteratively to reduce them to approximately a half-dozen of each. Next, a group of expert clinicians (K. Levine, L.A. Guli, and J. Hobson) were presented with this list to a) help reduce the number to five topic-matched (i.e. aimed at achieving the same goals) activities per condition, and b) confirm that the activities do indeed adequately differentiate between knowledge- and performance-training approaches. Upon their approval, the final list of activities (see Appendix K) was sent to the Dissertation Committee for approval; the target goals/topics of the final set of activities were: *starting a conversation, trading information, staying on topic, expressing your emotions*, and *understanding the feelings of others*.

In the next step, the participants were recruited to participate in an initial diagnostic visit and complete the measures of social knowledge, social motivation, and social creativity. In the third step (the second visit), these same participants engaged in a 2-hour paradigm that first assessed the next social performance-related variable (SIPS), as well as the social skills outcomes. Participant dyads were constructed and matched by age (+/- 1 year), sex, FSIQ, and relative severity of ASD symptoms. Dyads were brought to a video-equipped observation room with several age-appropriate games (a deck of cards, Connect Four, a ball, markers and a blank piece of paper); one participant did not complete this procedure. They were then informed that the research assistants had work

to do in the next room, but would return soon. Dyads were left in this room for 10 minutes, their unstructured interactions taped; these tapes were later coded for social interaction quality and quantity (see below). These dyads were then randomly assigned to complete either the social knowledge- or social performance-training tasks. These tasks involved unstructured peer interaction and, crucially, the core activities designated above. Then, the research assistants again left the room for 10 minutes, again informing the dyads that they had work to do, but would return soon. These interactions were also taped and coded. Participants completed measures of Theory of Mind (SEL) and emotion recognition (DANVA-2) before and after social engagement tasks to assess these outcomes; ERP analysis was conducted during the pre-test DANVA-2 to assess SIPS. The design of the data collection procedures is illustrated in Figure 6.

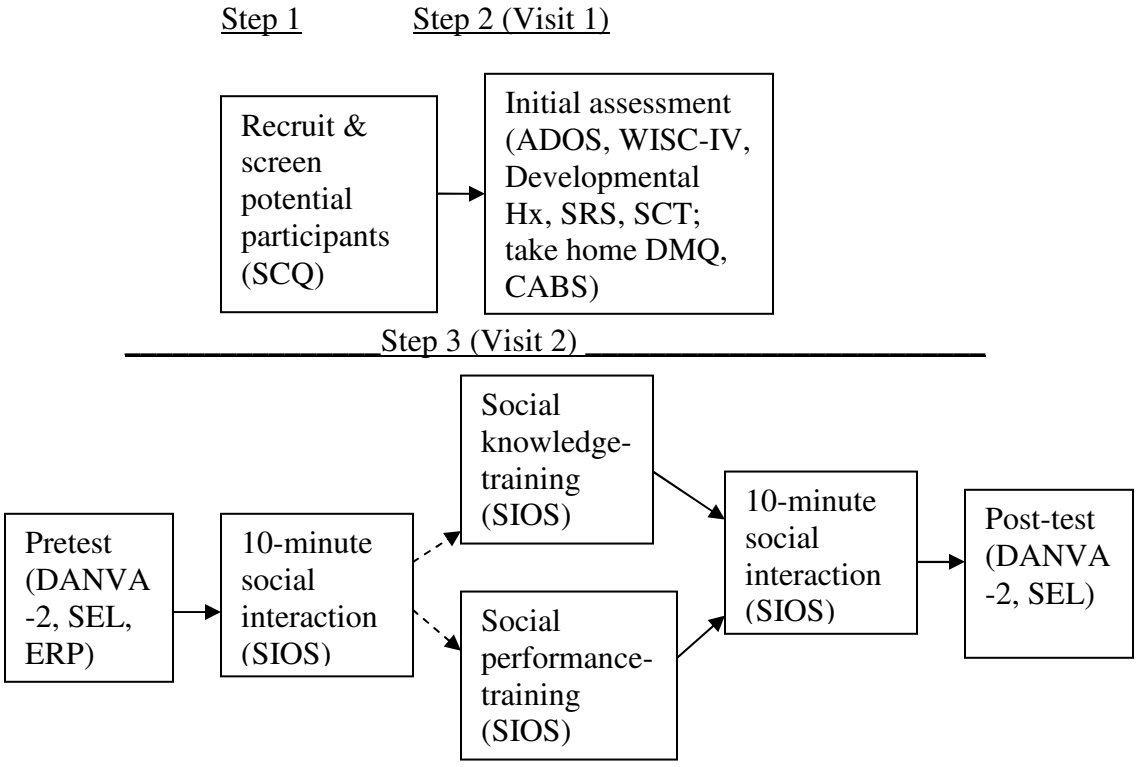

Figure 6. Diagram of design of data collection procedures. - - ▸ = random assignment.

Measures

Please see Appendix for copies of questionnaires and examples of other measures.

Descriptive measures.

Developmental History. Parents filled out a complete developmental history, including demographic information, diagnostic history, past intervention, and current medication status (see Appendix B).

Social Communication Questionnaire (SCQ; Rutter et al., 2005). The SCQ is a widely-used, well-normed screening measure for ASDs, with international validation across age groups (Bölte, Holtmann, & Poustka, 2008; Goin-Kochel & Cohen, 2008; Witwer & Lecavalier, 2007). It contains 40 binary (*yes* or *no*) items (sample item: Has she/he ever had any interests that preoccupy him/her and might seem odd to other people?) and three subscales: Communication, Reciprocal Social Interaction, and Restricted/Repetitive Behaviors (see Appendix C). It generates raw scores, with higher scores corresponding to a greater degree of impairment, and has a recommended ASD cutoff score of 15. It was used as an initial screening tool in this investigation. Internal consistency (Cronbach's α) was acceptable (.79).

Social Responsiveness Scale (SRS; Constantino & Gruber, 2005). The SRS is a well-normed measure of social impairment in social settings among individuals with ASDs (Bölte, Poustka, & Constantino, 2008; Constantino et al., 2003). It is a 65-item (sample item: has trouble keeping up with the flow of a normal conversation) questionnaire answered on a 1-4 Likert scale ranging from *not true* to *almost always true* (see Appendix E). It contains three subscales, Social Awareness (8 items), Social

Cognition (12 items), Social Communication (22 items), Social Motivation (11 items), and Autistic Mannerisms (12 items). The SRS yields *T*-scores, with higher scores corresponding to a higher degree of social impairment and autistic behavior in social settings. It was measured in this investigation as a secondary assessment of parent-reported autistic social impairment. Internal consistency was acceptable (.90). Additionally, the Social Motivation subscale on the SRS (internal consistency = .68) was correlated with DMQ scores to examine concurrent validity of the social motivation construct (see below).

Autism Diagnostic Observation Schedule (ADOS; Lord et al., 1999). The ADOS is considered the gold-standard measure for diagnostic confirmation of ASDs across age groups and diagnostic severity (Gotham, Pickles, & Lord, 2009; Mahoney et al., 1998; Sikora, Hartley, McCoy, Gerrard-Morris, & Dill, 2008), and was used as such in this investigation. The ADOS is a standardized observational scale consisting of about 10 tasks and 30 codes. Structured social interactions are created in which a behavior or a particular type of social response is likely to occur. The child's responses to these interactions are then coded on a 0 – 2 Likert scale ranging from *not abnormal behavior* to *very abnormal behavior* by a research-reliable examiner. The author (M.L.) became research-reliable on the ADOS prior to conducting this investigation. The ADOS contains 5 subscales: Language and Communication, Reciprocal Social Interaction, Play, Stereotyped Behaviors, and Restricted Interests. Children are considered to meet criteria for an ASD diagnosis if they meet or exceed recommended cutoff scores on the Communication (ASD = 2) and Reciprocal Social Interaction (ASD = 4) subscales, as

well as on a total Communication and Interaction algorithm (ASD = 7). Internal consistency was acceptable (.80).

Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV; Wechsler, 2003). A two subtest (Vocabulary and Matrix Reasoning) short form of the WISC-IV was used to estimate Full Scale IQ (FSIQ) to ensure criteria for HFASDs (FSIQ > 70) were met and to match groups based on FSIQ. The WISC-IV was chosen because it is considered the optimal instrument for estimating and matching based on IQ in HFASD populations (Mayes & Calhoun, 2008; Mottron, 2004). The chosen short form configuration was selected because of its demonstrated high reliability and validity coefficients (.926 and .873, respectively; Sattler & Dumont, 2004) and its rapid administration time (< 16 minutes; Ryan, Glass, & Brown, 2007).

Outcome measures.

Diagnostic Analysis of Nonverbal Accuracy-2 (DANVA-2; Nowicki, 2004). The DANVA-2 is a computer-based measure of accuracy in ability to detect emotions in faces and voices (see Appendix F). Participants observe 24 adult and 24 child faces and then listen to 24 adult and 24 child voices, and must identify them as either happy, sad, angry, or fearful; it generates raw error scores for face or voice responses (0 – 48). The DANVA-2 has been used frequently to explore ability to identify emotions in faces and voices by children and adolescents with HFASDs (e.g., Serra, Jackson, van Geert, & Minderaa, 1998), and has demonstrated treatment sensitivity on the Faces scale (Solomon et al., 2004) and the Voices scale (Lerner et al., 2011) in this population. In this investigation, the DANVA-2 composite Faces and Voices scores were derived from

performance on their respective modules. These scores were used at pre- and post-test to examine pre-test emotion identification ability as well as changes in this ability over the course of the paradigm. Stimuli were presented in a 2x2 (adult/child x faces/voices) block design, randomized within and between blocks. For Studies 2 and 3, to ensure that outcome measures all corresponded directionally (i.e. higher = "more"), Faces and Voices emotion recognition scales were reverse-scored such that higher scores correspond to better ability. Internal consistency was high across the Faces (.913) and Voices (.889) scales. These scales were used to represent the outcome variables of emotion recognition.

Stories from Everyday Life (SEL; Kaland et al., 2002). The SEL (see Appendix G) is an advanced Theory of Mind battery appropriate for individuals with HFASD in the target age range (Kaland, Callesen, Moller-Nielsen, Mortensen, & Smith, 2008; Kaland et al., 2002; Kaland, Smith, & Mortensen, 2007). It focuses on the ability to make distinctions about physical as well as mental states. Participants are presented with a story that leads towards a climax (e.g., the brother of a child who never cleans his room declares that said child has done "a splendid job of tidying up"), then are asked to answer questions regarding the physical condition (e.g., how does the child's room look?) and mental state (e.g., why does the brother make this statement?) of a character in the story. If a participant gives an answer to one of the test questions that is not quite correct (e.g., does not clearly indicate that they understand intended sarcasm in the above *irony* story), he is then given one or more additional questions in order to try to make it easier for him to understand the test question. No feedback about the accuracy of responses is given.

Responses to each question are taped at the time of the testing. If a participant gives more than one answer, only the most appropriate is marked.

The SEL includes 26 short stories or 13 pairs of different types of stories (A and B versions). To limit participant fatigue, the four social-cognitive story types that have demonstrated the greatest ability to distinguish between HFASD and TD adolescents (figure of speech, contrary emotions, mistaken intentions, and irony) were used (Kaland et al., 2002). Using these four story types, for each participant either the story A set was administered at pre-test and the story B set was administered at post-test, or vice versa (counterbalanced for order). A different RA administered each participants' pre-test and post-test SEL. Responses to the mental inference question for each story are rated on a 0–2-scale as *fully correct* (2 points), *partially correct* (1 point), or *incorrect* (0 points). Two RAs independently coded these responses, one *in vivo* while the measure was being administered, and the other from audiotape. Three RAs not involved in SEL administration were randomly assigned to rate these audiotapes. This process has yielded excellent inter-rater reliability in past administrations (Kaland et al., 2002; Kaland et al., 2007), and reliability was excellent in the present sample ICC(1,2) >. 85. As it has shown the best ability to discriminate individuals with ASD from TD individuals, only the mental inference scale (i.e. average mental inference score across the stories in a given set) was analyzed (Kaland et al., 2002). Internal consistency of the mental inference scale was acceptable (.58). This was used to represent the outcome variable of Theory of Mind.

Social Interaction Observation Scale (SIOS; Bauminger, 2002, 2007b). The SIOS is a measure of prosocial interaction designed for use with individuals with

HFASDs. It assesses three primary domains, *positive interaction* (e.g., eye contact with smile, sharing), *low-level interaction* (e.g., close proximity, functional communication), and *negative interaction* (e.g., physical and verbal aggression), as well as *total interaction* (Lerner & Mikami, in press), and measures discrete 50-second samples of interaction followed by 10 seconds of recording (see Appendix J). Its three subscales (Positive interaction, Low-Level interaction, and Negative interaction) conceptually map on to the three scales of the CABS (assertive, passive, and aggressive; Michelson & Wood, 1982), indicating that the CABS may capture children's social knowledge of the *specific* domains of social competence observed in the SIOS. When characterizing these domains of interactions, positive interactions can be seen as unequivocally "good" (i.e. prosocial behaviors promoting greater likelihood of reciprocal peer engagement) and negative interactions can be seen as clearly "bad" (i.e. hostile behaviors promoting less peer engagement; Bauminger, 2002; Bauminger, Shulman, & Agam, 2003). Low-level interactions, however, may be more mixed, as they represent an incremental attempt at social interaction, though of a lesser quality (i.e. less likely to promote reciprocal peer engagement) relative to positive interactions; indeed, this "mixed" quality is reflected in the fact that comparable social skills intervention studies have reported both increases (Bauminger, 2002) and decreases (Bauminger, 2007b) in low-level interactions. In the present investigation, more low-level interactions alone or in conjunction with *more* total or positive interactions (reflecting attempts to interact in contrast to no interaction at all) as well as *less* low-level in conjunction with *more* total or positive interactions, are considered somewhat "good;" meanwhile, more low-level interactions in conjunction

with *less* total or positive interactions (reflecting a shift towards lower-quality interaction) are considered "bad."

The SIOS was used to rate ASD peer dyads' unstructured interaction; this microcoding of social behavior took place during the unstructured interaction components and the social training activity components of the paradigm (see Design & General Procedure above). Coders used 10 one-minute segments of behavior because the sessions were videotaped, so 10-second coding breaks were not necessary. During these samples, coders could rate up to three behaviors that best characterized the given segment (across any combination of subscales; e.g., sharing, close proximity, verbal aggression). The average of each subscale was calculated across segments, such that scores for each (as well as for total amount of interaction) ranged from 0 to 3. Before rating, three coders were trained on the SIOS manual, then achieved high reliability (ICC(2,3) > .80) on all scales with master codes on tapes from a previous sample (Lerner & Mikami, in press). They were then randomly assigned to double-code the tapes from the current study, counterbalanced by pair. Coders first rated the interactions occurring in the 10-minute unstructured periods that occurred before and after the training activities (randomly assigned, with coders kept unaware of whether tapes were pre- or post-test). Then, they rated the interactions that took place *during* social knowledge- and performance-training activities; this was done so that raters would remain unaware of condition assignment when rating the unstructured interactions. Regular reliability assessments were performed and results were discussed weekly to help minimize coder drift throughout coding, as recommended by Margolin et al. (1998). Reliability (ICC(1,2)) for Total (.92), Positive

(.94), Negative (.77), and Low-Level (.93) interactions was excellent. However, there was little variance in (few incidents of) Negative interaction, so it was excluded from subsequent analyses.

The SIOS was considered to be the *social behavior* outcome variable. SIOS scores during the knowledge- and performance-training activity components are analogous to social behavior *during* social skills intervention sessions. SIOS scores taken during the unstructured interaction immediately following the social activity component are analogous to generalized social behavior observed *after* social skills interventions.

Social Knowledge Measure.

Children's Assertive Behavior Scale (CABS; Michelson & Wood, 1982). The CABS is a 27-item multiple-choice self-report measure of knowledge of general and specific social skills (see Appendix H). A sample item states, "You made a mistake and someone else is blamed for it. You would usually a) Say nothing. b) Say, 'It's their mistake!' c) Say 'I made the mistake.' d) Say, 'I don't think the person did it.' e) Say, 'That's their tough luck!'". It generates three scales of self-reported social functioning: passive, aggressive, and assertive social behavior (Hobbs & Walle, 1985; Michelson & Wood, 1982; Scanlon & Ollendick, 1986). The CABS has been shown to correlate with peer, parent, and teacher reports of social competency and to discriminate between children with versus without a history of social skills training (Michelson & Wood, 1982); it has also demonstrated strong convergent validity with multiple measures of related constructs (Scanlon & Ollendick, 1986). Its aggressive subscale has been shown to reliably differentiate children of high- and low-sociometric status (Hobbs & Walle,

1985), and its passive and assertive scales have been shown to successfully "unbind" submissive and assertive behavior (Scanlon & Ollendick, 1986). It has previously been adapted to assess *social skills knowledge* by asking children what they thought "the right thing to do" was in each presented situation (Maedgen & Carlson, 2000; Wojnilower & Gross, 1988). It was used at Visit 1 in this investigation to assess the social knowledge of the participants; only the "correct" (i.e. assertive) scale was used, and it was reversed-scored such that higher values correspond to "more" knowledge. With this scoring, normative samples of comparably-aged TD youth have mean scores of approximately 43.77 (SD = 4.87; Maedgen & Carlson, 2000; Wojnilower & Gross, 1988); it has not previously been used with ASD samples. Internal consistency was acceptable (.87). This scale was used as a measure of *social knowledge*. See Study 2 below for more information on the construct validity of this measure.

Social Performance-Related Measures.

Dimensions of Mastery Questionnaire (DMQ; Morgan, Busch-Rossnagal, Barrett, & Harmon, 1997). The DMQ is a parent-report questionnaire containing a six-item subscale (sample item: tries hard to make friends with other kids) designed to assess child motivation to interact with peers (see Appendix D). It is answered on a 1-5 Likert scale ranging from *not at all typical* to *very typical* and generates raw scores. It been used previously to assess parent-reported social motivation to engage with peers among children with HFASDs (Fiske, 2008). The peer social motivation subscale is part of a larger 45-item scale (the full DMQ) assessing mastery motivation more broadly. However, only the peer social motivation subscale was used in this investigation because

of its relevance to the theorized role of social motivation in social competency deficits in ASDs. For convenience, the title of the full scale (DMQ) will be henceforth used to represent the peer social motivation subscale throughout this manuscript. The DMQ was used as a measure of the social performance-related variable of social motivation. Internal consistency was acceptable (.74).

The correlation between the DMQ and the SRS - Social Motivation subscale was significant and in the expected direction (r = -.44, p < .01), supporting the proposition that the DMQ tapped into the same social motivation construct as this SRS subscale. The DMQ correlated with total interaction with peers on the SIOS (r = .31, p = .05), indicating that those with more motivation did indeed interact more with their peers in the unstructured setting, supporting the construct validity of the measure. It also correlated negatively with age (r = -.32, p < .05), and DANVA-2 Faces (r = -.41, p < .01), suggesting that those with more social motivation were younger and did more poorly on facial emotion recognition.

Social Creativity Task (SCT; Mouchiroud & Bernoussi, 2008; Mouchiroud & Lubart, 2002). The SCT is a self-report measure of social creativity in a variety of scenarios (Appendix I). It requires participants to generate as many creative solutions to given social problems as possible. Social creativity has been shown to be a unitary construct that increases with development (Mouchiroud & Lubart, 2002) and correlates with social competencies, popularity, and parenting style (Mouchiroud & Bernoussi, 2008). As this investigation is principally concerned with social creativity in the peer domain, only two SCT scenarios, the “peers” and “dyad” tasks (Mouchiroud & Lubart,

2002) were used. To control for differences in writing ability, children were administered the SCT as a verbal interview during their first study visit. Children were asked to generate as many creative solutions as possible to the given social problems, and their responses were then recorded and transcribed. Next, a team of undergraduate coders were trained on a sample set of responses to judge the creativity of each answer according to a 7-point Likert scale (*not at all creative* to *extremely creative*), then rated participants' transcribed responses; previous research using the SCT has generated acceptable inter-rater agreement using this method (Mouchiroud & Bernoussi, 2008). All answers were double-coded, with coders assigned randomly, counterbalanced by coder pair. Regular reliability assessments were performed and results were discussed weekly to help minimize coder drift throughout coding (Margolin et al., 1998). Reliability of these ratings was excellent, ICC(1,2) = .79 (Cicchetti, 1994). The sum of each child's scores was divided by his/her total number of answers to control for fluency (Mouchiroud & Lubart, 2002), generating a final SCT score. Overall, the SCT was used as an index of the social performance-related variable of social creativity.

The SCT correlated in the expected direction with the ADOS ($r = -.49$, $p < .01$) and the SIOS – positive interaction scale ($r = .32$, $p < .05$), indicating that those with more social creativity had fewer autistic symptoms and more prosocial interactions with peers. This supports the construct validity of the SCT. Notably, while the CABS (social knowledge) also correlated with ADOS scores ($r = -.31$, $p = .05$), the SCT and CABS were uncorrelated ($r = -.03$, $p = .83$), suggesting that social knowledge and social creativity may tap into distinct cognitive elements underlying social impairment in ASD.

SIPS (see Study 1 below). SIPS was measured via the latency of the initial ERP-indexed response to facial (N170) and vocal (N100) stimuli on the DANVA-2 (see above; Nowicki, 2004). Such latency has been shown to be uniquely delayed in response to social stimuli (McPartland & Pelphrey, in press; McPartland et al., 2011) and to represent a unified multimodal emotion processing construct (independent of subsequent cognitive evaluation; see Study 1, below) among individuals with ASD. In the present study, ERPs were collected during the DANVA-2 using a 32-Channel BioSemi Active 2 system. For facial and vocal stimuli, ERPs were time-locked to the presentation of the stimulus. Data were digitally filtered at a low-pass of 30 Hz. Artifact rejection was conducted visually; all participants used for ERP analyses (n = 35) have >16 trials and >50% of trials were marked "good." Epochs of 150 – 700ms pre- to post-stimulus were created. Finally, ERPs were extracted from electrode sites homologous to those found in the previous literature (N170 extracted from PO4, N100 from Cz; Jeste & Nelson, 2009; Pinheiro et al., 2010). For more details on acquisition procedures and construct validity, see Study 1, below. As the N170 is a considerably more well-established ERP component (McPartland et al., 2004; McPartland et al., 2011; Webb et al., 2006; Webb et al., 2010), it was used in all analyses except those examining emotion recognition in voices, for which N100 is more directly comparable. Latencies were converted to z-scores a) to ensure normality of distribution, and b) because the goal of this investigation was to assess variability within the population. Overall, these latencies were used as indices of the social performance-related variable of SIPS.

Data Analytic Approach

Data analytic plans are presented in the detailed description of each Study below. However, in general across studies, hierarchical multiple regression procedures were used to test hypotheses, controlling for relevant covariates. For instance, in Study 1, age and IQ were controlled due to their likely influence on shifts in ERP components over time (Batty & Taylor, 2006; Jeste & Nelson, 2009; Nelson & McCleery, 2008). In Studies 2 and 3, IQ and ASD severity were controlled to ensure they did not introduce spurious effect on outcomes (e.g., verbal ability on ability to respond on the SEL).

In analyses involving the variable of observed social interaction on the SOIS. as participants were nested in dyads for the collection of this variable, variance in all outcomes was examined in a Hierarchical Linear Modeling (HLM) framework to determine whether there was significant Level 2 (between-dyad) variance. Using Guo's (2005) recommended cutoff (25% of variance at Level 2), I found that all SIOS outcomes had considerable Level 2 variance. Thus, analogous hierarchical multiple regression analyses (i.e. using the same sequence of steps) were conducted for these outcomes in an HLM framework.

In Study 2, to ensure that effects did not arise from past intervention experience, significant analyses were re-run controlling for past social skills intervention status (dummy coded) and quantity (number of past interventions). In Study 3, these post-hoc analyses were also run, though current medication status (dummy coded) was included as well.

Effect size estimates were provided according to Cohen's (1992) standards. No imputation procedures were used to address missing data concerns so as to provide conservative estimates of effects.

Study 1

Multimodal Emotion Processing in Autism Spectrum Disorders: An Event-Related Potential Study

Accurate recognition of affect is a requisite skill for adaptive social functioning and a noted domain of impairment in individuals with autism spectrum disorder (ASD; Baker, Montgomery, & Abramson, 2010; Philip et al., 2010; Rump et al., 2009). Deficits in identification of emotional content in faces (Rump et al., 2009) and voices (e.g., prosody; Baker et al., 2010) are well-documented in this population and are posited to represent a core deficit (Philip et al., 2010). Nevertheless, some research reveals subgroups of individuals with ASD who exhibit relatively preserved emotion recognition ability (Bal et al., 2010; Kuusikko et al., 2009; O'Connor et al., 2005), highlighting the under-studied topic of variability *within* ASD. Despite variable presentation and a limited understanding of its nature and course, emotion decoding represents a common intervention target (Beauchamp & Anderson, 2010; Lerner et al., 2011; Solomon et al., 2004). A critical goal for research is elucidating sensory and cognitive bases of emotion perception in ASD; this will aid in identifying meaningful subgroups and concretizing appropriate treatment targets.

Emotion processing deficits in ASD have been hypothesized to reflect a generalized, rather than sensory modality-specific, deficit in social perception (Beauchamp & Anderson, 2010; Jones et al., 2010; Philip et al., 2010). This account characterizes emotion processing deficits in different domains as a common developmental consequence of impairments in more basic social perceptual abilities (Batty et al., 2011). Therefore, difficulties with emotion processing should be evident in multiple sensory domains, or multimodal. Some recent research contradicts this account, demonstrating no fundamental difficulty with multimodal emotion recognition (Jones et

al., 2010) and intact basic emotion recognition (Rump et al., 2009) in adolescents with ASD. This suggests that putative "emotion processing deficits" may simply reflect discrete modality-specific perceptual abnormalities, or instances of heterogeneity in social perception among youth with ASDs.

In this study, I addressed this question directly by examining lower-level perceptual and cognitive processes across sensory modalities during emotion decoding within a sample of youth with ASD. By using event-related potentials (ERPs), stimulus-responsive peaks in the scalp-derived continuous electroencephalograph (EEG) that are effective for assessing basic processing in ASD (Jeste & Nelson, 2009; Nelson & McCleery, 2008), I measured multimodal perception in a fashion less vulnerable to variability associated with behavioral measurement (see Rump et al., 2009). In addition to isolating and quantifying cognitive processes that may underlie these deficits, the high temporal resolution of ERPs allows for description of both speed/efficiency (latency) and salience/intensity (amplitude) of such processes at individual processing stages representing distinct cognitive events. I employed ERPs recorded during a normed facial and vocal emotion-identification task to assess the presence and heterogeneity of a multimodal emotion processing abnormality in youth with ASD, and, if present, to specify its impact on emotion recognition.

Neural Correlates of Visual Emotion Perception

ERPs collected during presentation of facial stimuli reveal important information about social deficits in ASD populations (Dawson et al., 2005). Several studies in youth (Hileman, Henderson, Mundy, Newell, & Jaime, 2011; Webb et al., 2006) and adults

(McPartland et al., 2004; O'Connor et al., 2005, 2007) with ASD (though see Webb (2010)) reveal slowed processing of social information as measured by a short-latency face-sensitive component (N170; McPartland et al., 2011). The N170 marks early perceptual processes involved in recognition and identification of configural information in faces (Bentin et al., 1996; Nelson & McCleery, 2008) and has been shown to respond to emotional expressions (Blau et al., 2007), though see Eimer (2003). Neural generators of the N170 have been localized to occipitotemporal sites critical for social perception, including fusiform gyrus (Shibata et al., 2002) and superior temporal sulcus (Itier & Taylor, 2004).

Stages of processing subsequent to face structural encoding are more consistently reflective of emotional valence. The fronto-central N250 (Luo, Feng, He, Wang, & Luo, 2009) is evoked by observation of an emotionally expressive face (Balconi & Pozzoli, 2008; Carretie, Martin-Loeches, Hinojosa, & Mercado, 2001; Streit, Wolwer, Brinkmeyer, Ihl, & Gaebel, 2001; Wynn, Lee, Horan, & Green, 2008). The N250 is considered to mark higher-order face processing such as affect decoding, and is presumed to reflect the modulatory influence of subcortical structures, including amygdala (Streit et al., 1999). The degree to which cognitive processes marked by the fronto-central N250 are impacted in ASD are poorly understood. No ASD research to date has examined the relationship between facial emotion recognition ability and these neural markers of emotion processing.

Neural Correlates of Auditory Emotion Perception

Individual with ASD also show ERP evidence of abnormal processing of auditory speech information (Nelson & McCleery, 2008). Reduced amplitude during perception of speech sounds has been reported for auditory ERP components, including the P300 (Dawson, Finley, Phillips, Galpert, & et al., 1988), P1, N2, P3, and N4 (Whitehouse & Bishop, 2008); however, little is known about neural correlates of emotion identification during processing of vocal prosody in naturalistic speech.

Recent work in typically-developing (TD) adults has revealed that early emotion processing is indexed at emotional vocal (even sentential) stimulus onset in naturalistic speech by a central N100 (early sensory processing) component, a frontal P200 (integration of prosodic acoustic cues), and a frontal N300 (early emotional evaluation) component (Paulmann, Jessen, & Kotz, 2009; Paulmann & Kotz, 2008a, 2008b). This process is thought to involve a pathway projecting from superior temporal gyrus, through anterior superior temporal sulcus, to right inferior frontal gyrus and orbito-frontal cortex (Paulmann, Seifert, & Kotz, 2010). Though these components have been effective in studying other disorders involving social behavior, such as Williams Syndrome (Pinheiro et al., 2010), this line of research has not yet been applied to ASD.

Multimodality of Emotion Perception

Emotion recognition in humans is hypothesized to emerge from a unified, multimodal emotion processing ability (Borod et al., 2000). The vast majority of studies of emotion perception examine faces, often asserting that “basic to processing emotions is the processing of faces themselves” (p. 432, Batty et al., 2011). Crucially, this claim rests on the assumption of multimodal emotion processing; that is, the utility of facial

emotion processing for informing emotions generally lies in the notion that emotional face processing is an emergent process stemming from a more generalized latent emotion processing ability. So, assessment of the multimodality of emotion processing fills an essential gap in the literature linking emotional face processing to emotion processing generally in ASD.

It is not known whether individuals with ASD exhibit multimodal deficits in emotion perception. Recent behavioral studies assessing the presence of a unified multimodal emotion recognition deficit in ASD have yielded inconsistent results. Philip et al. (2010) found substantial emotion recognition deficits in faces, voices, and bodies among adults with ASD. However, Jones et al.(2010) found no significant overall deficits in facial or vocal emotion recognition in adolescents with ASD. These studies employed standardized and unstandardized behavioral tasks, which limit generalizability (Jones et al., 2010). I sought to clarify this area by integrating age-normed behavioral measures and ERPs to explore whether ERP-indexed patterns of emotion processing (rather than behavioral task responses) are related across modalities. Crucially, rather than continuing to highlight group differences between TD and ASD individuals, I aimed to better explore the oft-neglected topic of individual differences within ASD populations. This work has vital implications for understanding extent and domain-specificity of emotion recognition deficits in ASD, as well as for identifying appropriate intervention targets and subpopulations defined by intact emotion recognition ability.

Hypotheses

Based on the extant literature I specified three hypotheses. First, I predicted that youth with ASD would show deficits in facial and vocal emotion recognition on age-normed measures, but that a subset of the population would show intact emotion recognition ability. Second, I hypothesized that within-modality ERP latencies and amplitudes would correlate with performance on the associated emotion recognition task. Third, consistent with a unified multimodal emotion processing deficit, I predicted correlations across auditory and visual modalities for both behavioral measures and ERPs, before and after relevant controls. Finally, I hypothesized that, after relevant controls, within-modality ERP latencies and amplitudes would be effective in empirically defining subgroups with ASD based on emotion recognition.

Method

Participants

Participants included 40 consenting youth with ASD enrolled in a larger study of social functioning. All participants had pre-existing diagnoses of ASD, which were confirmed with the Autism Diagnostic Observation Schedule (Lord et al., 1999), administered by a research-reliable examiner (ML). All participants met ADOS cutoffs for ASD. A reliable and valid abridged version of the Wechsler Intelligence Scale for Children-IV (Vocabulary and Matrix Reasoning; Ryan et al., 2007; Wechsler, 2003) was administered to confirm normative cognitive ability (IQ > 70). After EEG processing (six participants were excluded due to excessive artifact), the final sample included 34 individuals (26 male; M_{age} = 13.07, SD = 2.07).

Behavioral Measure

Diagnostic Analysis of Nonverbal Accuracy-2 (DANVA-2; Nowicki, 2004). The DANVA-2 is a widely-used, age-normed, standardized measure of emotion recognition in adult and child faces (Nowicki & Carton, 1993) and voices (Baum & Nowicki, 1996; Demertzis & Nowicki, 1998). Participants rate visual stimuli: 24 child and 24 adult faces indicating high- or low-intensity happy, sad, angry, and fearful faces by pressing a button indicating the selected emotion. They also rate auditory stimuli: 24 child and 24 adult voices saying the phrase, "I'm leaving the room now, but I'll be back later," indicating high- or low-intensity happy, sad, angry, and fearful emotion in the same manner. The DANVA-2 produces scores indicating raw number of errors in emotion recognition such that lower numbers indicate better performance. Both the facial (Solomon et al., 2004) and vocal (Lerner et al., 2011) modules have been used with ASD youth. In this study, stimuli were presented in a 2x2 (adult/child x faces/voices) block design, randomized within and between blocks. Adult/child and high/low-intensity scales were derived (scales were not derived for individual emotions due to lack of statistical power). Scale reliability (Cronbach's α) was high across the facial (.913) and vocal (.889) scales.

ERP Measures

Stimuli and procedures. ERP data collection took place during administration of DANVA-2 stimuli. All stimuli were presented in a sound attenuated room with low ambient light using MatLab 7.9.0. Participants were seated before a 24" flat-screen color monitor (60 Hz, 1024 x 768 resolution) at a viewing distance of approximately 75 centimeters, with a keyboard immediately in front of them. Each stimulus was

accompanied by an on-screen listing of the four emotion choices, with each corresponding to a key press. Participants were permitted to take as long as needed to choose an emotion (even after cessation of presentation of each stimulus), and a 1000ms blank-screen inter-stimulus interval was provided after each choice. Participants were provided on-screen and verbal instructions prior to procedures; experimenters ensured that participants could comfortably reach the keyboard. Facial stimuli were presented on the monitor for up to 3000ms each against a black background. Vocal stimuli were presented via screen-mounted speakers at approximately 65db.

EEG acquisition. EEGs were recorded continuously at ~2000Hz using Actiview Software and active referencing. A 32-Channel BioSemi Active 2 cap, with Ag/AgCl-tipped electrodes arranged according to the 10/20 international labeling system, was fitted to each participant's head according to manufacturer specifications. A small amount of electrolyte gel was applied to each electrode to allow for low electrode offsets. Additional electrodes were placed at sura and infra orbital sites of each eye to monitor for vertical and horizontal eye movements. Data were sampled with the ground electrode being formed by the common mode sense active electrode and the driven right leg passive electrode. For all stimuli, ERPs were time-locked to stimulus onset.

ERP processing. ERP processing was completed with EEGLab (version 9.0.3.4b) and ERPLab (version 1.0.0.42) Matlab packages. Data were re-sampled to 500Hz, re-referenced against a whole-head average, and digitally filtered at a low-pass of 30 Hz using a Butterworth filter. Artifact rejection was conducted visually on continuous waveforms; epochs with ocular or clear movement artifact were excluded from analyses,

and exclusions were made blind to condition and participant. All participants used for final analyses had >16 trials and >50% of their trials marked "good" for both face and voices stimuli. The number of "good" trials did not differ significantly by condition. Epochs of 150 pre- to 700ms post-stimulus were created (precluding the possibility of ocular artifacts due to stimulus length), and each epoch was corrected against a 100ms baseline. Finally, ERPs were extracted from electrode sites corresponding to those used in the previous literature for face-responsive (Figure 7; N170 & N250; Jeste & Nelson, 2009; McPartland et al., 2004; Nelson & McCleery, 2008) and voice-responsive (Figure 8; N100, P200, N300; Paulmann et al., 2009; Pinheiro et al., 2010) ERPs, after confirming morphology in the grand average, and each individual, waveform. Peak amplitude and latency for each component were averaged for each participant and exported for analysis.

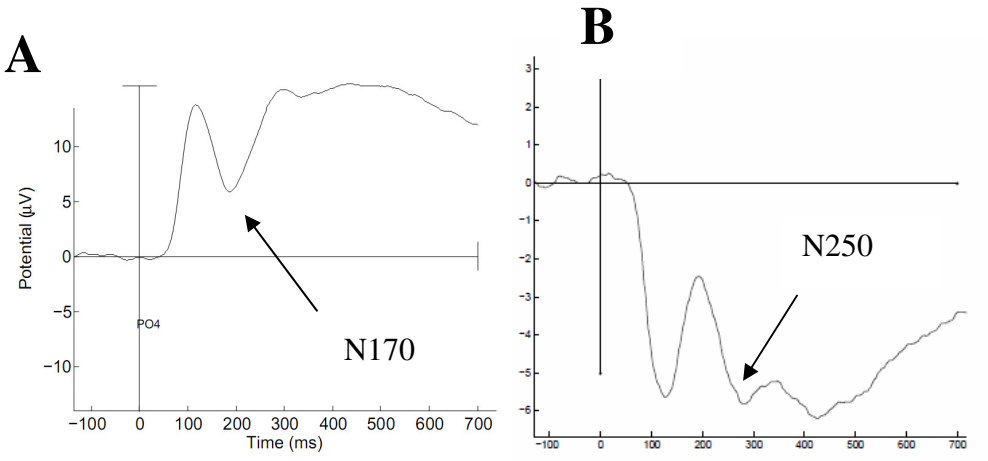

Figure 7. Grand averaged ERP waveforms to faces: A) N170 (peak between 160 and 220ms) extracted from electrode PO4; B) N250 (peak between 220 and 320ms) extracted from a composite of C4, F4, and FC2.

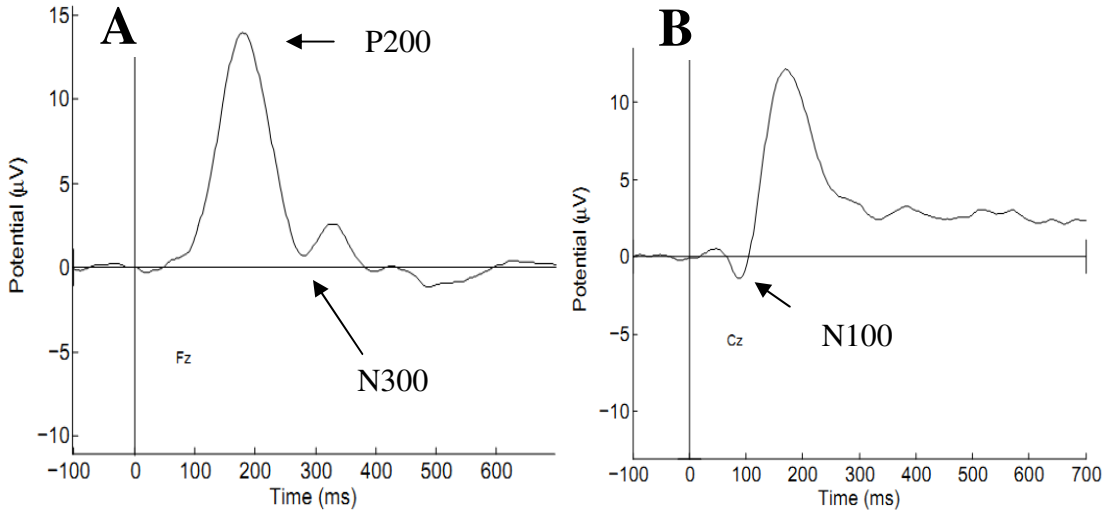

Figure 8. Grand averaged ERP waveforms to voices. A) P200 (peak between 180 and 220 ms) and N300 (peak between 280 and 320ms) extracted from electrode Fz. B) N100 (peak between 90 and 130ms) extracted from Cz.

Data Analytic Plan

To test my first hypothesis, that youth with ASD would show deficits on the emotion recognition behavioral task, paired-sample one-tailed *t*-tests were conducted, comparing observed values to age-normed means. I also examined the distributions of

scores to see whether a subset of the population performed at or above the norm-referenced mean.

To test my second hypothesis, that amplitudes and latencies of modality-specific ERPs (recorded during emotion recognition tasks) would correlate with concurrent emotion recognition performance, one-tailed Spearman's *rho* correlations (chosen because the stated aim was to describe within-sample individual differences) between overall within-modality performance and within-modality ERP latencies and amplitudes were conducted. If significant effects were found, post-hoc probing was conducted to examine the source (child vs. adult; high vs. low intensity).

To test my third hypothesis, that behavioral performance and ERP response would correlate across modalities (indicating a unified multimodal emotion processing deficit), I first conducted one-tailed Spearman's *rho* correlations between performance on DANVA-2 Faces and DANVA-2 Voices. If significant effects were found, post-hoc probing was conducted to examine the source (child vs. adult; high vs. low intensity). Second, I conducted one-tailed Spearman's *rho* correlations between face-specific ERP amplitudes and latencies and voice-specific ERP amplitudes & latencies. As ERP amplitudes and latencies show shifts over ontogenetic time and may be influenced by IQ in both ASD and TD (Jeste & Nelson, 2009; Nelson & McCleery, 2008; Webb et al., 2006), I re-ran all significant correlations as partial correlations, controlling for age and IQ.

Finally, since I hypothesized that a subsample of participants would display intact emotion recognition and that ERP amplitudes and latencies would predict performance, I

examined whether ERP predictors of performance that remained significant after controlling for confounds could predict whether a given individual did or did not experience deficits relative to age norms. I did this by first examining whether an individual performed at or above (i.e. fewer errors) the norm-referenced mean on each DANVA-2 subscale, and dummy coding whether they did (1 = *intact ability*, 0 = *impaired ability*). Then, I ran a binary logistic regression predicting category membership from each remaining ERP predictor, controlling for age and IQ. If significant, I examined the exponent of the ERP predictor coefficient to obtain an odds-ratio of an individual's likelihood of having intact emotion recognition.

Results

Hypothesis 1: Deficits in Emotion Recognition

Table 1 presents sample demographics and descriptive statistics. For adult stimuli, participants with ASD made significantly more emotion recognition errors for faces ($t(33) = -1.98$, $p = .028$) and marginally more errors for voices ($t(33) = -1.63$, $p = .057$). For child stimuli, participants made significantly more emotion recognition errors for voices ($t(33) = -3.47$, $p < .001$) compared to age group norms but were not different from norms for faces ($t(33) = -1.24$, $p = .11$). Notably, for all DANVA-2 scales, there was considerable variability in performance across participants, with the top quartile performing at least a standard deviation above the mean of the standardization sample, and the bottom quartile performing considerably below standardization mean.

Table 1
Descriptive Characteristics of ASD Participants

	ASD Sample		DANVA-2 Age-Normed TD Standardization Sample
	Mean (SD) [Q1, Q3]	Range	Mean (SD)
Age (years)	13.07 (2.07)	9.80 – 16.67	
Full-Scale IQ	111.06 (15.58)	74 – 138	N/A
ADOS	11.03 (3.62)	7 – 20	N/A
DANVA-2 Adult Faces	5.53 (2.15) [4, 8]	2 – 10	4.90 (.70)
DANVA-2 Child Faces	3.68 (2.37) [2, 5]	0 – 9	3.22 (.27)
DANVA-2 Adult Voices	8.71 (3.21) [6, 11]	4 – 18	7.91 (.96)
DANVA-2 Child Voices	6.24 (2.71) [4.5, 9]	1 – 13	4.81 (.47)

ADOS = Autism Diagnostic Observation Schedule. DANVA-2 = Diagnostic Analysis of Nonverbal Accuracy-2. Q1 = top of 1st quartile. Q3 = top of 3rd quartile.

Hypothesis 2: ERP Correlates of Emotion Recognition

Faces. A significant correlation was found between number of errors on DANVA-2 Faces and N170 latency (*rho* = .32, $p = .03$; see Figure 9A). No relation was found between the N250 amplitude or latency and DANVA-2 performance. Post-hoc probing suggested that the observed effect was driven by N170 response to adult (*rho* = .40, $p < .01$) and low-intensity faces (*rho* = .34, $p = .02$).

Voices. A significant correlation was found between errors on DANVA-2 Voices and N100 latency (*rho* = .43, $p < .01$; see Figure 9B). No relation was found between amplitudes or latencies of the P200 or N300 and DANVA-2 performance. Post-hoc probing suggested this effect to be driven by N100 response to adult (*rho* = .36, $p = .02$) and low-intensity voices (*rho* = .32, $p = .03$).

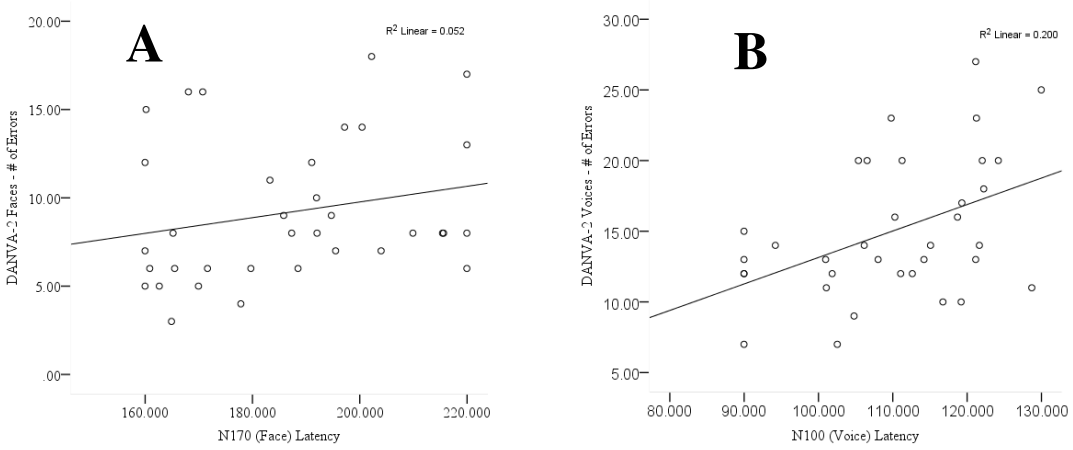

Figure 9. A. Correlation between posterior N170 and performance on DANVA-2 Faces. B. Correlation between central N100 and performance on DANVA-2 Voices. Note: these outcomes represent number of errors, so lower values correspond to better performance; similarly, for these latencies, lower numbers correspond to faster processing.

Hypothesis 3: Multimodality of Emotion Processing

No significant relationship ($p = .065$) was found between performance on DANVA-2 Faces and Voices. However, correlations were found between N170 latency to faces and N100 latency to voices (Figure 10; $rho = .47$, $p < .01$) and N250 amplitude to faces and N300 amplitude to voices ($rho = .36$, $p < .05$), but not between any other cross-modal ERP components.

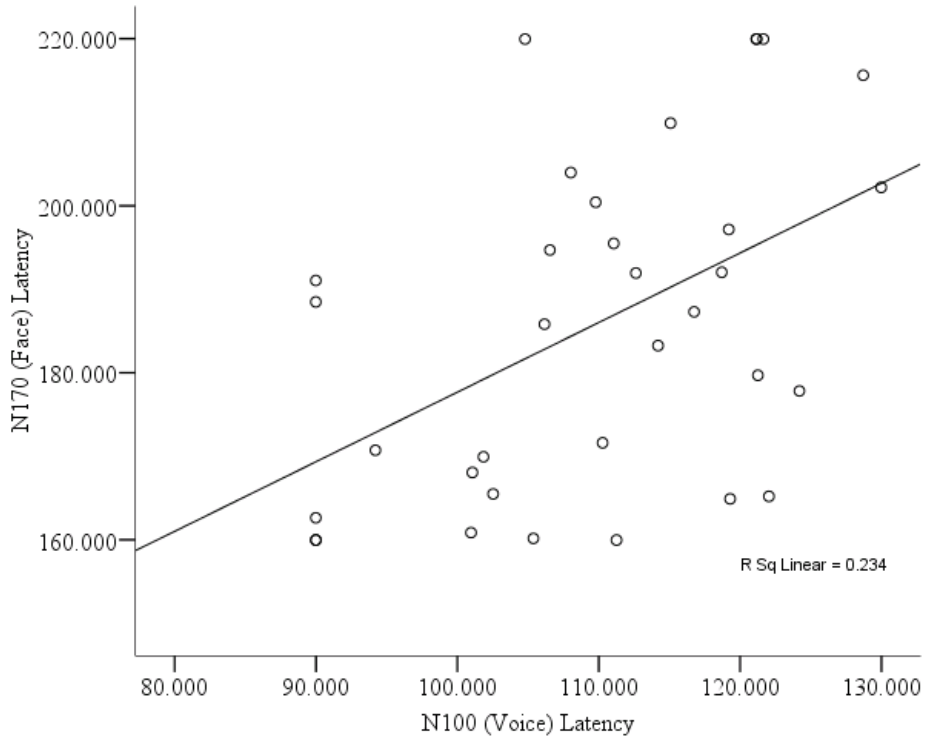

Figure 10. Correlation between central N100 latency to voices and posterior N170 latency to faces.

Influence of Age and IQ

After controlling for age and IQ, the relationship between N170 latency and DANVA-2 Faces was marginally significant (*rho* = .26, *p* = .07), while the relationships with adult (*rho* = .04, *p* = .42) and low intensity faces (*rho* = .21, *p* = .12) were no longer significant.

After controls, the relationship between N100 latency and DANVA-2 Voices remained significant (*rho* = .34, *p* < .05), as did the relationship with adult voices (*rho* = .43, *p* < .01); the relationship with low-intensity voices was marginally significant (*rho* = .27, *p* < .07).

After controls, the correlations between N170 latency to faces and N100 latency to voices (*rho* = .45, $p < .01$) and between N250 amplitude to faces and N300 amplitude to voices (*rho* = .46, $p < .01$) remained significant.

Predicting Intact and Impaired Subgroups

Only the relationships between N100 latency and DANVA-2 total and adult Voices remained significant in the previous analyses. Thus, these were used to predict category membership. After controlling for age and IQ, N100 latency did not predict likelihood of having intact vocal emotion recognition ($exp(\beta)$ = .972, p = .38). However, after such controls, N100 latency did predict likelihood of having intact adult vocal emotion recognition ($exp(\beta)$ = .927, $p < .05$). This indicates that for every 1ms decrease in N100 latency, there was a 7.3% increase in the likelihood that an individual would have intact emotion recognition to adult voices.

Discussion

This study sought to elucidate heterogeneity in emotion perception and assess the presence of multimodal deficits in emotion perception among youth with ASD using an emotion recognition task and ERP measurements of emotion processing. Participants showed significant impairment in identification of adult faces and child voices. Across all indices, there was a wide range of performance, with the top quartile performing above age norms, and the bottom quartile performing well below. Thus, results suggest variability in emotion recognition ability in youth with ASD, with a considerable portion of the population evincing significant deficits to either faces or voices. Latencies of early perceptual ERP markers of face and voice perception were related to behavioral measures

such that faster, stronger responses were associated with improved performance. Subsequent ERP components commonly associated with emotion decoding were not related to behavioral performance. This pattern of results suggests that, rather than emotion recognition deficits in ASD populations resulting from higher-order processes (Rump et al., 2009), they stem from atypicalities at the earliest stages of social perception (McPartland & Pelphrey, in press; McPartland et al., 2011).

The relationship between ERP indices and behavioral performance was strongest for subtler emotions and those displayed by adult stimuli regardless of modality. I see two possible interpretations of the observation regarding subtler emotions. This may reflect that individuals with ASD tend to use more "cognitive" rather than "automatic" strategies to interpret emotions (Dissanayake & Macintosh, 2003). Among high-intensity emotions, salient visual and auditory cues are clear, so cognitive strategies may be readily employed. However, among low-intensity emotions, these cues are less clear, so only those youth who are able to quickly encode configural information may use that information to make subsequent judgments of emotional content. Another possibility, given the correlations evident at early processing stages, is that accessibility of pertinent sensory information (e.g., a stronger visual or auditory signal) facilitates emotion processing. Regarding the finding of stronger associations for adult stimuli, I speculate that this may reflect greater familiarity and increased facility (reflected by fewer errors) with child stimuli. Less-familiar adult stimuli may, like low-intensity stimuli, contain fewer familiar cues. Thus, those who more quickly encode configural information may use it for subsequent emotional evaluation.

Many effects were related to developmental and cognitive factors; however, the effect of N100 on emotion recognition in overall voices, adult voices and low-intensity voices, and the effect of N170 on facial emotion recognition, remained evident. Thus, as in typical development (Batty & Taylor, 2006), developmental differences in age (and IQ) may partially account for the relationship between early configural processing of faces and ability to accurately identify facial emotions. The same cannot be said for voices, where the relationship of early sensory vocal information processing to vocal emotion decoding ability remained especially robust.

Contrary to my hypothesis, emotion recognition performance did not correlate across modalities. This suggests within-individual variability in emotion recognition ability, as found previously in facial emotion perception research in ASD (Bal et al., 2010; Kuusikko et al., 2009). Thus, behaviorally, emotion recognition deficits in ASD do not appear multimodal (Jones et al., 2010), suggesting that they are either discrete processes, or that cross-modal variability in cognitive processing may impact behavioral performance. ERP measures did, however, associate across modalities. Latency of the early components (N170 and N100) and amplitude of later components (N250 and N300) were correlated; these relationships maintained after controlling for age and IQ. The former finding suggests that difficulty with *speed* of sensory processing of social information (or *social information processing speed*) in ASD populations is not limited to a specific modality (i.e. faces or voices), and may indicate a pervasive deficit in basic social perception emanating from the fusiform and superior temporal regions. This is consistent with fMRI research on affect perception in ASD (Pelphrey, Morris, McCarthy,

& LaBar, 2007), and supports findings of selective slowed early social information processing speed (as indexed by N170) in response to facial stimuli in ASD compared to TD individuals (McPartland et al., 2011). Indeed, these effects suggest that efficiency of social information processing, rather than quality of mental representation of emotions (Rump et al., 2009) or indifference to social stimuli (Joseph, Ehrman, McNally, & Keehn, 2008; Whitehouse & Bishop, 2008), underlies general emotion processing deficits in ASD. Thus, there *does* appear to be a multimodal deficit in the basic stages of emotion processing in this population.

However, the latter finding indicates that intensity (if not speed) of cognitive emotional evaluation is consistent within individuals across modalities. This consistency may allow some youth to employ compensatory cognitive processes to mask or overcome otherwise early deficits in social perception. This is consistent with the "hacking hypothesis" (Bowler, 1992; Dissanayake & Macintosh, 2003) of ASD social cognition.

Finally, I found that N100 latency to voices, after controlling for age and IQ, predicted whether an individual had intact or impaired ability to identify emotions in adult voices. This suggests that ERP analysis of vocal emotion processing may be an especially fertile area for study. Additionally, it reveals that, not only do a substantial proportion of youth with ASD maintain intact emotion recognition abilities, but also that ERP-indexed early sensory processing of social stimuli may suggest a *taxonomy of emotion processing profiles* that may more accurately capture the complex endophenotype of social cognition within ASD. This finding may also provide a window

into an effective intervention mechanism, as adult voice emotion recognition has been shown to be amenable to intervention (Lerner et al., 2011).

Limitations

There were several limitations to the present study. First, the DANVA-2 presents static faces, a single vocal sentence, and four basic emotions. Future studies should use dynamic faces (Rump et al., 2009), varying sentential content (Paulmann & Kotz, 2008b), and a broader range of emotions (Bal et al., 2010) during ERP data collection to assess generalizability of the obtained underlying multimodal emotion processing deficit. Second, while this study assessed the relationship between emotion processing and emotional recognition, it did not assess how these abilities relate to on-line social competence. Since social deficits are theorized to be the "real-world" consequences of emotion processing deficits (Beauchamp & Anderson, 2010), future work should include such measurement. Third, my sample was limited in age and diagnostic severity. Future work should assess the presence of a multimodal emotion processing deficit in younger (Webb et al., 2006), older (O'Connor et al., 2007), and lower-functioning individuals with ASD. Fourth, this study did not assess the influence of past intervention experience on participants' emotion recognition or processing abilities. Such work could provide more direct clues as to the malleability of these processes for future interventions. Fifth, this study lacked TD controls. Thus, while my results achieve my stated aim of elucidating the nature and variability in emotion processing *within* the ASD population, they shed little light on the degree of abnormality of this processing. Finally, the ERP methodology cannot provide precise information about spatial localization of the neutral source of

emotion processing. However, current high spatial resolution techniques (e.g., functional Magnetic Resonance Imaging) do not have the temporal resolution to differentiate the observed early perceptual component processes in electrophysiology. Thus, while future research should assess emotion processing in ASD populations using high spatial resolution techniques, using present technology my results could only be obtained through ERPs.

Future Research & Implications

This was among the first studies to obtain ERP measurement *during* an on-line emotion recognition task, the first to obtain ERP correlates of emotion recognition in vocal prosody, the first to use electrophysiology to assess multimodal emotion recognition ability, and the first to employ such methodology to derive an empirical taxonomy of social cognitive impairment in youth with ASD. Overall, these results suggest that early sensory processing of multimodal social information (*social information processing speed*) may be especially implicated in emotion recognition difficulties among youth with ASD, and that these difficulties may be consistent within individuals across modes of emotion perception. Such findings reinforce previous literature suggesting that some individuals with ASD may have difficulty employing otherwise "automatic" neural mechanisms of emotion perception (Jeste & Nelson, 2009; McPartland & Pelphrey, in press; McPartland et al., 2011; Whitehouse & Bishop, 2008), and may thus rely on less efficient, explicit cognitive appraisals to render judgments of emotional content (Bowler, 1992; Dissanayake & Macintosh, 2003). However, it also

suggests that some individuals with ASD possess more intact social perception capabilities for evaluating emotions.

Future research should further explore relations between multimodal emotion processing and on-line behavioral outcomes, and the potential malleability of early ERP components in this population. Such work would be valuable in augmenting the effectiveness of interventions designed to improve social-emotional functioning. Additionally, research should explore whether these deficits are evident in young children with ASD, as they may be an outgrowth of already-identified ontogenetically early social perceptual abnormalities (Lebreton et al., 2009).

This study suggests that many youth with ASD *do* possess multimodal deficits in emotion recognition, and that these deficits are reflected in a construct of *social information processing speed*. This indicates that interventions that focus on cognitive appraisals of emotional information may fail to address the core deficit underlying emotion recognition impairment in this population. Since recent research suggests that ERPs are sensitive and amenable to intervention in this population (Faja et al., 2012), treatments aiming to increase social information processing speed to improve social-emotional competence should be explored.

Study 2

Knowing What to Do: The Role of Social Knowledge in Social Deficits among Youth with Autism Spectrum Disorders

Deficits in social functioning are pathognomonic among individuals with autism spectrum disorders (ASD). Such deficits are evident across domains of measurement, including social behavior (peer interaction), social perception (emotion recognition), and social cognition (Theory of Mind) (Baron-Cohen & Glidden, 2001; Bauminger, 2002; Carter et al., 2005; Rump et al., 2009). Throughout that ASD literature, it has been presumed that youth experience failures in these domains because they "don't know what to do" socially, leading to most social skills interventions being designed, at least in part, to provide such knowledge (Attwood, 2007; Laugeson et al., 2009; Mesibov, 1984; White et al., 2007). However, little work has directly examined whether this lack of *social knowledge* is, in fact, related to key social outcomes. Additionally, no known research has examined whether other factors involved in planning, processing, and executing skilled social behavior play a comparable role to social knowledge in producing such behavior.

This study directly examines the role of social knowledge relative to other key factors in producing successful social functioning across multiple key outcomes (e.g., social behavior, Theory of Mind, social perception; Koenig et al., 2009; McKown et al., 2009); in doing so, it elucidates the process by which skilled social behavior emerges (or fails to emerge) in this population, and provides guidance for intervention design, implementation, and customization. Crucially, little work has elucidated a coherent model of processes that may underlie deficits across such outcomes in ASDs. Clarifying the role of social knowledge relative to other putative processes may lead to such a model.

Social Knowledge and Performance

Gresham (1997), drawing from Ladd & Mize (1983), provided a taxonomy of why some children fail to engage in appropriate behavior. He distinguished between social acquisition deficits (referred to here and elsewhere as *social knowledge* deficits), in which children lack knowledge of the social behaviors they should perform, and social performance deficits, in which children know the social behaviors that they should perform, yet fail to do so (de Boo & Prins, 2007). Thus, while Gresham (1997) considered both knowledge and performance to be necessary for competent social functioning, researchers have only recently begun to explore whether social problems present in ASDs derive from impairments in social knowledge or social performance (Lerner, Hileman, et al., in press; Matson et al., 2007) or can be remediated by treating one or the other (Lerner & Mikami, in press; Lerner et al., 2011).

Understanding whether social problems in a given individual are derived from a social knowledge- or a social performance-based deficit has implications for the etiology of the dysfunction ("why do they not know what to do" vs. "why do they not do what they know"). It also provides direction for intervention content (providing social information that is lacking vs. determining the factors that prevent appropriate enactment of the known behavior). Indeed, if children do not possess reliable social knowledge deficits, then delivery of social knowledge-oriented interventions may be inappropriate and potentially ineffective (Nixon, 2001).

While the clinical and theoretical importance of distinguishing between social knowledge- and performance-based deficits has been acknowledged for some time in the

Attention Deficit/Hyperactivity Disorder (ADHD) literature (de Boo & Prins, 2007; Maedgen & Carlson, 2000; Wojnilower & Gross, 1988), it has scarcely been explored in ASD populations (Koenig et al., 2009). In fact, the prevailing presumption for more than 20 years has been that social deficits among individuals with ASDs, as well as deficits in putatively core related social mechanisms such as Theory of Mind and emotion recognition, derive from an inability to acquire social skills (i.e. a knowledge deficit; Laugeson et al., 2009; Matson et al., 2007; Mesibov, 1984).

This presumption has persisted despite substantial work showing that children with ASDs, particularly those with intact cognitive ability, appear to possess greater social knowledge than would be expected from their behaviors, if their deficits were purely knowledge-based (Happe, 1995; Laugeson et al., 2009; Rump et al., 2009). It has been suggested that individuals with HFASDs may possess "latent social skills" that are suppressed by inaccurate processing of social and emotional information (Andari et al., 2010), directly indicating the presence of a performance deficit. Nonetheless, the question of whether social deficits in individuals with ASDs are primarily knowledge- or performance-based has never been directly tested.

Social Performance-Related Factors

Some theoretical models of ASD social pathology have posited a performance deficit; that is, they have suggested that the acquiring of specific social knowledge may be minimally related to the social problems experienced by children with ASDs (Greenspan & Wieder, 1998; Gutstein et al., 2007). Rather, they posit that an array of factors common to ASDs may play an equally important (if not more important) role in

predicting social deficits. Three key factors that are common across many non-knowledge-based models of social deficits in ASDs include impairments in social motivation (Dawson et al., 2005), social creativity (Hobson et al., 2009), and speed of processing social information (McPartland & Pelphrey, in press; McPartland et al., 2011). As these factors exist independent of social knowledge but may still directly affect an individual's ability to perform known social skills (Gresham, 1997; Nixon, 2001), they may be considered to represent social performance deficits. However, models comparing these factors have yet to be tested.

Impaired social motivation, or a limitation in one's engagement with social input, has been hypothesized to be a fundamental deficit in children with ASDs that may underlie concurrent deficits in social mechanisms (e.g., emotion recognition and Theory of Mind) and social behavior (Dawson et al., 2005; Koegel & Mentis, 1985). Recent neural evidence suggests that individuals with ASDs do possess impairment in social motivation, and that this may directly affect social learning (Scott-Van Zeeland et al., 2010). This is consistent with recent findings that brain regions associated with reward are neuroanatomically identical to those mediating subjective social orienting and preferences, even in the absence of explicit reward (Behrens et al., 2009); that is, the same processes that facilitate motivation to interact with others may permit attending-to and learning in social scenarios. This suggests that social motivation may be a necessary (if not sufficient) condition for engagement in successful social behavior. Thus, impaired social motivation may interfere with social functioning, irrespective of social knowledge.

Limited social creativity, or a difficulty with flexibly responding to social situations (Fischer et al., 2005; Mouchiroud & Bernoussi, 2008), has also been cited as a core underlying feature of ASDs (Gutstein et al., 2007; Rapin, 2002). Social creativity has been defined as the application of collective imagination to solving a problem (Fischer et al., 2005) and as the use of original solutions to solve a social problem (Mouchiroud & Bernoussi, 2008; Mouchiroud & Lubart, 2002). A central feature of definitions of social creativity, however, is the ability to adaptively and creatively engage in a social environment without the use of pre-defined, prescribed behaviors (i.e., engage a peer fluidly and successfully; Koenig et al., 2009). Crucially, social creativity so defined has been shown to be linked to social competence and peer acceptance (Mouchiroud & Bernoussi, 2008). Hobson et al. (2009) suggest that lack of social creativity in individuals with ASDs, and consequent social deficits, may result from extended lack of experience engaging in successful peer interactions.

Inefficient processing of social stimuli (e.g., faces) has also been cited as a unique and key area of deficit in ASD populations (Rump et al., 2009). Such processing involves the ability to rapidly discriminate increasingly subtle emotions, an ability which typically develops at a consistent pace throughout childhood and early adolescence (McKone et al., 2007). This processing is thought to underlie social perception and functioning by permitting rapid interpretation of cues crucial for appropriate responding (McKone et al.). It also appears uniquely slower in youth with ASDs as measured by both behavioral (Bal et al., 2010; Rump et al., 2009) and electrophysiological measures (McPartland & Pelphrey, in press; McPartland et al., 2011). While recent research indicates that such

social information processing speed (SIPS) may indeed underlie social perception in faces and voices in this population (see Study 1) , little work has yet examined its relation to a wide array of downstream social functioning outcomes.

Thus, while social knowledge deficit models posit that knowledge of prescriptive steps is necessary for attaining positive outcomes across an array of social functioning variables (Koenig et al., 2009), social performance deficit models suggest that such knowledge may already be present; instead, they suggest that social motivation, social creativity, and SIPS may be necessary for performance of adaptive social behavior. Notably, such models do not suggest that social knowledge is unrelated to social functioning; rather, they suggest it is a necessary, but not sufficient, condition for social success.

Hypotheses

Based on prevailing theory of social functioning in ASDs (Laugeson et al., 2009), I hypothesized that social knowledge would predict social functioning variables after controlling for autistic symptoms and cognitive ability. However, following the theory that performance-related factors should affect social functioning above and beyond social knowledge (Lerner, Hileman, et al., in press), I hypothesized that social performance-related variables would predict significant variance in social functioning after controlling for knowledge. Finally, because it is probable that multiple factors concurrently contribute to proficient social functioning (Koenig et al., 2009), I explored whether knowledge and performance-related variables might interact to best explain social functioning outcomes.

Method

Participants

Participants were 41 youth (33 male; 35 Caucasian, 1 African American, 1 Hispanic/Latino, 2 Mixed, 2 unknown Ethnicity; M_{age} = 12.01, SD_{age} = 2.07). All participants had pre-existing diagnoses of ASD, and were first screened to ensure they surpassed clinical cutoffs (Norris & Lecavalier, 2010) on the parent-report Social Communication Questionnaire (SCQ; Rutter et al., 2005); internal consistency (Cronbach's α) was acceptable (.79). Diagnoses were then confirmed with the gold-standard Autism Diagnostic Observation Schedule (ADOS; Lord et al., 1999), administered by a research-reliable examiner; internal consistency was acceptable (.80). Finally, a reliable, valid, abridged version of the Wechsler Intelligence Scale for Children-IV (Ryan et al., 2007; Wechsler, 2003) was administered to confirm intact cognitive ability (IQ > 70).

Procedure

Participants attended two visits at a University research laboratory. At the first visit, they and their parents completed written and verbal consent and assent procedures; diagnostic, cognitive, social knowledge, motivation, and creativity measures were collected. At the second visit, participants reviewed consent information, then completed either emotion recognition or Theory of Mind tasks (order counterbalanced). SIPS measures were collected during emotion recognition tasks. Then, participants were brought in pairs to a video-equipped observation room with several age-appropriate games (e.g., cards, Connect Four); one participant did not complete this procedure. They

were then informed that the research assistants had work to do in the next room, but would return soon. Participants were left in this room for 10 minutes, their unstructured interactions taped; these tapes were later coded for social interaction (see below).

Measures – Predictors

Children's Assertive Behavior Scale (CABS; Michelson & Wood, 1982). The CABS is a 27-item multiple-choice self-report measure of knowledge of general and specific social skills. A sample item states. "You made a mistake and someone else is blamed for it. You would usually a) Say nothing. b) Say, 'It's their mistake!' c) Say 'I made the mistake.' d) Say, 'I don't think the person did it.' e) Say, 'That's their tough luck!'" It generates three scales of self-reported social functioning: passive, aggressive, and assertive social behavior (Hobbs & Walle, 1985; Michelson & Wood, 1982; Scanlon & Ollendick, 1986). The CABS has been shown to correlate with peer, parent, and teacher reports of social competency and to discriminate between children with versus without a history of social skills training (Michelson & Wood, 1982); it has also demonstrated strong convergent validity with multiple measures of related constructs (Scanlon & Ollendick, 1986). As has been done previously (Maedgen & Carlson, 2000; Wojnilower & Gross, 1988), in the present study it was adapted to assess social skills knowledge by asking children what they thought "the right thing to do" was in each presented situation. For the present study, only the "correct" (i.e. assertive) scale was used, and it was reversed-scored such that higher values correspond to "more" knowledge. With this scoring, normative samples of comparably-aged typically-developing (TD) youth have mean scores of approximately 43.77 (SD = 4.87; Maedgen

& Carlson, 2000; Wojnilower & Gross, 1988); it has not previously been used with ASD samples. Internal consistency was acceptable (.87).

Dimensions of Mastery Questionnaire –Social Persistence with Peers (DMQ; Morgan et al., 1997). The DMQ is a parent-report questionnaire containing a six-item subscale (Social Persistence with Peers; sample item: tries hard to make friends with other kids) designed to assess child motivation to interact with peers. Only this subscale was used. It is answered on a 5-point Likert scale (*not at all typical* to *very typical)* and generates raw scores. It been used to assess parent-reported social motivation to engage with peers among children with ASDs (Fiske, 2008). Internal consistency was acceptable (.74).

Social Creativity Task (SCT; Mouchiroud & Lubart, 2002). The SCT is a measure of creative responses to social scenarios. Social creativity has been shown to be a unitary construct that increases with development (Mouchiroud & Lubart, 2002) and correlates with social competencies, popularity, and parenting style (Mouchiroud & Bernoussi, 2008). While this measure has not been previously explored in this population, it expands upon an existing social flexibility/creativity construct (Hobson et al., 2009). As this study is principally concerned with social creativity in the peer domain, the "peers" and "dyad" tasks (Mouchiroud & Lubart, 2002) were used. In a verbal interview, children were asked to generate as many creative solutions as possible to social problems, and their responses were recorded and transcribed. Next, a team of undergraduate coders were trained on a sample set of responses to judge the creativity of each answer according to a 7-point Likert scale (*not at all creative* to *extremely creative*),

then rated participants' transcribed responses. All answers were double-coded, with coders assigned randomly, counterbalanced by coder pair. Reliability of these ratings was excellent, ICC(1,2) = .79 (Cicchetti, 1994). The sum of each child's scores was divided by his/her total number of answers to control for fluency (Mouchiroud & Lubart, 2002), generating a final SCT score.

Social Information Processing Speed (SIPS; see Study 1). SIPS was measured via the latency of the initial, automatic, obligatory (i.e. prior to voluntary or effortful) ERP-indexed response to facial (N170) and vocal (N100) stimuli on the Diagnostic Analysis of Nonverbal Accuracy-2 (DANVA-2, see below; Nowicki, 2004). Such latency has been shown to be uniquely delayed in response to social stimuli (McPartland & Pelphrey, in press; McPartland et al., 2011) and to represent a unified multimodal emotion processing construct (independent of subsequent, more prefrontal cognitive evaluation; see Study 1) among individuals with ASD. In the present study, ERPs were collected during the DANVA-2 using a 32-Channel BioSemi Active 2 system. For facial and vocal stimuli, ERPs were time-locked to the presentation of the stimulus. Data were digitally filtered at a low-pass of 30 Hz. Artifact rejection was conducted visually; all participants used for ERP analyses (n = 35) have >16 trials and >50% of trials were marked "good." Epochs of 150 – 700ms pre- to post-stimulus were created. Finally, ERPs were extracted from electrode sites homologous to those found in the previous literature (N170 extracted from PO4, N100 from Cz; Jeste & Nelson, 2009; Pinheiro et al., 2010). For more details on acquisition procedures, see Study 1. As the N170 is a considerably more well-established ERP component (McPartland et al., 2004; McPartland et al., 2011),

it was used in all analyses except those examining emotion recognition in voices, for which N100 is more directly comparable. Latencies were converted to *z*-scores a) to ensure normality of distribution, and b) because the goal of this study was to assess variability within the population.

Measures – Social Functioning Outcomes

Stories from Everyday Life (SEL; Kaland et al., 2002). The SEL is an advanced Theory of Mind battery appropriate for individuals with ASD in the target age range (Kaland et al., 2008; Kaland et al., 2002; Kaland et al., 2007), focusing on the ability to make distinctions about physical and mental states. Participants are presented with a story that leads towards a climax (e.g., the brother of a child who never cleans his room declares that said brother has done "a splendid job of tidying up"), then are asked to answer questions regarding the physical condition (e.g., how does the child's room look?) and mental state (e.g., why does the brother make this statement?) of a character in the story. If a participant gives an answer to one of the test questions that is not quite correct (e.g., does not clearly indicate that they understand intended sarcasm in the above irony story), he is then given one or more additional questions in order to try to make it easier for him to understand the test question. No feedback about the accuracy of responses is given. Responses to each question were taped, and later coded by trained coders on a 0 – 2 scale (*incorrect* to *correct*). All answers were double-coded, with coders assigned randomly, counterbalanced by pair. As it has shown the best ability to discriminate individual with ASD from TD individuals, only the mental inference question was used (Kaland et al., 2002); only the four story types that best discriminated these groups

(figures of speech, irony, contrary emotions, mistaken intentions) were used. Reliability of ratings was excellent for all stories, ICC(1,2) >. 85. Internal consistency of the mental inference scale was acceptable (.58).

DANVA-2 (Nowicki, 2004). The DANVA-2 is a widely-used, age-normed, standardized measure of emotion recognition in adult and child faces (Nowicki & Carton, 1993) and voices (Baum & Nowicki, 1996; Demertzis & Nowicki, 1998). Participants rate visual and auditory stimuli by pressing a button indicating the selected emotion. They rate 24 child and 24 adult faces and voices indicating high- or low-intensity happy, sad, angry, and fearful emotion. The DANVA-2 produces scores indicating raw number of errors in emotion recognition such that lower numbers indicate better performance. Both the facial (Solomon et al., 2004) and vocal (Lerner et al., 2011) modules have been used with ASD youth. Stimuli were presented in a 2x2 (adult/child x faces/voices) block design, randomized within and between blocks. Overall facial and vocal emotion recognition scales were derived and reverse-scored such that higher scores correspond to better ability. Internal consistency was high across the facial (.913) and vocal (.889) scales.

Social Interaction Observation Scale (SIOS; Bauminger, 2002, 2007a, 2007b). The SIOS is a measure of prosocial interaction designed for use with individuals with ASDs. It covers total amount of interaction, as well as three qualitative domains: positive interaction (e.g., eye contact with smile, sharing), low-level interaction (e.g., close proximity, functional communication), and negative interaction (e.g., physical and verbal aggression). It has been shown to be sensitive to both social knowledge- and

performance-training in youth with ASD (Lerner & Mikami, in press). Its three subscales (Positive interaction, Low-Level interaction, and Negative interaction) conceptually map on to the three scales of the CABS (assertive, passive, and aggressive; Michelson & Wood, 1982), indicating that the CABS may capture children's social knowledge of the specific domains of social competence observed in the SIOS. When characterizing these domains of interactions, positive interactions can be seen as unequivocally "good" (i.e. prosocial behaviors promoting greater likelihood of reciprocal peer engagement) and negative interactions can be seen as clearly "bad" (i.e. hostile behaviors promoting less peer engagement; Bauminger, 2002; Bauminger et al., 2003). Low-level interactions, however, may be more mixed, as they represent an incremental attempt at social interaction, though of a lesser quality (i.e. less likely to promote reciprocal peer engagement) relative to positive interactions; indeed, this "mixed" quality is reflected in the fact that comparable social skills intervention studies have reported both increases (Bauminger, 2002) and decreases (Bauminger, 2007b) in low-level interactions. In the present study, more low-level interactions alone or in conjunction with *more* total or positive interactions (reflecting attempts to interact in contrast to no interaction at all) as well as *less* low-level in conjunction with *more* total or positive interactions, are considered somewhat (though in the case of more low-level interaction alone, not unambiguously) "good;" meanwhile, more low-level interactions in conjunction with *less* total or positive interactions (reflecting a shift towards lower-quality interaction) are considered "bad."

The SIOS was used to rate ASD peer dyads' unstructured interaction, using 10 one-minute segments of behavior. During these samples, coders could rate up to three behaviors that best characterized the given segment (across any combination of subscales; e.g., sharing, close proximity, verbal aggression). The average of each subscale was calculated across segments, such that scores for each (as well as for total amount of interaction) ranged from 0 to 3. Before rating, coders were trained on the SIOS manual, then achieved high reliability (ICC(2,3) > .80) on all subscales with master codes on tapes from a previous sample (Lerner & Mikami, in press). They were then randomly assigned to double-code the present tapes, counterbalanced by pair. Reliability (ICC(1,2)) for Total (.92), Positive (.94), Negative (.77), and Low-Level (.93) interactions was excellent. However, there was little variance in (few incidents of) Negative interaction, so it was excluded from subsequent analyses.

Data Analytic Plan

The three hypotheses were analyzed using hierarchical multiple regressions. To test hypothesis 1, that social knowledge would contribute positively to social functioning, controlling for autistic symptoms (ADOS) and FSIQ on step 1, I added the social knowledge measure on step 2 in regressions predicting each outcome. To test hypothesis 2, that the performance-related factors would contribute to social functioning after controlling for social knowledge, I added the social motivation, creativity, and SIPS measures together on step 3 in these regressions. Finally, to test hypothesis 3, that knowledge and performance-related factors would interact to best predict social functioning, I added interaction terms between knowledge and each performance-related

variable on step 4. Because of the nested structure of the SIOS data, in which participants' social behavior was examined in dyads, were assessed the possibility that participants' behaviors had been influenced by their partner. There was significant and substantial (Guo, 2005) Level 2 variance in the SIOS outcomes (83%, 57%, and 77% for Positive, Low-Level, and Total). As such, these models were run in a hierarchical linear modeling (HLM) framework with a random intercept effect. R^2 (and Level 1 pseudo-R^2 for HLM models) effect sizes (Cohen, 1992; Tasca & Gallop, 2009) were calculated for overall models as well as ΔR^2 for each separate significant coefficient. To address whether effects may be due to past intervention status, all significant analyses were re-run controlling for previous social skills intervention status (dummy coded) and quantity (number of interventions). As noted above, six participants had missing SIPS data, and one participant had missing SIOS data. To ensure conservative results interpretation, no imputation procedures were used; however, HLM models were analyzed using full maximum likelihood estimation, which is robust to missingness.

Results

Descriptives

Table 2 presents descriptive statistics. Youth with ASDs demonstrated comparable mean social knowledge (43.22) to values obtained by TD youth (43.77) in past studies of TD (see Maedgen & Carlson, 2000; Wojnilower & Gross, 1988), though greater variability (SD_{ASD} = 7.86, SD_{TD} = 4.87). Youth with ASDs in my sample also demonstrated a wide range of emotion recognition ability, such that some participants demonstrated relatively intact functioning (see Nowicki, 2004); on average, they also

exhibited Theory of Mind skills that were comparable to values obtained by same-age peers with ASD in other studies (see Kaland et al, 2002).

Table 2
Sample Descriptive Statistics

Variable	Mean (SD)
Age	12.91 (2.07)
Sex[1]	33 (80.5%) male
FSIQ*	109.95 (15.51)
ADOS	11.15 (3.66)
CABS	43.22 (7.86)
DMQ	15.58 (4.55)
SCT	2.61 (.96)
N170 Latency[2]	0 (1.0)
N100 Latency[2]	0 (1.0)
SEL	.55 (.49)
DANVA-2 Faces (reverse scored)	38.39 (4.08)
DANVA-2 Voices (reverse scored)	32.95 (4.74)
SIOS Total[3]	2.27 (.59)
SIOS Positive[3*]	1.17 (.75)
SIOS Negative[3*]	.01 (.03)
SIOS Low-Level[3*]	1.09 (.41)

N = 41 unless otherwise specified. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. N170/N100 Latency = Z-score of ERP latency to emotional faces (N170) and voices (N100). SEL = Stories from Everyday Life – Mental Inference. DANVA-2 = Diagnostic Analysis of Nonverbal Accuracy-2. SIOS = Social Interaction Observation Scale.
[1]Values not means or SDs. [2]*N* = 35, *Z*-score. [3]*N* =40. * = significant Level 2 variance.

Univariate Correlations

Table 3 presents correlations between continuous variables. Older youth had better Theory of Mind, emotion recognition, and somewhat better social knowledge, but less (and less Positive) social interaction and social motivation, relative to younger youth. Those with higher IQ exhibited better Theory of Mind and emotion recognition, and had fewer autistic symptoms, relative to youth with lower IQ. Youth with fewer autistic symptoms had better Theory of Mind, social knowledge, and social creativity relative to

youth with more autistic symptoms; notably, Theory of Mind, social knowledge, and social creativity variables were uncorrelated with one another, suggesting that they each tap into different components of autistic symptomology. Social knowledge did not correlate significantly with any social performance or functioning variables, except for marginal correlations suggesting that more social knowledge related to less Positive interaction and less social motivation. Social motivation correlated with more peer interaction but poorer emotion recognition. Social creativity correlated with more Positive interaction. SIPS correlated with less Low-Level interaction and better emotion recognition in voices. Theory of Mind correlated marginally with emotion recognition in voices.

Table 3
Correlations among Continuous Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	1	.23	-.20	.27^{+}	-.37*	.09	-.27	-.24	.38*	.35*	.34*	-.42**	-.30^{+}	-.04
2. FSIQ		1	-.39*	.11	-.06	.08	-.06	-.22	.50***	.36*	.34*	.12	.17	-.13
3. ADOS			1	-.31*	.07	-.41**	-.15	-.16	-.34*	-.03	-.06	-.04	-.18	.25
4. CABS (reversed)				1	-.27^{+}	.03	-.09	.05	.09	-.05	-.08	-.26	-.27	.13
5. DMQ					1	.08	.22	-.01	.02	-.41**	-.09	.31*	.24	-.01
6. SCT						1	.11	.05	.19	.09	.01	.24	.31*	-.14
7. N170 Latency							1	.48**	.06	-.23	-.07	.19	.03	-.29^{+}
8. N100 Latency								1	-.10	-.16	-.45**	.02	-.16	.36*
9. SEL									1	.20	.30^{+}	-.07	-.01	-.07
10. DANVA-2 Faces										1	.28^{+}	-.05	-.09	.10
11. DANVA-2 Voices											1	-.15	-.11	-.01
12. SIOS – Total												1	.84***	-.10
13. SIOS – Positive													1	-.63***
14. SIOS – Low-Level														1

$^{+}p < .10$. $*p < .05$. $**p < .01$. $***p < .001$. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. N170/N100 Latency = Z-score of ERP latency to emotional faces (N170) and voices (N100). SEL = Stories from Everyday Life – Mental Inference. DANVA-2 = Diagnostic Analysis of Nonverbal Accuracy-2. SIOS = Social Interaction Observation Scale.

Hypothesis 1 – Effect of Social Knowledge

While IQ predicted Theory of Mind ($\beta = .41$, $p < .05$) and emotion recognition in faces and voices (Model 2, Tables 3 and 4), and ADOS marginally predicted Low-Level interaction ($\beta_{20} = .02$, $p = .08$), social knowledge did not predict any outcomes after control of these variables.

Hypothesis 2 – Effects of Social Performance-Related Factors

Controlling for knowledge and other performance-related variables, social motivation predicted poorer emotion recognition in faces (Model 3, Table 4). The overall model effect was large, while the marginal effect of social motivation was medium ($\Delta R^2 = .14$)

Controlling for knowledge and other performance-related variables, faster SIPS predicted better emotion recognition in voices (Model 3, Table 5). The overall model effect was large, while the marginal effect of SIPS was small ($\Delta R^2 = .12$).

Hypothesis 3 – Knowledge and Performance Interactions

Controlling for knowledge and performance main and interaction effects, there was a significant interaction between social knowledge and SIPS in predicting emotion recognition in voices. (Model 4, Table 5). Post-hoc probing indicated that SIPS predicted better emotion recognition for those with high social knowledge ($B = -3.74$, $p < .01$), while it had no effect for those with low social knowledge, ($B = -.52$, $p = .61$). The overall model effect was large, while the marginal effect of the interaction was small ($\Delta R^2 = .11$)

Controlling for knowledge and performance main and interaction effects, there was an interaction between social knowledge and social motivation in predicting Low-Level interaction (Table 6). Post-hoc probing indicated that the positive association between social motivation and Low-Level interaction appeared stronger for youth with low levels of social knowledge ($\beta_4 = .22$, $p < .05$), relative to youth with greater social knowledge ($\beta_4 = .16$, $p < .05$). While the overall model produced a large Level 1 (σ^2) effect compared to the unconditional model (pseudo-$R^2 = .32$), the Level 1 marginal effect of the interaction was medium (pseudo-$\Delta R^2 = .17$).

Table 4

Hierarchical Multiple Regression Predicting Emotion Recognition in Faces (DANVA-2 Faces)

	Model 1			Model 2			Model 3			Model 4		
	B	se *B*	*β*	*B*	se *B*	*β*	*B*	se *B*	*B*	*B*	se *B*	*β*
FSIQ	.10	.05	.38*	.10	.05	.38*	.09	.04	.35*	.10	.05	.37^{+}
ADOS	.07	.20	.07	.05	.21	.04	.15	.21	.14	.11	.23	.10
CABS				-.04	.09	-.08	-.08	.09	-.16	-.15	.37	-.30
DMQ							-.36	.15	-.40*	-.37	1.06	-.42
SCT							.94	.71	.22	-.33	4.89	-.08
N170							-.55	.64	-.14	3.29	4.25	.82
CABS x DMQ										.00	.02	.04
CABS x SCT										.03	.11	.34
CABS x N170										-.09	.10	-.99
Total R^2		.13			.14			.36			.39	
F for ΔR^2		2.47^{+}			.21			3.24*			.43	

*$p < .05$,** $p < .01$,*** $p < .001$. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. N170 Latency = Z-score of ERP latency to emotional faces (N170). DANVA-2 = Diagnostic Analysis of Nonverbal Accuracy-2.

Table 5

Hierarchical Multiple Regression Predicting Emotion Recognition in Voices (DANVA-2 Voices)

	Model 1			Model 2			Model 3			Model 4		
	B	se *B*	*β*	*B*	se *B*	*β*	*B*	se *B*	*β*	*B*	se *B*	*β*
FSIQ	.13	.06	.42*	.13*	.06	.40*	.09	.06	.27	.10	.06	.30
ADOS	.28	.24	.20	.23	.25	.17	.10	.28	.07	.10	.28	.07
CABS				-.07	.11	-.10	-.10	.11	-.15	.08	.42	.12
DMQ							-.12	.18	-.12	-.48	1.12	-.45
SCT							-.03	.93	-.01	4.39	5.90	.85
N100							-1.83	.83	-.37*	6.80	4.09	1.38
CABS x DMQ										.01	.03	.35
CABS x SCT										-.10	.13	-.87
CABS x N100										-.21	.10	-1.78*
Total R^2		.15			.16			.30			.41	
F for ΔR^2		2.88^{+}			.37			1.77			1.58	

*$p < .05$,** $p < .01$,*** $p < .001$. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. N100 Latency = Z-score of ERP latency to emotional voices (N100). DANVA-2 = Diagnostic Analysis of Nonverbal Accuracy.

Table 6
Final HLM Model Predicting Low-Level Interaction (SIOS) from Main Effects and Social Knowledge Interactions

SIOS Low-Level	**Parameter**	**Fixed Effects**				σ^2	τ
		Coefficient	**SE**	**T-ratio**	**p-value**		
Intercept	β_0	1.154	0.077	15.056	0.000	.048	.080
FSIQ	β_1	-0.011	0.008	-1.371	0.193		
ADOS	β_2	-0.015	0.032	-0.492	0.631		
CABS	β_3	0.053	0.029	1.800	0.095		
DMQ	β_4	0.189	0.076	2.469	0.028		
SCT	β_5	0.049	0.408	0.120	0.906		
N170	β_6	-0.361	0.897	-0.403	0.694		
CABS x DMQ	β_7	-0.003	0.001	-2.497	0.027		
CABS x SCT	β_8	-0.003	0.009	-0.350	0.732		
CABS x N170	β_9	0.007	0.020	0.380	0.710		

FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. N170 Latency = Z-score of ERP latency to emotional faces (N170). SIOS = Social Interaction Observation Scale.

Post-hoc: Effects of Past Intervention

Inclusion of previous intervention status variables (binary and continuous) did not alter any significant results. The only effect was that those who had experienced previous interventions (binary variable) performed significantly better than those who had not in terms of emotion recognition in faces ($F(1,26) = 5.79$, $p = .02$).

Discussion

Models of social deficits and interventions in the ASD literature have long posited social knowledge to be central (Laugeson et al., 2009; Mesibov, 1984). Meanwhile, social performance-related factors have been theorized to either augment social knowledge or independently contribute to social functioning (Koenig et al., 2009; Lerner, Hileman, et al., in press), but little research has examined either directly. This study examined social knowledge and social performance-related factors in predicting social functioning in youth with ASD.

Social knowledge did not show robust univariate correlations with outcomes; however, significant univariate correlations were obtained between several social performance-related factors and outcomes. Additionally, after controlling for IQ and ASD symptom severity, social knowledge did not predict any outcomes. Controlling for other main effects, social motivation predicted poorer emotion recognition in faces, while faster SIPS predicted better emotion recognition in voices. Meanwhile, social knowledge moderated SIPS such that SIPS appeared beneficial in terms of emotion recognition to youth with high social knowledge. Additionally, high social motivation appeared more

strongly associated with low-level interaction for youth with low social knowledge relative to those with high social knowledge.

Collectively, these results suggest that evident impairments in social knowledge may not relate directly to social outcomes. Indeed, compared to values obtained by TD samples in other research using the same social knowledge measure (Maedgen & Carlson, 2000; Wojnilower & Gross, 1988), social knowledge did not appear impaired among participants with ASD in my sample. This calls into question the prevailing model that social problems in ASD emerge from a social knowledge deficit (Mesibov, 1984). While some individuals may have difficulty reporting "correct" social behaviors, these difficulties may not usefully inform whether they demonstrate and employ appropriate social skills. Thus, at least among those with intact IQ, social deficits among youth with ASDs, as with ADHD (Maedgen & Carlson, 2000), may represent social performance deficits, rather than knowledge or acquisition deficits. Interventions may, thus, be misguided in targeting social knowledge to improve social functioning; this may help explain the inconsistent effects of interventions that do so (White et al., 2007).

In terms of performance-related variables, while social creativity correlated with more positive interaction, these effects disappeared after relevant controls. Thus, while the previously-unexplored social creativity construct may be useful to consider in this population, its effects, preliminarily, appear to be subsumed by its relation to ASD symptoms. Future research should further explore this construct and its relation to ASD symptoms (Hobson et al., 2009).

Faster SIPS related to both less low-level interaction and better vocal emotion recognition. While the effect on low-level interaction disappeared after relevant controls, this nonetheless suggests that this objective indicator of neural processing of social information may have important applications for "real-world" social functioning. Additionally, social knowledge moderated SIPS such that SIPS predicted vocal emotion recognition among those with normative or high knowledge. This finding supports a more nuanced relationship between social knowledge and performance-related variables. Specifically, it indicates that SIPS may not benefit the emotion recognition of those youth with ASD who have poor social knowledge, and supports the theorized importance of such processing in social functioning (Rump et al., 2009). Thus, interventions that require fast SIPS (e.g., fast-paced social games) may be helpful for those with more social knowledge, while such interventions may provide little benefit for those with less social knowledge. Future research should continue to explore vocal (rather than facial) emotion recognition, as these results suggest that it may provide a more robust outcome in relation to the studied predictors (see Study 1). Such research should also employ ERP recording of SIPS to better understand its degree of deficit (McPartland & Pelphrey, in press; McPartland et al., 2011), and relation to social functioning and intervention (Faja et al., 2012).

Although social motivation is the social performance-related variable that has received the most attention in ASD literature (e.g., Dawson et al., 2005; Koegel & Mentis, 1985), social motivation produced the most mixed results in this study. While greater social motivation correlated with more peer interaction, this effect disappeared

after relevant controls. Moreover, more motivation predicted *poorer* facial emotion recognition, even after controls. Notably, the social motivation measure used was rather imperfect, capturing parents' report of their child's attempts to initiate and maintain interactions with peers. As such, this measure may not capture a "pure" social motivation construct, but rather *social persistence*. Such a construct accords well with my findings, suggesting that ASD youth with more social impulsivity may "get ahead of themselves," attempting to initiate and maintain interactions without attention to the subtle social cues involved in successful peer relations. Future research should use additional instruments to assess whether a "purer" social motivation construct may produce similar outcomes.

Results on the observed social interaction variables provide a more nuanced picture. Specifically, they suggest that social motivation was associated with more low-level interaction, and this effect was particularly accentuated for youth with low social knowledge. Yet, these effects are not unambiguously positive, as more ASD-like, low-level interactions are not thought to contribute to successful peer relationship (Bauminger, 2002), and are often targeted for *reduction* in intervention (Bauminger, 2007b). Nonetheless, this result helps to clarify the picture of how these factors predict outcomes. Specifically, it seems that youth with little idea of how to engage with peers (low social knowledge) who nonetheless desire to do so (high motivation) are most likely to produce more poor quality cursory social behaviors. This may occur because they would like to engage, but lack the skills to do so well. Interestingly, having *less* social motivation may preclude youth with low social knowledge from engaging in as many of these poor-quality interactions. Thus, these results indicate that multiple complex factors

indeed interact to predict competent and subtle social behavior; as such, it is crucial to account for the relation between such factors in developing, defining, and deploying interventions to improve social functioning.

Overall, these results highlight the importance of considering disparate outcome measures of social functioning in this population (Koenig et al., 2009), and provide a basis for future examinations to elucidate a more comprehensive model of the relationship between social knowledge, performance-related factors, and disparate outcomes in this population.

There are several factors that limit interpretation of these results. First, there was no TD group; thus, it is not known whether these relations between social knowledge and functioning are unique to ASD populations. Second, the age range of the participants was fairly limited to early and mid-adolescence; future research should examine the role of social knowledge and performance-related factors in younger school-age and older adolescent samples. Third, the sample size was only moderate for these analyses. Fourth, several of the measures have either no (social creativity, social knowledge) or little (social motivation) past use within this population. Future research should examine the construct validity of these measures in ASD samples. Fifth, I used only one measure of social knowledge. Without a TD sample, it is difficult to know, then, if some youth with ASDs were truly unimpaired in social knowledge, or if this was simply a measurement artifact of the CABS. Finally, while I did examine the effect of past intervention experience on obtained results, the retrospective measure was imprecise. Future research

should more closely examine whether these relations may be affected by psychosocial or pharmacological intervention.

This study has several implications for further research and clinical endeavors. First, it suggests models positing a primacy for social knowledge in social functioning among youth with ASD (Mesibov, 1984) should be reevaluated. Second, it supports models that implicate diverse predictors and outcomes in understanding the multifaceted construct of social functioning (Koenig et al., 2009; McKown et al., 2009). Third, it opens the door for more nuanced consideration of the relationship between these and other social performance-related factors (e.g., anxiety; White et al., 2007) and social functioning outcomes.

Finally, this study has direct implications for intervention design and implementation. Despite a purported emphasis on both social knowledge and performance (e.g., Stichter et al., 2010), most social skills interventions for ASDs have focused on strategies such as social scripts, structured teaching, and reinforcement of specific desired behaviors (see Laugeson et al., 2009; Matson et al., 2007; White et al., 2007), which are consonant with the prevailing social knowledge-deficit model. This focus runs contrary to known limitations of social knowledge-training programs to affect social behavior, despite their effect on self-reported social knowledge (McMahon et al., 2000). Meanwhile, some have argued that primarily training social performance may produce superior outcomes (Gutstein et al., 2007). This study provides a first step towards better describing the relationship between social knowledge and performance-

related factors to outcomes, which may aid resolution of this crucial debate and provide an avenue for optimized interventions.

These results highlight the necessity of carefully tailoring intervention components to accord with empirically-supported mechanisms of social functioning (Nixon, 2001). Careful assessment of such mechanisms (especially social performance-related factors) may facilitate the development of modular social skills programs, tailored to address the specific outcomes through channels individualized to the unique profile of each child or adolescent with ASD.

Study 3

Assessing Change in Social Skills with Social Knowledge- and Performance-Training Activities

Deficits in social functioning are pathognomonic among individuals with autism spectrum disorders (ASD), especially for high-functioning individuals (HFASD) who have otherwise intact cognitive ability. Such deficits are evident across domains of measurement, including social behavior (peer interaction in structured and unstructured settings), social perception (emotion recognition), and social cognition (Theory of Mind) (Baron-Cohen & Glidden, 2001; Bauminger, 2002; Carter et al., 2005; Rump et al., 2009). Recent research has demonstrated that, to characterize these deficits, it may be useful to consider whether youth with ASD have social problems because they " do not know what to do" (a *social knowledge* deficit) or because of deficits in *social performance*-related domains such as social motivation, creativity, or information processing, which prevent them from expressing their knowledge (see Study 2).

However, little work has examined whether this distinction may inform which components (i.e. different training activities) of social skills interventions are most effective, or which participants are most likely to respond to such interventions. Such a differentiation is crucial, as most social skills interventions incorporate elements designed to train both social knowledge and performance, along with periods of unstructured interaction (Attwood, 2007; Laugeson et al., 2009; Mesibov, 1984; Stichter et al., 2010; White et al., 2007), with little empirical guidance as to which elements best optimize outcomes.

This study employs a dismantling approach (Kiesler, 2004) via brief training sessions to attempt to disentangle the unique effects of relatively "pure" social knowledge- and performance-training activities on change in youths' demonstration of

socially skilled behavior in structured and unstructured interactions, as well as in social cognitive abilities. Further, it examines whether pre-test differences in social knowledge and performance-related factors predict individual differences in change in social outcomes across and within these conditions. As such, it is designed to aid in both assessing the proximal effects of each condition, as well as factors that may facilitate treatment response more generally; thus, this study aims to aid intervention design and theory, and to move towards the development of prospective treatment response profiles based on consonance between deficits and intervention approaches.

Variability in Social Skills Interventions for ASDs

Social skills interventions targeted at remediating social deficits in individuals with ASDs have existed for more than 20 years (Mesibov, 1984). Roughly 15 years ago, their status was questionable, with one meta-analysis concluding that they were ineffective (Kavale et al., 1997). Other work suggested that they may be effective only for improving in-session display of social behavior (Barry et al., 2003; Koegel & Frea, 1993; Kransny et al., 2003; Matson et al., 2007). Indeed, this was the strongest evidence for the efficacy of these interventions for years, as generalization of these skills after session completion and in the absence of a structured setting remained elusive (White et al., 2007). Recently, there has been a significant increase in research on these interventions (Lerner, Hileman, et al., in press; Matson et al., 2007; Rao et al., 2008; Schreiber, 2011; White et al., 2007), with reviews yielding heterogeneous and inconclusive results (Koenig et al., 2009). Effect sizes have varied widely (from extremely small to large on standardized metrics) between studies, target outcomes (i.e.,

Theory of Mind, in-session prosocial behavior, generalized social behavior, emotion recognition), and populations (i.e., all ASDs versus HFASDs, across age groups, etc.). While social skills interventions for school-age children with ASD have recently been deemed "evidence-supported" (Reichow & Volkmar, 2009), examination of common or specific techniques and theories that may be optimal, particularly for individuals with HFASDs, remain largely unexplored (Schreiber, 2011).

Knowledge- and performance-training strategies. Critically, addressing these questions will require ensuring that the theory of mechanisms sustaining social deficits within the population is both accurate and consonant with chosen intervention strategies. The distinction between social knowledge and performance deficits may be useful for this purpose (Gresham, 1997; Nixon, 2001). Intervention strategies purely consonant with social knowledge deficits focus on directly teaching social knowledge by didactically providing information on appropriate action (e.g., when to make eye contact, how to initiate a conversation), while intervention strategies consonant with social performance deficits focus on providing a context in which socially skilled behaviors may be effectively enacted by mitigating those factors that prevent an individual from such enactment.

Youth with ASD are known to exhibit a systematic, rules-bound cognitive style (Baron-Cohen & Belmonte, 2005; Qian & Lipkin, 2011), especially with reference to social information (Hoyt et al., 2006; Kransny et al., 2003; Laugeson et al., 2009; Matson et al., 2007), which is thought to prevent them from learning about social interaction via typical, implicit, automatic or inferential processes. Social knowledge-training

approaches posit that didactic provision of discrete, *a priori* specified rules and steps about specific social situations provide the best way to capitalize on this cognitive style to elicit prosocial behavior and perspective-taking (A. P. Goldstein & McGinnis, 1997; Laugeson et al., 2009). Contingent reinforcement of these steps is also provided, but always as a way to ensure that participants remain cognitively engaged-with and keyed-into the correct set of rules for the given situation, and that they encode the specific procedural knowledge (i.e. successful implementation of behavioral steps) associated with that situation. Social knowledge-training models specify the importance of having social instruction activities mirror specific "real life" situations as closely as possible (A. P. Goldstein & McGinnis, 1997). As such, the goal is to ensure that a child *knows* specific behavioral steps to enact in a given setting, and then to train that child such that he or she *knows* to use those behaviors in analogous situations. Hence, such strategies posit that the optimal pathway for achieving in-session and generalized competent social behavior among youth with ASD exists via the mechanism of increased knowledge and cued use of specific appropriate social behaviors.

In contrast, interventions based on social performance-training principles posit that, due to the same proclivity towards a systematic, rules-based approach to social interactions, reinforcement of specific scripts may yield increased rigidity of social behavior, and thus poorer social competence and learning (Greenspan & Wieder, 1998; Gutstein et al., 2007). Rather, social performance-training strategies for youth with ASD posit that impoverished *social creativity* (Mouchiroud & Bernoussi, 2008) and *motivation* (Scott-Van Zeeland et al., 2010), as well as slowed *social information processing speed*

(SIPS; McPartland & Pelphrey, in press; McPartland et al., 2011) are key factors that may block expression of skilled behavior, even if the individual already possesses the knowledge about what behavior to perform. Therefore, mitigating deficits in each of these areas is necessary in treatments for eliciting in-session and generalized prosocial behavior (Guli et al., 2008; Lerner & Levine, 2007).

Social creativity is the ability to generate varied and novel responses to social situations (Mouchiroud & Lubart, 2002). Poor social creativity may lead to a limited and inflexible social repertoire that may leave one ill-prepared to engage with or learn from the complexity of *in vivo* peer interactions (Hobson et al., 2009). Strategies to enhance social creativity, then, aim to promote generation of a wide and varied set of novel responses to (realistic or outlandish) social scenarios, regardless of their practical feasibility (Guli et al., 2008) to enhance preparedness for and responsiveness to unstructured interaction (Guli, 2005; Guli et al., under review). Likewise, such strategies, by providing a broad sample of social behaviors and responses, may aid participants in considering different social perspectives, thus promoting perspective-taking abilities such as Theory of Mind and emotion recognition (T. R. Goldstein & Winner, in press). Crucially, such strategies aim to promote the spontaneous generation and execution of social responses without pre-specification of what such behaviors might look like (i.e. without specifically highlighting rules of "correct" social behavior), to preclude employment of the rigid, rules-based cognitive processing style.

Social motivation represents interest in or intrinsic drive to pursue social interactions (Chevallier et al., 2012). Poor social motivation may lead to limitations in

initiation and maintenance of social interactions, as well as impoverished social experiences that preclude the development of Theory of Mind and emotion recognition ability (Chevallier et al., 2012; Koegel & Mentis, 1985). Strategies to enhance social motivation aim to increase such reciprocal social behaviors in structured and unstructured settings (as well as consequent social cognitive skills) by making social interactions themselves more motivating; they do so by embedding within these interactions topics or activities participants already find engaging (Koegel & Mentis, 1985; Koegel et al., 2009; Lerner & Levine, 2007).

SIPS involves the ability to rapidly discriminate increasingly subtle emotions, permitting efficient interpretation of social cues (see Study 1; McKone et al., 2007). Slower SIPS may lead participants to fail to "catch" social information when it happens (McPartland et al., 2011), leaving youth with ASD a fraction of a second behind in peer interactions. This may lead them to struggle to keep up in fluid peer settings, leading to downstream effects on prosocial behavior, encoding of social information (see Study 1), and perspective-taking. Strategies to enhance SIPS have participants quickly and repeatedly identify (Lerner et al., 2011) or discriminate between (Faja et al., 2012) social and emotional stimuli (e.g., faces), in hopes that this will accelerate their ability to automatically do so in social settings.

While strategies to remediate each of these factors may be considered atomistically, naturalistic social performance-training interventions aim to incorporate them in tandem during structured and unstructured games (Guli et al., 2008; Lerner & Levine, 2007). Additionally, social performance-training interventions do not require

intervention activities to closely mirror "real life" social interaction, as they tend to prioritize motivated interaction and creative, rapid response over the use of accurate social scripts.

Strategies used in the literature. To date, despite a purported emphasis on both social knowledge and performance (e.g., Stichter et al., 2010), most social skills interventions for HFASDs have aimed to capitalize on the rules-based cognitive style of youth with ASD (A. P. Goldstein & McGinnis, 1997; Hoyt et al., 2006; Kransny et al., 2003), and have consequently focused on training social knowledge via strategies such as social scripts, structured teaching, and reinforcement of *specific* desired behaviors (see Laugeson et al., 2009; Matson et al., 2007; White et al., 2007). Indeed, the degree to which the HFASD social skills literature focuses on knowledge-training strategies is somewhat unique relative to other social skills literatures (Lerner, White, et al., in press). It is thus consonant with the prevailing social knowledge-deficit model of social problems in ASDs. This runs somewhat contrary to known limitations of social knowledge-training-focused approaches in changing skilled social behavior displayed in- and out-of-session, despite their ability to affect self-reported social knowledge in other youth populations (e.g., McMahon et al., 2000). Nonetheless, such interventions are widely used for individuals with HFASDs to attempt to train in-session (Barry et al., 2003; Matson et al., 2007) and generalized (Bauminger, 2002; Laugeson et al., 2009) social behavior, as well as outcomes such as Theory of Mind and emotion recognition (Rao et al., 2008). Some have argued, however, that use of alternative strategies such as

social performance-training may produce superior social skills intervention outcomes (Gutstein et al., 2007).

Many social skills interventions include components of social performance-training such as errorless teaching (shaping behaviors without identifying certain actions as "wrong" to promote social creativity), developing a positive environment (such that socialization is intrinsically motivating), and orchestrating peer involvement (such that peer interactions are additionally motivating, and may be processed more rapidly; White et al., 2007). However, inclusion of such strategies along with knowledge-training has not allowed for the identification of those strategies that may be therapeutically optimal, nor facilitated differentiation of the role of social performance versus knowledge deficits in the etiology of social problems among individuals with ASDs.

There has recently been greater examination of largely social performance-based approaches for promoting social skills (Corbett et al., 2011; Doyle, 2001; Guli et al., under review; Guli et al., 2008; Gutstein et al., 2007; LeGoff, 2004; Lerner & Levine, 2007; Lerner & Mikami, in press; Lerner et al., 2011) and social play (Lerner & Mikami, in press; Luckett et al., 2007; Sherratt & Peter, 2002). In studies where youth were assigned to a condition to increase social motivation (a performance-related variable) or a control condition, those who received the manipulation to enhance motivation displayed increased quantity and quality of social interaction during and after training activities (Koegel & Mentis, 1985; Koegel et al., 2009). Another study yielded promising results for generalization and maintenance of skills, demonstrating changes among a group receiving social performance-training, relative to a matched clinical comparison group

receiving treatment as usual in the community, in multiple domains of social functioning that endured at 3 and 6 weeks post-treatment (Lerner et al., 2011). Others have demonstrated significant improvements in emotion recognition and Theory of Mind as a result of social performance-training (Corbett et al., 2011). Still others have demonstrated significant improvements in generalized social skills (out-of-session) among youth receiving social performance-training compared to matched controls engaging in social knowledge-training interventions after 3 years of continuous intervention in both groups (Legoff & Sherman, 2006). Comparable results have been lacking in knowledge-training treatment models (e.g., McMahon et al., 2000). Likewise, social performance approaches have preliminarily demonstrated results in terms of improvements in social anxiety (Lerner, Calhoun, et al., 2009; Lerner, Calhoun, et al., in press) and autistic impairment in social settings (Lerner, Spies, et al., 2009). They have also shown more rapid (though comparable in magnitude) improvements in social play and social preference relative to performance-training approaches (Lerner & Mikami, in press). Related approaches have been shown to improve Theory of Mind in typically-developing (TD) children and adolescents (T. R. Goldstein & Winner, in press). Again, though, many contemporary social skills interventions incorporate elements of both knowledge- and performance-training (Laugeson et al., 2009; Stichter et al., 2010; Tse et al., 2007), making it difficult to assess unique effects of either element. As such, there exists support for closer examination of the difference between these models.

Dismantling studies. A powerful approach for examining differences between models of intervention is the dismantling study, which seeks to identify the active

ingredients of existing evidence-based therapies (Kiesler, 2004). This approach focuses on identifying "micro interventions" that exist within broader psychotherapeutic packages, elucidating the theory of change that underlies each one and determining the contribution of each component to treatment efficacy. For instance, this approach has helped disentangle the relative efficacy of behavioral experiments, exposure, and interpersonal/emotional processing components of cognitive-behavioral therapy (CBT) for anxiety disorders via assignment to relatively "pure" treatment conditions (Holtforth et al., 2004; McMillan & Lee, 2010).

Such studies often differentiate between psychoeducational components (e.g., teaching clients about the cognitive-behavioral triad; Freeman et al., 1990; Miklowitz et al., 2008), and behavioral components (e.g., systematic desensitization via exposure therapy; Bermudes et al., 2009; Hamblen et al., 2009). Analogously, social knowledge-training focuses on teaching clients correct rules of social behavior, while social performance-training aims to provide a context that promotes social motivation, creativity, and rapid social information processing -- factors theorized to block expression of socially skilled behavior in ASD populations. As social knowledge- and performance-training represent undifferentiated potential active ingredients within an evidence-supported treatment (Reichow & Volkmar, 2009), they represent ideal candidates for a dismantling approach.

One small-scale study has used a dismantling methodology to assess differences in social performance- and knowledge-training approaches. Lerner and Mikami (in press) randomly assigned 13 youth with HFASD to four, once-weekly 90-minute sessions (each

composed of two 40-minute sub-sessions with a 10-minute break in the middle) of knowledge- or performance-training. While no generalized effects on parent report were obtained in either condition, both groups displayed group leader-reported increases in social skills and within-group peer-reported increases in reciprocated friendship-making by the end of the intervention period relative to at pre-test. While these results point to comparable efficacy for these conditions, results on additional sociometric and observed interaction outcomes augment this story. Specifically, children in the performance-training condition befriended each other faster and interacted more after a single session relative to knowledge-training. However, those in knowledge-training "caught up" over the course of the four sessions. This suggests, then, that the comparable overall outcome effects emerged via different mechanisms of peer interaction, which operate at different rates. That effects were measureable over such a brief intervention (with group differences on sociometrically-assessed social preference evident after a single 90-minute session, and differences on naïve observer-rated peer interaction evident after a single 40-minute sub-session) suggests that these mechanisms might be operating quite quickly, and may be evident in single well-differentiated knowledge- and performance-training sessions. Thus, identification of social knowledge- and performance-training mechanisms is plausible via examination of proximal effects on social behavior of brief, "pure" knowledge- versus performance-training sessions (Holtforth et al., 2004).

Evidence seems strongest that engaging in brief knowledge- versus performance-training activities will yield differential outcomes in youth's observed positive social behaviors and social interaction rates (Lerner & Mikami, in press). Although no study to

date has investigated whether such brief training activities will yield changes on social-cognitive processes such as Theory of Mind and emotion recognition, I speculate this may occur. First, there is evidence that longer (e.g., summer or school-year), more diffuse (i.e. less concentrated doses of intervention content) performance-training interventions demonstrate large effects on Theory of Mind and emotion recognition (T. R. Goldstein & Winner, in press; Lerner et al., 2011), while comparable knowledge-training interventions may not (Barnhill et al., 2002; Solomon et al., 2004; White et al., 2007). It is possible that intensely applied, pure performance-training sessions can be examined as a test of "micro interventions" (Kiesler, 2004), which are useful in identifying the minimum *dose* of a treatment condition necessary to produce change (Kazdin, 2007; Lerner, White, et al., in press). As a dose-response analysis has not yet been conducted in the social skills intervention literature, identifying potential minimum dosages can be useful for ensuring that future studies do not fail to detect effects due to clinically underpowered interventions. Conversely, if changes in behavior or social-cognitive processes are evident in short periods of time, this would indicate that social skills training mechanisms may operate rapidly, and provide support for the proposed processes as mechanistic in longer training periods (Lerner & Mikami, in press; Lerner, White, et al., in press).

Knowledge, Performance, and Individual Differences

Individuals with HFASD vary substantially in their pre-existing levels of social knowledge or performance-related factors (see Study 2). These variables may, in turn, predict individual differences in youths' ability to benefit from opportunities for peer

interaction in general, as well as from specific techniques within social skills interventions.

When offered opportunities for peer interaction, youth with higher levels of performance-related factors may be likely to benefit from this experience and thus display progressive increases in observed social interaction, Theory of Mind, and accurate recognition of others' emotions. Even in young TD children, prosocial interaction tends to increase, and solitary behaviors decrease, over play time (Ridgers et al., 2011), even in periods as short as 30 minutes (Greenwood, Walker, Todd, & Hops, 1981), such that TD children naturally display an accumulative, "snowballing" effect of total and positive interaction over time via exposure to peers. Conversely, ASD youth fail to naturally show this same "snowballing" process, such that they demonstrate less (and less positive) spontaneous interaction with peers (especially other ASD youth) cross-sectionally (Bauminger et al., 2003) and over time (LeGoff, 2004). However, it has long been theorized that individual differences in some performance-related variables may predict responsiveness to opportunities for social interactions among youth with ASD (Koegel & Mentis, 1985); recent research suggests that higher levels of social motivation may potentiate youth maintaining their engagement when interacting with peers (Chevallier et al., 2012), suggesting that social motivation may facilitate this "snowballing" in ASD youth. Speculatively, this relationship could occur via higher levels of other performance-related variables (i.e. those with more social creativity may key into opportunities to try out an increasingly broad array of social behaviors; those with faster SIPS may "catch" more and more opportunities to interact over time). As the

development of perspective-taking abilities such as Theory of Mind and emotion recognition is thought to be dependent upon the experience of learning about others' perspectives by taking advantage of opportunities for social interaction (see Figures 1 and 2; Peterson et al., 2005; Wellman et al., 2011), these outcomes could likewise evince benefits via this "snowballing" effect.

Meanwhile, social knowledge may be more static or inert. That is, it is likely to only promote engagement in those instances where youth have specifically learned a social script that fits the exact situation. As naturalistic opportunities to engage with peers rarely contain a series of these specifically-trained social situations, social knowledge may not predict accumulation ("snowballing") of positive, sustained social interaction (and consequent experience-dependent learning of perspective-taking) in the presence of opportunities to engage with peers. This may be especially the case for individuals with ASD due to their tendency towards a precise, rigid, rules-bound cognitive style (Qian & Lipkin, 2011). However, relations between social knowledge, performance-related factors, and outcomes of social behavior and perspective-taking in the presence of social interaction opportunities have never been examined.

Importantly, such an examination has implications for interventions *as currently delivered*. Most social skills interventions, in addition to containing both structured knowledge- and performance-training components, also offer unstructured opportunities to engage with other peers receiving the intervention (Barry et al., 2003; Kransny et al., 2003; Laugeson et al., 2009; Lerner & Mikami, in press; Lerner et al., 2011; Matson et al., 2007; Rao et al., 2008; White et al., 2007). Importantly, these unstructured interaction

opportunities are thought to enhance the efficacy of the structured intervention components on social competence by giving youth the chance to practice positive social behavior and engagement (A. P. Goldstein & McGinnis, 1997; Kroeger, Schultz, & Newsom, 2007; Laugeson et al., 2009; Lerner & Levine, 2007). Thus, the examination of whether pre-test capacities for social knowledge versus social performance may predict youths' response to opportunities to interact with peers provides relevant information about which youth are most likely to benefit from key components (unstructured and structured interaction time) in existing social skills intervention packages.

Pre-test social knowledge and performance-related factors may also predict differential response to knowledge- versus performance-training strategies, providing insight into a potential "match" between baseline characteristics and treatment conditions (Lerner, White, et al., in press). Such a focus on "Aptitude x Treatment interactions" represents an area of active enquiry in other domains of psychotherapy research (Norcross & Wampold, 2011; Simon & Perlis, 2010; Vlaeyen & Morley, 2005). For instance, in the CBT literature, it is suggested that both maladaptive cognitions around the ability to change behavior and challenges accepting difficult experiences may be mechanisms sustaining anxiety and depression (Forman et al., 2007). Cognitive Therapy (CT) and Acceptance and Commitment Therapy (ACT) are similarly-effective CBT interventions (Forman et al.) thought to reduce internalizing symptoms via different mechanisms (decreasing maladaptive cognitions versus increasing acceptance of experiences, respectively). Recent research suggests that, as hypothesized, effects of CT are mediated via use of strategies to decrease maladaptive cognitions (but not to increase

acceptance of difficulties), and effects of ACT are mediated via strategies to increase acceptance (but not decrease maladaptive cognitions; Forman et al., 2012). Thus, it is plausible that an individual with relatively greater deficits in terms of maladaptive cognitions would benefit more from CT, while someone with greater deficits in terms of acceptance would benefit more from ACT (i.e. greater deficit in the targeted domain would predict a "match" to treatment condition). Along these lines, youth with poorer social knowledge might receive greater benefit from social knowledge- relative to performance-training, while those with poorer social performance-related factors might receive greater benefit from performance- relative to knowledge-training (i.e. a deficit-related "match"). Conversely, relative strength in a given domain may reflect an individuals' preferred social learning style (i.e. someone with greater social knowledge might simply have an easier time learning social information concretely). In this case, children with greater social knowledge might receive greater benefit from social knowledge- relative to social performance-training, while children with greater social performance-related factors might receive greater benefit from performance- relative to knowledge-training. As this question has never been explored in social skills interventions, both explanations are plausible. Either way, however, this Aptitude x Treatment approach provides a way to relate the heterogeneity in mechanisms of social deficit in ASD to targeted intervention procedures. An ideal method for assessing this relationship is the dismantling approach described above (Kiesler, 2004).

Hypotheses

I first hypothesized that participation in brief, "pure" social performance-training activities would predict a greater increase in outcomes (observed in-session and generalized prosocial behavior, Theory of Mind, and emotion recognition) relative to knowledge-training activities. Such a finding would suggest that social performance-training approaches may, on average, represent a preferred treatment model for youth with ASD. Additionally, it would suggest that differences found in longer intervention trials (Lerner & Mikami, in press) begin early as opposed to being fully attributable to accumulating effects across multiple sessions. Finally, it would highlight that social skills interventions for ASD youth are generally dissociable according to the knowledge-performance divide in terms of general efficacy and putative mechanisms.

However, individual differences in mechanisms of social deficit (i.e. primarily knowledge- or performance-based) may predict differential response regardless of treatment condition. Specifically, higher levels of social performance-related factors may yield greater responsiveness to opportunities to engage in interactions with peers (Guli et al., 2008; Lerner & Levine, 2007). Thus, my second hypothesis was that, controlling for condition assignment, those with better social performance-related factors at pre-test (i.e., social creativity, social motivation, SIPS) would experience greater improvements in social outcomes, while social knowledge would not predict such change. Building on Study 2, this would further support a social performance-related deficit, as it would indicate a stronger relation between change in social outcomes and performance-related factors in the presence of peer interaction (i.e. that performance-related variables promote

a social "snowballing" effect). It would also provide a picture of which youth might be most likely to respond to social skills interventions as currently delivered.

Finally, capitalizing on the Aptitude x Treatment principle (Smith & Sechrest, 1991), I explored whether individual differences in pre-test levels of knowledge or performance-related variables might predict a differential response to treatment condition. However, as this was an exploratory hypothesis, I did not specify an *a priori* direction. That is, I did not indicate whether greater ability in a given domain (i.e. knowledge) would predict *greater* or *lesser* change in the analogous condition (i.e. knowledge-training). Greater condition-consonant change might indicate that baseline variables reflect learning styles, while lesser change might indicate that youth experience impaired "aptitude" in the targeted condition. Either way, significant deficit by treatment condition interactions would indicate that, while there may be heterogeneity in mechanisms of social functioning in ASD, this heterogeneity can be used to "match" participants to treatment conditions (Norcross & Wampold, 2011; Simon & Perlis, 2010; Smith & Sechrest, 1991). Moreover, it would support the knowledge-performance distinction as an effective way to characterize individual differences predicting such a "match" (Gresham, 1997; Nixon, 2001).

Method

Participants

Participants were a subsample of 38 youth with HFASD (30 male; 33 Caucasian, 1 Hispanic/Latino, 2 mixed, 2 unknown ethnicity; M_{age} = 12.92, SD_{age} = 2.09) who completed all study procedures (see Design & General Procedures, as well as Figure 5).

Procedure

Participants in this study completed all pre- and post-test measures indicated in the Design & General Procedures section above (see Figure 6). Specifically, participants first attended a study visit at which diagnostic and cognitive measures, as well as measures of social knowledge, creativity, and motivation were completed. Then, participants were requested to attend a second visit, for which they were assigned to dyads. Participants in a dyad were matched in age (+/- 1 year), sex, FSIQ, and relative severity of ASD symptoms. At the beginning of this second visit, each participant independently completed measures of Theory of Mind and emotion recognition; Event-related potential (ERP) data were collected during the emotion recognition task at this time to assess SIPS. Dyads were then brought to a video-equipped observation room with several age-appropriate games (a deck of cards, Connect Four, a ball, markers and a blank piece of paper). They were then informed that the research assistants (RAs) had work to do in the next room, but would return soon. Dyads were left in this room for 10 minutes, their unstructured interactions taped; these tapes were later coded for social interaction quality and quantity (see below). These dyads were then randomly assigned to complete either the social knowledge- or performance-training tasks, which lasted for approximately 20 minutes. These tasks involved unstructured peer interaction and, crucially, the knowledge- and performance-training activities (see below and Appendix K). Then, the RAs again left the room for 10 minutes, again informing the dyads that they had work to do, but would return soon. These interactions were also taped and coded. At

the end of this second unstructured interaction period, participants again completed the Theory of Mind and emotion recognition measures to assess change on these outcomes.

Knowledge- and performance-training activities. I surveyed existing treatment manuals (e.g., A. P. Goldstein & McGinnis, 1997; Guli et al., 2008; Gutstein et al., 2007; Laugeson et al., 2009; Lerner & Levine, 2007) to identify and isolate approximately one dozen relatively "pure" performance-training activities and one dozen knowledge-training activities. These activities were then reviewed with the Committee Chair (A.Y. Mikami) iteratively to reduce them to approximately a half-dozen of each. Next, a group of expert clinicians (K. Levine, L.A. Guli, and J. Hobson) were presented with this list to a) help reduce the number to five topic-matched (i.e. aimed at achieving the same goals) activities per condition, and b) confirm that the activities do indeed adequately differentiate between knowledge- and performance-training approaches. Upon their approval, the final list of activities (see Appendix K) was sent to the Dissertation Committee for approval; the target goals/topics of the final set of activities were: *starting a conversation, trading information, staying on topic, expressing your emotions,* and *understanding the feelings of others*. For each target goal, one knowledge- and one performance-training activity was chosen. Thus, the activities selected for each condition were matched on target goals and quantity (five activities for each treatment condition). Additionally, activities selected for each condition were matched in length (five activities totaling approximately 20 minutes; no less than 1 minute and no more than 5 minutes per activity), and RAs were trained to provide comparable levels of engagement and contact in both conditions. Importantly, while knowledge- and performance-training

interventions may often be mixed (and contain components of the other intervention approach) in "real world" practice, the knowledge-training activities used here focus on the "core" element that is purely didactic, while the performance-training condition focus on "core" elements that are *motivational*, as well as *creativity*- and *SIPS*-focused (with no didactic component), to provide a test that accentuates the contrast between conditions and maximizes the chance of obtaining differential effects.

In the knowledge-training condition, RAs were trained to present all activities in a discussion format. They were told to elicit responses to questions and ensure that participants understood all steps in the social interaction topic being taught (i.e. six steps to starting a conversation). RAs ensured that participants did not try out these steps, but instead were prompted to think about and state ways and situations in which to use them. Thus, RAs provided reinforcement for when each participant demonstrated knowledge of the *a priori* identified rules and steps associated with a given interaction, and the ability to explain specific "real life" situations in which they could use them (A. P. Goldstein & McGinnis, 1997; Laugeson et al., 2009).

In the performance-training condition, RAs were trained to present all activities in an active game format. They were told to elicit participation and to ensure that participants had a chance to play all roles in each game. RAs ensured that participants played the games, employed "errorless teaching" to shape creative participation, but did not ask participants to think about "real life" ways or situations in which the specific strategies of the games could be used. RAs a) modified game content to embed participant interests to increase social motivation (in Competitive Excuses, Group Story,

and Sausage), b) reinforced novel responses rather than "realistic" responses to promote social creativity (in Competitive Excuses, Group Story, Emotion Ball, and Sausage) and c) encouraged rapid identification of social and emotional content in peers' faces and voices to increase SIPS (in all activities; Guli et al., 2008; Gutstein et al., 2007; Hobson et al., 2009; Lerner & Levine, 2007).

Manipulation check. All sessions were timed and coded by the participating RAs for adequate completion of target activities (i.e. activities were administered according to the study scripts) and child participation (i.e. participants engaged actively in the activity rather than sitting aside or not responding). I verified each of these times and codes. RAs successfully administered 100% of activities in each condition. In terms of session length, Levene's Test for Equality of Variances was significant ($F = 10.88$, $p = .002$), so an independent-samples *t*-test not assuming equal variances was used; this test revealed no difference in length of session ($M_{Knowledge}$ = 18:31, $SD_{Knowledge}$ = 4:00; $M_{Performance}$ = 16:46, $SD_{Performance}$ = 2:08; $t = 1.455$, $p = .16$). All participants participated in all activities in the performance-training condition, while two participants (from separate dyads) did not participate in one activity in knowledge-training; proportion of participation in activities was not different between groups ($\chi^2 = 2.11$, $p = .15$).

Measures – Diagnostic & Cognitive

Social Communication Questionnaire (SCQ; Rutter et al., 2005). The SCQ is a widely-used, well-normed screening measure for ASDs, with international validation across age groups (Bölte, Holtmann, et al., 2008; Goin-Kochel & Cohen, 2008; Witwer & Lecavalier, 2007). It contains 40 binary (*yes* or *no*) items (sample item: Has she/he ever

had any interests that preoccupy him/her and might seem odd to other people?) and three subscales: Communication, Reciprocal Social Interaction, and Restricted/Repetitive Behaviors. It generates raw scores, with higher scores corresponding to a greater degree of impairment, and has a recommended ASD cutoff score of 15. It was used as an initial screening tool, as well as a pre-test condition matching variable in this study. Internal consistency (Cronbach's α) was acceptable (.79).

Social Responsiveness Scale (SRS; Constantino & Gruber, 2005). The SRS is a well-normed measure of social impairment in social settings among individuals with ASDs (Bölte, Poustka, et al., 2008; Constantino et al., 2003). It is a 65-item (sample item: has trouble keeping up with the flow of a normal conversation) questionnaire answered on a 1-4 Likert scale ranging from *not true* to *almost always true*. It contains three subscales, Social Awareness (8 items), Social Cognition (12 items), Social Communication (22 items), Social Motivation (11 items), and Autistic Mannerisms (12 items). The SRS yields *T*-scores, with higher scores corresponding to a higher degree of social impairment and autistic behavior in social settings. It was used a pre-test condition matching variable in this study. Internal consistency was acceptable (.90). Additionally, the Social Motivation subscale on the SRS (internal consistency = .68) was correlated with scores on the measure used to assess social motivation (see below), suggesting concurrent validity of the social motivation construct.

Autism Diagnostic Observation Schedule (ADOS; Lord et al., 1999). The ADOS is considered the gold-standard measure for diagnostic confirmation of ASDs across age groups and diagnostic severity (Gotham et al., 2009; Mahoney et al., 1998;

Sikora et al., 2008), and was used as such in this study. The ADOS is a standardized observational scale consisting of about 10 tasks and 30 codes. Structured social interactions are created in which a behavior or a particular type of social response is likely to occur. The child's responses to these interactions are then coded on a 0 – 2 Likert scale ranging from *not abnormal behavior* to *very abnormal behavior* by a research-reliable examiner. The author (M.L.) became research-reliable on the ADOS prior to conducting this investigation. The ADOS contains 5 subscales: Language and Communication, Reciprocal Social Interaction, Play, Stereotyped Behaviors, and Restricted Interests. Children are considered to meet criteria for an ASD diagnosis if they meet or exceed recommended cutoff scores on the Communication (ASD = 2) and Reciprocal Social Interaction (ASD = 4) subscales, as well as on a total Communication and Interaction algorithm (ASD = 7). Internal consistency was acceptable (.80).

Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV; Wechsler, 2003). A two subtest (Vocabulary and Matrix Reasoning) short form of the WISC-IV was used to estimate Full Scale IQ (FSIQ) to ensure criteria for HFASDs (FSIQ > 70) were met and to match conditions based on FSIQ. The WISC-IV was chosen because it is considered the optimal instrument for estimating and matching based on IQ in HFASD populations (Mayes & Calhoun, 2008; Mottron, 2004). The chosen short form configuration was selected because of its demonstrated high reliability and validity coefficients (.926 and .873, respectively; Sattler & Dumont, 2004) and its rapid administration time (< 16 minutes; Ryan et al., 2007).

Measures – Predictors

Children's Assertive Behavior Scale (CABS; Michelson & Wood, 1982). The CABS is a 27-item multiple-choice, self-report measure of knowledge of general and specific social skills. A sample item states, "You made a mistake and someone else is blamed for it. You would usually: a) Say nothing. b) Say, 'It's their mistake!' c) Say 'I made the mistake.' d) Say, 'I don't think the person did it.' e) Say, 'That's their tough luck!'". It generates three scales of self-reported social functioning: passive, aggressive, and assertive social behavior (Hobbs & Walle, 1985; Michelson & Wood, 1982; Scanlon & Ollendick, 1986). The CABS has been shown to correlate with peer, parent, and teacher reports of social competency and to discriminate between children with versus without a history of social skills training (Michelson & Wood, 1982); it has also demonstrated strong convergent validity with multiple measures of related constructs (Scanlon & Ollendick, 1986). It has previously been adapted to assess social skills knowledge by asking children what they thought "the right thing to do" was in each presented situation (Maedgen & Carlson, 2000; Wojnilower & Gross, 1988). It was used in this study to assess the social knowledge of the participants; only the "correct" (i.e. assertive) scale was used, and it was reversed-scored such that higher values correspond to "more" knowledge. It was used as a pre-test matching variable and predictor of change in outcome variables.

Dimensions of Mastery Questionnaire –Social Persistence with Peers (DMQ; Morgan et al., 1997). The DMQ is a parent-report questionnaire containing a six-item subscale (sample item: tries hard to make friends with other kids) designed to assess child motivation to interact with peers. It is answered on a 1-5 Likert scale ranging from *not at*

all typical to *very typical* and generates raw scores. It been used previously to assess parent-reported social motivation to engage with peers among children with HFASDs (Fiske, 2008). The peer social motivation subscale is part of a larger 45-item scale (the full DMQ) assessing mastery motivation more broadly. However, only the peer social motivation subscale was used in this investigation because of its relevance to the theorized role of social motivation in social competency deficits in ASDs. For convenience, the title of the full scale (DMQ) will be henceforth used to represent the peer social motivation subscale throughout this study. The DMQ was used as a measure of the social performance-related variable of social motivation. Internal consistency was acceptable (.74). It was used as a pre-test matching variable and predictor of change in outcome variables.

Social Creativity Task (SCT; Mouchiroud & Lubart, 2002). The SCT is a self-report measure of social creativity in a variety of scenarios. It requires participants to generate as many creative solutions to given social problems as possible (e.g., what to do when you want to play with a group of peers, but they say "no"). Social creativity has been shown to be a unitary construct that increases with development (Mouchiroud & Lubart, 2002) and correlates with social competencies, popularity, and parenting style (Mouchiroud & Bernoussi, 2008). As this investigation is principally concerned with social creativity in the peer domain, only two SCT scenarios, the "peers" and "dyad" tasks (Mouchiroud & Lubart, 2002) were used. To control for differences in writing ability, children were administered the SCT as a verbal interview during their first study visit. Children were asked to generate as many creative solutions as possible to the given

social problems, and their responses were then recorded and transcribed. Next, a team of undergraduate coders were trained on a sample set of responses to judge the creativity of each answer according to a 7-point Likert scale (*not at all creative* to *extremely creative*), then rated participants' transcribed responses; previous research using the SCT has generated acceptable inter-rater agreement using this method (Mouchiroud & Bernoussi, 2008). All answers were double-coded, with coders assigned randomly, counterbalanced by coder pair. Regular reliability assessments were performed and results were discussed weekly to help minimize coder drift throughout coding, as recommended by Margolin et al. (1998). Reliability of these ratings was excellent, ICC(1,2) = .79 (Cicchetti, 1994). The sum of each child's scores was divided by his/her total number of answers to control for fluency (Mouchiroud & Lubart, 2002), generating a final SCT score. Overall, the SCT was used as a pre-test matching variable and predictor of change in outcome variables.

Social Information Processing Speed (SIPS**;** see Study 1). SIPS was measured via the latency of the initial automatic, obligatory (i.e. prior to voluntary or effortful) ERP-indexed response to facial (N170) and vocal (N100) stimuli (independent of subsequent, more prefrontal cognitive evaluative responses) on the Diagnostic Analysis of Nonverbal Accuracy-2 (DANVA-2, see below; Nowicki, 2004). For more details on acquisition procedures, see Study 1 (above). As the N170 is a considerably more well-established ERP component (McPartland et al., 2004; McPartland et al., 2011), it was used in all analyses except those examining emotion recognition in voices, for which N100 is more directly comparable. Latencies were converted to *z*-scores a) to ensure normality of distribution, and b) because the goal of this study was to assess variability

within the population. SIPS was used as a pre-test matching variable and predictor of change in outcome variables.

Measures – Social Functioning Outcomes

Stories from Everyday Life (SEL; Kaland et al., 2002). The SEL is an advanced Theory of Mind battery appropriate for individuals with HFASD in the target age range (Kaland et al., 2008; Kaland et al., 2002; Kaland et al., 2007). It focuses on the ability to make distinctions about physical as well as mental states. Participants are presented with a story that leads towards a climax (e.g., the brother of a child who never cleans his room declares that said child has done "a splendid job of tidying up"), then are asked to answer questions regarding the physical condition (e.g., how does the child's room look?) and mental state (e.g., why does the brother make this statement?) of a character in the story. If a participant gives an answer to one of the test questions that is not quite correct (e.g., does not clearly indicate that they understand intended sarcasm in the above irony story), he is then given one or more additional questions in order to try to make it easier for him to understand the test question. No feedback about the accuracy of responses is given. Responses to each question are taped at the time of the testing. If a participant gives more than one answer, only the most appropriate is marked.

The SEL includes 26 short stories, or 13 pairs of different types of stories (A and B versions). To limit participant fatigue, the four social-cognitive story types that have demonstrated the greatest ability to distinguish between HFASD and TD adolescents (figure of speech, contrary emotions, mistaken intentions, and irony) were used (Kaland et al., 2002). Using these four story types, for each participant either the story A set was

administered at pre-test and the story B set was administered at post-test, or vice versa (counterbalanced for order). A different RA administered each participants' pre-test and post-test SEL. Responses to the mental inference question for each story are rated on a 0–2-scale as *fully correct* (2 points), *partially correct* (1 point), or *incorrect* (0 points). Two RAs independently coded these responses, one *in vivo* while the measure was being administered, and the other from audiotape. Three RAs not involved in SEL administration were randomly assigned to rate these audiotapes. This process has yielded excellent inter-rater reliability in past administrations (Kaland et al., 2002; Kaland et al., 2007), and reliability was excellent in the present sample ICC(1,2) >. 85. As it has shown the best ability to discriminate youth with HFASD from TD youth, only the mental inference scale (i.e. average mental inference score across the stories in a given set) was analyzed (Kaland et al., 2002). Internal consistency of the mental inference scale was acceptable (.58). The SEL was used as a pre-test matching variable and indicator of change in Theory of Mind.

DANVA-2 (Nowicki, 2004). The DANVA-2 is a computer-based measure of accuracy in ability to detect emotions in faces and voices. Participants observe 24 adult and 24 child faces and then listen to 24 adult and 24 child voices, and must identify them as either happy, sad, angry, or fearful; it generates raw error scores for face or voice responses (0 – 48). The DANVA-2 has been used frequently to explore ability to identify emotions in faces and voices by children and adolescents with HFASDs (e.g., Serra, Jackson, van Geert, & Minderaa, 1998), and has demonstrated treatment sensitivity on the Faces scale (Solomon et al., 2004) and the Voices scale (Lerner et al., 2011) in this

population. In this investigation, the DANVA-2 composite Faces and Voices scores were derived from performance on their respective modules. These scores were used at pre- and post-test to examine pre-test emotion identification ability as well as changes in this ability over the course of the paradigm. Stimuli were presented in a 2x2 (adult/child x faces/voices) block design, randomized within and between blocks. To ensure that outcome measures all corresponded directionally (i.e. higher = "more"), Faces and Voices emotion recognition scales were reverse-scored such that higher scores correspond to better ability. Internal consistency was high across the Faces (.913) and Voices (.889) scales. The DANVA-2 Faces and Voices scores were used as matching variables and indicators of change in emotion recognition.

Social Interaction Observation Scale (SIOS; Bauminger, 2002, 2007a, 2007b). The SIOS is a measure of prosocial interaction designed for use with individuals with HFASDs. It assesses total amount of interaction, as well as three qualitative subscales: Positive interaction (e.g., eye contact with smile, sharing), Low-Level interaction (e.g., close proximity, functional communication), and Negative interaction (e.g., physical and verbal aggression). When characterizing these types of interactions, positive interactions can be seen as unequivocally "good" (i.e. prosocial behaviors promoting greater likelihood of reciprocal peer engagement) and negative interactions can be seen as clearly "bad" (i.e. hostile behaviors promoting less peer engagement; Bauminger, 2002; Bauminger et al., 2003). Low-level interactions, however, may be more mixed, as they represent an incremental attempt at social interaction, though of a lesser quality (i.e. less likely to promote reciprocal peer engagement) relative to positive interactions; indeed,

this "mixed" quality is reflected in the fact that comparable social skills intervention studies have reported both increases (Bauminger, 2002) and decreases (Bauminger, 2007b) in low-level interactions. In the present study, more low-level interactions alone or in conjunction with *more* total or positive interactions (reflecting attempts to interact in contrast to no interaction at all), as well as *less* low-level in conjunction with *more* total or positive interactions, are considered somewhat (though in the case of more low-level interaction alone, not unambiguously) "good;" meanwhile, more low-level interactions in conjunction with *less* total or positive interactions (reflecting a shift towards lower-quality interaction) are considered "bad." Overall, however, Total and Positive interaction as measured on the SIOS have been shown to be sensitive to both social knowledge- and performance-training in youth with HFASD, and to differentiate them after only 40 minutes of interaction (Lerner & Mikami, in press).

Coders rated tapes in 60-second segments, and could rate up to three behaviors (across any combination of subscales; e.g., sharing, close proximity, verbal aggression) that best characterized the given segment. The average of each subscale was calculated across segments, such that scores for each (as well for total amount of interaction) ranged from 0 to 3. Before rating, coders were trained on the SIOS manual, then achieved high reliability (ICC(2,3) > .80) on all subscales with master codes on tapes from a previous sample (Lerner & Mikami, in press). They were then randomly assigned to double-code the tapes from the current study, counterbalanced by pair. Coders first rated the interactions occurring in the 10-minute unstructured periods that occurred before and after the training activities (randomly assigned, with coders kept unaware of whether

tapes were pre- or post-test). Then, they rated the interactions that took place *during* social knowledge- and performance-training activities; this was done so that raters would remain unaware of condition assignment when rating the unstructured interactions. Regular reliability assessments were performed and results were discussed weekly to help minimize coder drift throughout coding (Margolin et al., 1998). Reliability (ICC(1,2)) for Total (.92), Positive (.94), Negative (.77), and Low-Level (.93) interactions was excellent. However, there was little variance in (few incidents of) negative interaction, so it was excluded from subsequent analyses. Change in SIOS scales between pre-test and post-test was used as a measure of change in social interaction in unstructured settings. Change in SIOS scales between pre-test and during training activities was used for three reasons. First, it was used as an additional manipulation check (because performance-training was less didactic and more interactive than knowledge-training). Second, it was examined because in-session effects should precede generalized effects (especially in brief interventions; Blacher et al., 2003; Lerner & Mikami, in press; Lerner, White, et al., in press). Finally, it was analyzed because much of the social skills intervention literature has used in-session effects as an outcome (Barry et al., 2003; Koegel & Frea, 1993; Matson et al., 2007), suggesting it may provide a window into change mechanisms in existing interventions.

Data Analytic Plan

First, $\chi 2$ tests for categorical variables and independent samples *t*-tests for continuous variables were run to ensure that randomization successfully produced equivalent groups at pre-test.

Then, the three hypotheses were analyzed using hierarchical multiple regressions. To test hypothesis 1, that social performance-training would produce superior effects relative to knowledge-training on change in social functioning outcomes, I controlled for autistic symptoms (ADOS), FSIQ, and pre-test values of the given outcome on step 1, then added condition assignment (dummy coded, 0 = *knowledge-training*, 1 = *performance-training*) on step 2 in regressions predicting each outcome (outcomes measured during activities and at post-test for SIOS; at post-test only for DANVA-2 and SEL). To test hypothesis 2, that performance-related factors would predict relative increases in social functioning outcomes as compared to social knowledge after controlling for training effects, I added the social knowledge, social motivation, creativity, and SIPS measures together on step 3 in these regressions.

Finally, I tested hypothesis 3, the exploratory hypothesis that interactions between knowledge and performance-related factors and condition assignment would either reflect impaired "aptitude" in the specified domain (i.e. knowledge-training would best help those with poorer social knowledge) or reflect learning styles associated with the given domain (i.e. knowledge-training would best help those with better social knowledge). I did this by adding interaction terms between condition assignment, knowledge, and each performance-related variable on step 4.

Because of the nested structure of the SIOS data, in which participants' social behavior was examined in dyads, I assessed the possibility that participants' behaviors had been influenced by their partner. There was significant and substantial (Guo, 2005) Level 2 variance in the SIOS outcomes (83%, 57%, and 77% for Positive, Low-Level,

and Total). As such, these models were run in a hierarchical linear modeling (HLM) framework with a random intercept effect.

R^2 effect sizes (Cohen, 1992) were calculated for overall regression models as well as ΔR^2 for each separate significant coefficient. Level 2 overall model (pseudo-R^2) and marginal (pseudo-ΔR^2) effect sizes were calculated for HLM models examining differences between conditions (i.e. hypothesis 1), and corresponding Level 1 effect sizes were calculated for HLM models examining between-subjects (individual difference) predictors (i.e. hypotheses 2 and 3; Tasca & Gallop, 2009). To address whether effects may be due to medication or past intervention status, all significant analyses were re-run controlling for *current* medication (on any psychoactive medications during the study) and *previous* social skills intervention (has ever received such interventions) status (dummy coded), as well as previous intervention quantity (number of interventions received) on step 1. Three participants had missing SIPS data due to excessive EEG measurement artifacts (see Study 1). To ensure conservative results interpretation, no imputation procedures were used; however, HLM models were analyzed using full maximum likelihood estimation, which is robust to missingness.

Results

Descriptives

Participants in the knowledge- and performance-training conditions did not differ significantly on demographic variables or pre-test measures of outcome variables and nearly all predictors (see Table 7). The only exceptions were number of past social skills interventions and social knowledge, for which participants in the knowledge-training

condition had more previous interventions and greater social knowledge relative to those in the performance-training condition.

Table 7
Demographic and Pre-test Characteristics of the Knowledge- and Performance-Training Groups

Variable	Knowledge-Training (n =19) Mean (SD)	Performance-Training (n =19) Mean (SD)	p^1
Child age (years)	13.60 (2.20)	12.26 (1.76)	.05
Male (n)	15	15	1.0
Caucasian (n)	18	15	.20
Psychotropic medication (n)	17	13	.11
Past intervention (n)	19	16	.07
# of past interventions	3.79 (2.07)	2.47 (1.61)	.04
Full-Scale IQ	112.63 (12.00)	107.58 (16.53)	.29
Social Responsiveness Scale	85.37 (13.37)	90.89 (10.75)	.17
Social Communication Questionnaire	20.05 (5.66)	20.00 (6.52)	.98
Autism Diagnostic Observation Schedule	10.42 (3.93)	11.79 (3.24)	.25
DANVA-2 Faces	38.21 (4.53)	38.53 (3.76)	.82
DANVA-2 Voices	32.74 (5.18)	33.21 (4.58)	.77
Stories from Everyday Life – Mental Inference	.65 (.49)	.48 (.50)	.30
SIOS – Total	2.28 (.58)	2.32 (.54)	.82
SIOS – Positive	1.14 (.73)	1.26 (.80)	.64
SIOS – Low-Level	1.14 (.44)	1.04 (.40)	.49
Children's Assertive Behavior Scale (Social Knowledge)	47.21 (4.10)	40.47 (8.73)	<.01
Dimensions of Mastery Questionnaire (Social Motivation)	15.26 (4.77)	16.16 (4.24)	.55
Social Creativity Tasks	2.74 (1.06)	2.54 (.85)	.54
SIPS – Face (z-score)	.17 (1.13)	-.13 (.90)	.40
SIPS – Voice (z-score)	.10 (1.05)	-.04 (1.02)	.71

Note. Psychotropic medication represents any medication currently taken for a mental health condition. Past intervention represents having had any intervention for social skills problems. DANVA-2 = Diagnostic Analysis of Nonverbal Accuracy. SIOS = Social Interaction Observation Scale. SIPS = Social Information Processing Speed; SIPS – Face = N170 ERP latency to faces; SIPS – Voice = N100 ERP latency to voices. [1] p-values are from χ^2 tests for categorical variables and independent samples t-tests for continuous variables.

Across conditions, participants did not change in DANVA-2 Faces or Voices, SEL, Low-Level interaction *during* or *after* training sessions, or Total interaction *after* training sessions (see Table 8). However, on average, participants decreased in Positive interactions *during* and *after* training sessions, and their Total interactions *during* training sessions relative to pre-test interaction.

Table 8
Mean Change in Outcome Variables across Groups

Variable	Change Mean (SD)	p^1
DANVA-2 Faces	.66 (4.23)	.34
DANVA-2 Voices	.45 (3.98)	.49
Stories from Everyday Life – Mental Inference	-.02 (.52)	.85
SIOS – Total – Pre-During	-.53 (.65)	<.01
SIOS – Positive – Pre-During	-.64 (.81)	<.01
SIOS – Low-Level – Pre-During	.12 (.60)	.22
SIOS – Total – Pre-Post	-.09 (.39)	.14
SIOS – Positive – Pre-Post	-.27 (.49)	<.01
SIOS – Low-Level – Pre-Post	.16 (.52)	.06

Note. DANVA-2 = Diagnostic Analysis of Nonverbal Accuracy. SIOS = Social Interaction Observation Scale. SIPS = Social Information Processing Speed. Pre-During = Change in SIOS scale between pre-test interactions and amount of peer interaction taking place *during* training activities. Pre-Post = Change in SIOS scores between pre-test and post-test interactions. [1] *p*-values are from paired-sample *t*-tests.

Hypothesis 1 – Differences by Training Condition

After controlling for IQ and ASD severity, as well as pre-test values of outcomes, assignment to the performance- or knowledge-training condition did not significantly predict post-test SEL (β = .04, p = .89), DANVA-2 Faces (β = -.18, p = .17), or Voices (β = -.09, p = .46). Condition also did not predict change in Low-Level interaction (β_{01} = .11, p = .58) *during* activities (relative to pre-test) or Low-Level (β_{01} = -.05, p = .76),

Positive (β_{01} = .12, p = .70), or Total interaction (β_{01} = .07, p = .82) *after* activities (relative to pre-test). However, those in the performance-training condition experienced relatively greater Total (see Figure 11) interaction *during* training activities as compared to those in the knowledge-training condition (see Table 9); this overall model effect (pseudo-R^2 = .36) and Level 2 marginal effect of condition (pseudo-ΔR^2 = .40) were large. This effect appeared to be driven specifically by greater Positive (β_{01} = .65, p < .01; see Figure 12) interaction; this overall model effect (pseudo-R^2 = .69) and Level 2 marginal effect of condition (pseudo-ΔR^2 = .70) were large. Specifically, examination of Figures 11 and 12 suggest that while youth in both knowledge-training and performance-training conditions decreased in Total and Positive interactions during training activities relative to pre-test, the magnitude of this decrease was greater in the knowledge-training relative to in the performance-training condition.

Table 9
HLM Models Predicting Change by Training Condition in Social Interaction Quality and Quantity

SIOS Total Interaction – During Activities	**Parameter**	**Fixed Effects**				σ^2	τ
		Coefficient	**SE**	**T-ratio**	**p-value**		
Intercept	β_{00}	1.756	.108	16.189	<.001	.038	.216
Condition	β_{01}	.758	.217	3.495	.003		
Total Interaction (pre-test)	β_1	.609	.173	3.513	.003		
FSIQ	β_2	-.009	.003	-2.385	.029		
ADOS	β_3	-.024	.012	-2.018	.060		
SIOS Positive Interaction – During Activities							
Intercept	β_{00}	.541	.058	9.296	<.001	.043	.046
Condition	β_{01}	.649	.116	5.575	<.001		
Positive Interaction (pre-test)	β_1	-.078	.152	-.516	.613		
FSIQ	β_2	-.003	.004	-.745	.466		
ADOS	β_3	-.002	.019	-.122	.905		

FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. SIOS = Social Interaction Observation Scale.

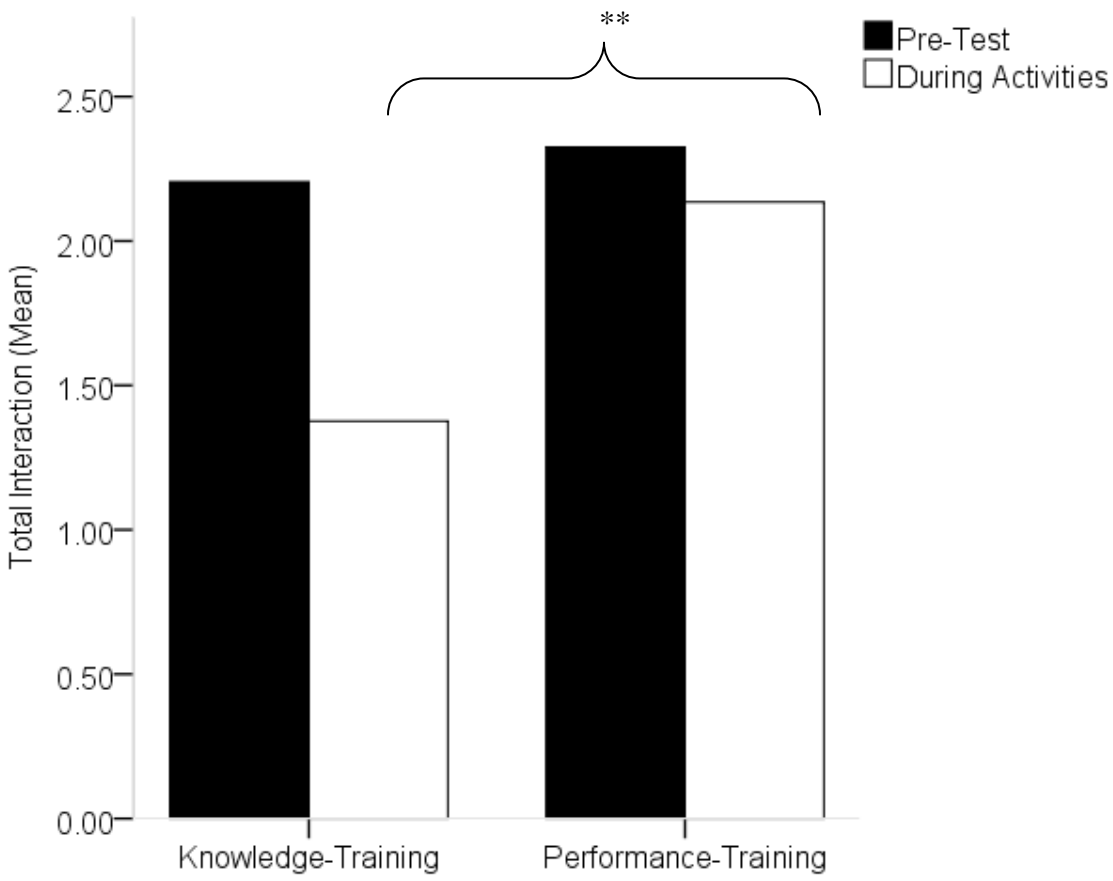

Figure 11. ** $p < .01$. Bar graph demonstrating main effect of condition on change in Total peer interaction between pre-test and during training activities. While both groups decreased in their interactions on average (see Table 8), the decrease was significantly greater in the knowledge- relative to the performance-training condition.

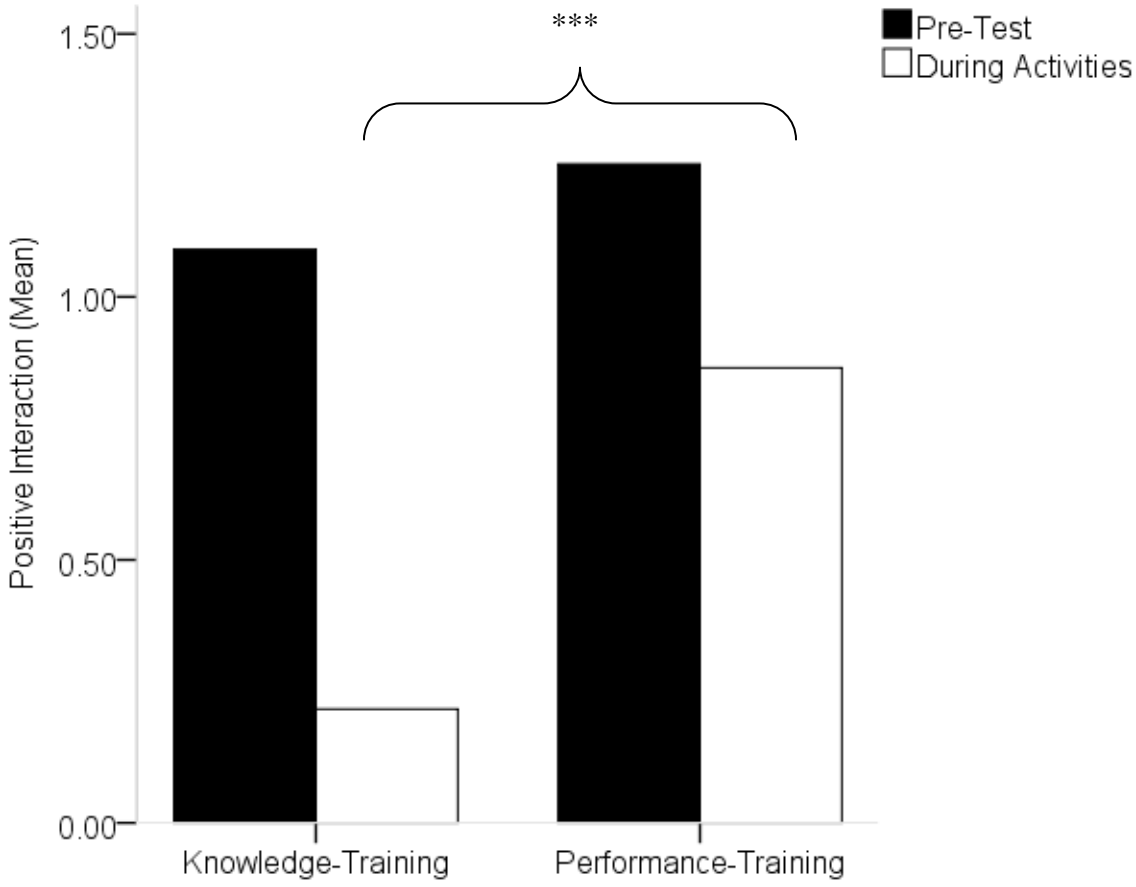

Figure 12. *** $p < .001$. Bar graph demonstrating main effect of condition on change in Positive peer interaction between pre-test and during training activities. While both groups decreased in their Positive interactions on average (see Table 8), the decrease was significantly greater in the knowledge- relative to the performance-training condition.

Hypothesis 2 – Effects of Knowledge and Performance-Related Variables

After controlling for IQ, ADOS score, pre-test values, and condition assignment, social knowledge and the social performance-related variables (DMQ, SCT, and SIPS) did not predict change in emotion perception in faces (all $p > .49$) or voices (all $p > .11$). They also did not predict change in Positive or Low-Level interaction between pre-test and such interaction at post-test.

However, after these controls, social creativity predicted a medium-small ($\Delta R^2 = .12$) decrease in Theory of Mind (SEL; see Table 10, Model 3; Figure 13).

SIPS and social creativity also predicted increased Total interaction during training activities (see Table 11; see Figure 14); this overall model effect (pseudo-$R^2 = .82$), as well as the Level 1 marginal effects of SIPS (pseudo-$\Delta R^2 = .73$) and social creativity (pseudo-$\Delta R^2 = .66$), were large. This SIPS effect was also present for Positive (see Table 11) and Low-Level interactions (see Table 11) during training activities; these overall model effects were large (pseudo-$R^2 = .76$ and .38, respectively), while the Level 1 marginal effects of SIPS were large (pseudo-$R^2 = .72$) and small (pseudo-$R^2 = .11$), respectively. Thus, while this SIPS predictor did not significantly distinguish *quality* of interactions, its effect was much larger for Positive relative to Low-Level interactions. More social motivation also predicted relatively increased Positive interaction during training activities (see Table 11), with a medium Level 1 marginal effect (pseudo-$R^2 = .14$).

Finally, less social motivation but faster SIPS predicted more Total social interaction at post-test (see Table 11); this overall model effect was large (pseudo-$R^2 =$

.47), while the Level 1 marginal effects of SIPS (pseudo-R^2 = .02) social motivation (pseudo-R^2 = .10) were small. These effects were not driven by concurrent changes in Positive (all $p > .31$) or Low-Level (all $p > .31$) interaction on any variable.

Table 10

Hierarchical Multiple Regression Predicting Change in Theory of Mind (Stories from Everyday Life) Associated with Social Creativity

	Model 1			Model 2			Model 3		
	B	se *B*	*β*	*B*	se *B*	*β*	*B*	se *B*	*β*
SEL - Pre-test	.17	.17	.19	.17	.17	.19	.16	.17	.18
FSIQ	.01	.01	.29	.01	.01	.29	.01	.01	.28
ADOS	.00	.02	.03	.00	.02	.03	-.02	.02	-.23
Condition				.03	.15	.04	-.04	.16	-.05
CABS							-.01	.01	-.16
DMQ							.01	.02	.10
SIPS – Face							.02	.08	.03
SCT							-.18	.09	-.40*
Total R^2		.165			.166			.306	
F for ΔR^2		1.699			.045			1.253	

*$p < .05$. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. SIPS – Face = Z-score of N170 ERP latency to emotional faces. SEL = Stories from Everyday Life – Mental Inference.

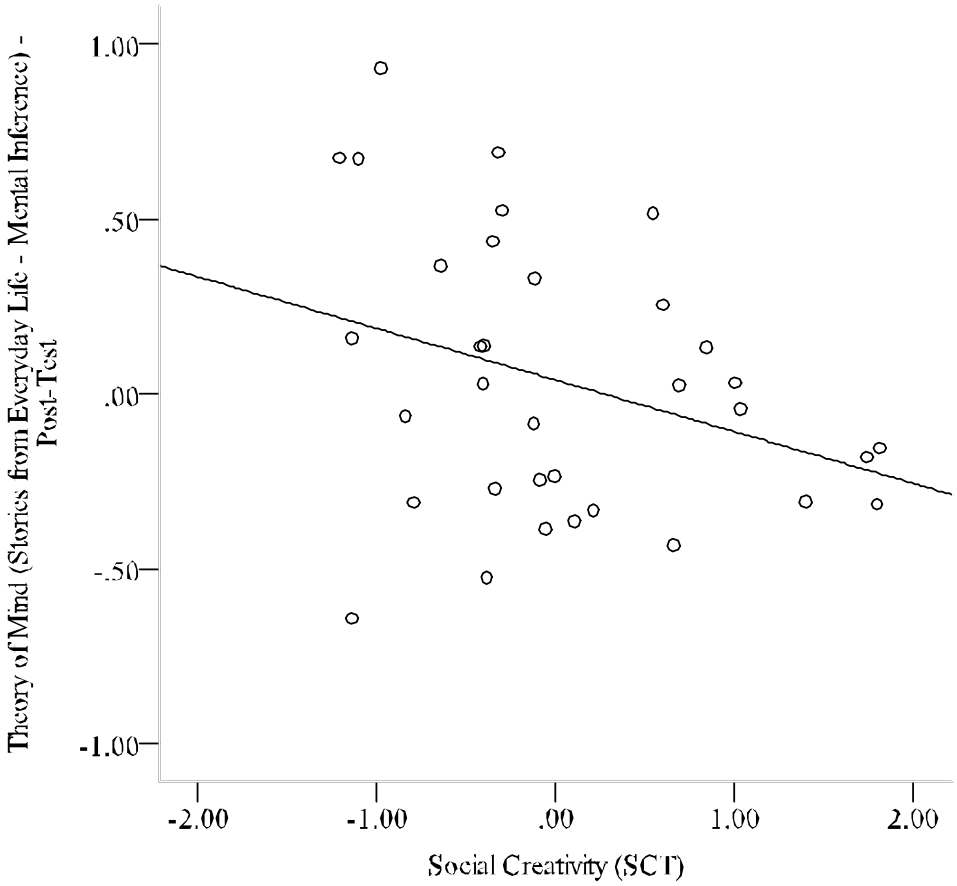

Figure 13. Partial regression plot demonstrating change in Theory of Mind associated with pre-test Social Creativity. Model controls for IQ, ASD symptom severity, pre-test Theory of Mind, condition assignment, social knowledge, social motivation, and social information processing speed.

Table 11

HLM Models Predicting Change in Quality and Quantity of Social Interactions Based on Social Knowledge and Performance-Related Variables

SIOS Total Interaction – During Activity	**Parameter**	**Fixed Effects**				σ^2	τ
		Coefficient	**SE**	**T-ratio**	**p-value**		
Intercept	β_{00}	1.793	.113	15.882	<.001	.015	.222
Condition	β_{01}	.673	.226	2.980	.009		
Total Interaction (pretest)	β_{1}	.512	.091	5.603	<.001		
FSIQ	β_{2}	-.009	.001	-6.174	<.001		
ADOS	β_{3}	.008	.006	1.277	.221		
CABS	β_{4}	-.014	.007	-1.947	.070		
DMQ	β_{5}	.008	.006	1.277	.221		
SIPS – Face	β_{6}	-.126	.022	-5.558	<.001		
SCT	β_{7}	.066	.025	2.669	.018		
SIOS Positive Interaction – During Activity							
Intercept	β_{00}	.530	.061	8.690	<.001	.011	.061
Condition	β_{01}	.580	.122	4.762	<.001		
Positive Interaction (pretest)	β_{1}	-.119	.125	-.949	.36		
FSIQ	β_{2}	.003	.002	1.433	.172		
ADOS	β_{3}	.029	.011	2.555	.02		
CABS	β_{4}	.008	.009	.846	.411		
DMQ	β_{5}	.011	.005	2.303	.036		
SIPS – Face	β_{6}	-.059	.018	-3.225	.006		
SCT	β_{7}	.057	.030	1.873	.081		

SIOS = Social Interaction Observation Scale. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. SIPS – Face = Z-score of N170 ERP latency to emotional faces. SEL = Stories from Everyday Life – Mental Inference. SCT = Social Creativity Task.

Table 11, continued
HLM Models Predicting Change in Quality and Quantity of Social Interactions Based on Main Effects of Social Knowledge and Performance-Related Variables

SIOS Low-Level Interaction – During Activity	**Parameter**	**Fixed Effects**				σ^2	τ
		Coefficient	**SE**	**T-ratio**	**p-value**		
Intercept	β_{00}	1.264	.010	12.696	<.001	.052	.152
Condition	β_{01}	.093	.199	.466	.647		
Low-Level Interaction (pretest)	β_{1}	.155	.255	.609	.552		
FSIQ	β_{2}	-.008	.003	-2.365	.032		
ADOS	β_{3}	-.039	.030	-1.277	.221		
CABS	β_{4}	-.013	.023	-.579	.571		
DMQ	β_{5}	-.011	.012	-.984	.341		
SIPS – Face	β_{6}	-.087	.039	-2.220	.042		
SCT	β_{7}	.080	.053	1.507	.153		
SIOS Total interaction – Post-test							
Intercept	β_{00}	2.124	.159	13.345	<.001	.081	.413
Condition	β_{01}	.040	.318	.127	.900		
Total Interaction (pre-test)	β_{1}	.631	.363	1.738	.103		
FSIQ	β_{2}	-.016	.008	-1.975	.067		
ADOS	β_{3}	-.035	.027	-1.293	.216		
CABS	β_{4}	-.018	.024	-.723	.481		
DMQ	β_{5}	-.023	.011	-2.132	.050		
SIPS – Face	β_{6}	-.108	.046	-2.376	.031		
SCT	β_{7}	-.012	.097	-.127	.901		

SIOS = Social Interaction Observation Scale. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. SIPS – Face = Z-score of N170 ERP latency to emotional faces. SEL = Stories from Everyday Life – Mental Inference. SCT = Social Creativity Task.

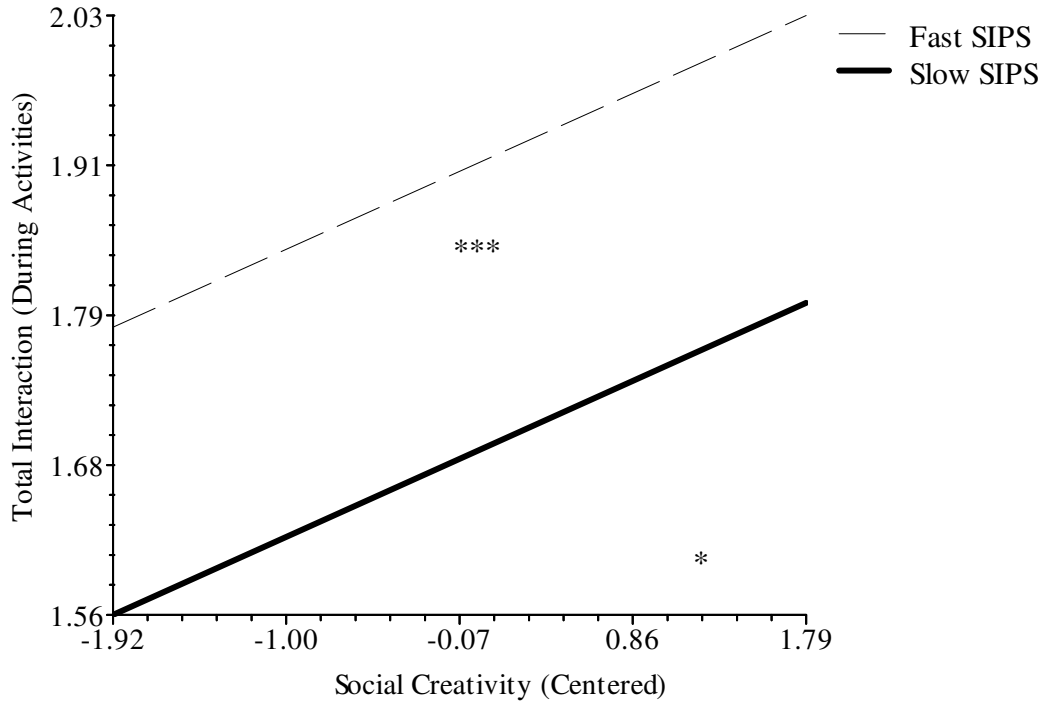

Figure 14. * $p < .05$, *** $p < .001$. SIPS = Social information Processing Speed (i.e. N170 latency). Regression plot demonstrating concurrent main effects social creativity and SIPS on increases in Total interaction *during* activities, across conditions. Model controls for IQ, ASD symptom severity, pre-test Total interaction, condition assignment, social knowledge, and social motivation.

Hypothesis 3 – Interactions between Knowledge- and Performance-Related Variables and Training Condition

After controlling for IQ, ADOS score, pre-test values, condition assignment, social knowledge, and the social performance-related variables (DMQ, SCT, and SIPS), interactions between condition and the knowledge and performance-related variables did not predict change in Theory of Mind (SEL; all $p > .12$) or facial emotion recognition (DANVA-2 Faces; all $p > .47$). They also did not predict change in Positive interaction (all $p > .12$), Low-Level interaction (all $p > .08$), or Total interaction (all $p > .14$) from pre-test to post-test.

However, after these controls, there was a small ($\Delta R^2 = .06$) interaction between social creativity and condition assignment in predicting vocal emotion recognition (DANVA-2 Voices; see Table 12). Post-hoc probing indicated that social creativity was not related to change in vocal emotion recognition in the social knowledge-training condition ($\beta = .12$, $p = .59$), but that more social creativity predicted a relative decrease in vocal emotion recognition in the performance-training condition ($\beta = -.55$, $p = .01$; see Figure 15).

There was also an interaction effect between social creativity and condition assignment on change in Total interaction (see Table 13); this overall model effect (pseudo-$R^2 = .91$) and the Level 1 marginal effect of the interaction (pseudo-$\Delta R^2 = .94$) were large. Post-hoc probing indicated that, while there was no effect of social creativity on Total interaction in the performance-training condition ($\beta_7 = -.14$, $p = .10$), social

creativity was associated with a significant increase in Total interaction in the knowledge-training condition ($\beta_7 = .21$, $p < .01$; see Figure 16).

Additionally, there were significant interaction effects between social knowledge and condition assignment on change in Positive and Low-Level interaction during activities (see Table 13); these overall model effects (pseudo-$R^2 = .87$ and .73, respectively) and Level 1 marginal effects of these interactions (pseudo-$\Delta R^2 = .36$ and .44, respectively) were large. Post hoc-probing of the Positive interaction effect indicated that the slope of social knowledge predicting change in Positive interaction was not significantly different from zero in either the performance-training ($\beta_4 = -.02$, $p = .10$) or knowledge-training ($\beta_4 = .01$, $p = .58$) conditions; however, the direction of the beta weights suggests that greater social knowledge was associated with a relative increase in Positive interaction in the knowledge-training condition as compared to the performance-training condition (see Figure 17). Probing of the Low-Level interaction effect indicated that, while there was no effect of social knowledge on Low-Level interaction in the performance-training condition ($\beta_4 = -.01$, $p = .57$), it was associated was a significant decrease in Low-Level interaction in the knowledge-training condition ($\beta_4 = -.07$, $p = .01$; see Figure 18).

Table 12

Hierarchical Multiple Regression Predicting Change in Emotion Recognition in Voices (DANVA-2 Voices)

	Model 1			Model 2			Model 3			Model 4		
	B	se *B*	*B*	*B*	se *B*	*B*	*B*	se *B*	*β*	*B*	se *B*	*β*
DANVA-2 Voices Pre-test												
FSIQ	.89	.16	.75***	.90	.16	.76***	.89	.17	.75***	.94	.19	.79***
ADOS	.02	.05	.05	.01	.06	.03	-.01	.06	-.01	-.08	.07	-.21
	-.04	.22	-.03	-.03	.22	-.02	-.20	.26	-.12	-.26	.29	-.16
Condition				-1.11	1.47	-.09	-1.33	1.66	-.11	-24.89	17.35	-2.10
CABS							-.10	.12	-.14	-.33	.28	-.44
DMQ							-.22	.17	-.17	-.41	.24	-.31
SIPS - Voice							.12	.82	.02	.90	1.30	.15
SCT							-1.38	.84	-.22	-3.42	1.21	-.55**
CABS(int)										.24	.30	.85
DMQ(int)										.10	.37	.14
N100(int)										-1.56	1.67	-.19
SCT (int)										4.15	1.89	1.01*
Total R^2		.580			.588			.656			.740	
F for ΔR^2		13.350***			.565			1.172			1.633	

FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. SIPS – Voice = Z-score of N100 ERP latency to emotional voices. DANVA-2 Voices = Diagnostic Analysis of Nonverbal Accuracy-2 Voices module. (int) = interaction between Condition and specified covariate.

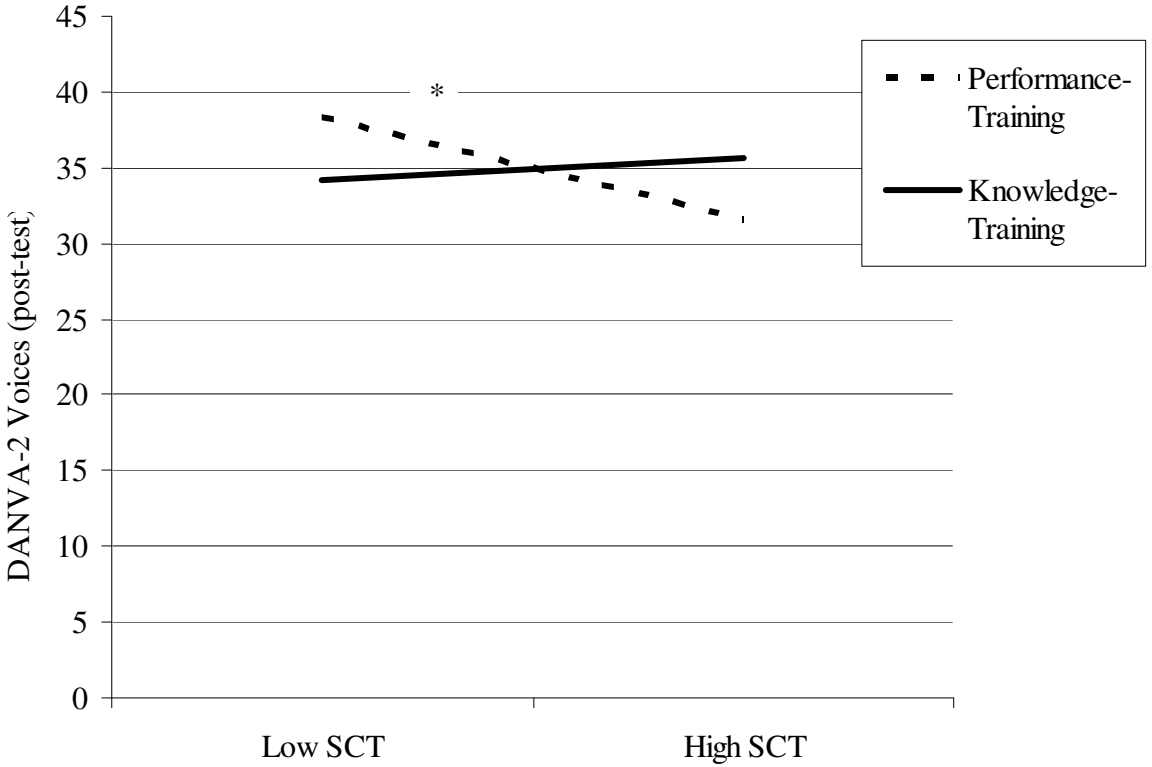

Figure 15. *$p < .05$. Interaction effect demonstrating that there is no effect of social creativity in the knowledge-training condition, but that greater social creativity predicted a relative decrease in vocal emotion recognition in the performance-training condition.

Table 13

HLM Models Predicting Change in Quality and Quantity of Social Interactions Based on Interactions between Condition Assignment and Social Knowledge and Performance-Related Variables

SIOS Total Interaction – During Activity	**Parameter**	**Fixed Effects**				σ^2	τ
		Coefficient	**SE**	**T-ratio**	**p-value**		
Intercept	β_{00}	1.793	.113	15.886	<.001	.007	.226
Condition	β_{01}	.673	.226	2.981	.009		
Total Interaction (pre-test)	β_{1}	.431	.142	3.034	.011		
FSIQ	β_{2}	-.024	.006	-3.847	.003		
ADOS	β_{3}	-.061	.022	-2.741	.019		
CABS	β_{4}	-.041	.012	-3.436	.006		
CABS x Condition	β_{41}	-.014	.012	-1.126	.284		
DMQ	β_{5}	.003	.005	.678	.512		
DMQ x Condition	β_{51}	.013	.010	1.289	.224		
SIPS – Face	β_{6}	-.125	.017	-7.560	<.001		
SIPS – Face x Condition	β_{61}	.010	.065	.156	.879		
SCT	β_{7}	.035	.024	1.442	.177		
SCT x Condition	β_{71}	.344	.114	3.011	.012		

SIOS = Social Interaction Observation Scale. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. SIPS – Face = Z-score of N170 ERP latency to emotional faces. SEL = Stories from Everyday Life – Mental Inference. SCT = Social Creativity Task.

Table 13, *continued*

HLM Models Predicting Change in Quality and Quantity of Social Interactions Based on Interactions between Condition Assignment and Social Knowledge and Performance-Related Variables

SIOS Positive Interaction – During Activity	**Parameter**	**Fixed Effects**				σ^2	τ
		Coefficient	**SE**	**T-ratio**	**p-value**		
Intercept	β_{00}	.530	.061	8.709	<.001	.006	.063
Condition	β_{01}	.581	.122	4.773	<.001		
Positive Interaction (pre-test)	β_{1}	-.082	.125	-.657	.525		
FSIQ	β_{2}	-.001	.005	-.270	.792		
ADOS	β_{3}	.018	.017	1.043	.319		
CABS	β_{4}	-.005	.012	-.445	.665		
CABS x Condition	β_{41}	.028	.011	2.569	.026		
DMQ	β_{5}	.013	.008	1.661	.125		
DMQ x Condition	β_{51}	.009	.014	.631	.541		
SIPS – Face	β_{6}	-.045	.018	-2.524	.028		
SIPS – Face x Condition	β_{61}	.032	.040	.812	.434		
SCT	β_{7}	.030	.027	1.109	.291		
SCT x Condition	β_{71}	.145	.119	1.220	.248		

SIOS = Social Interaction Observation Scale. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. SIPS – Face = Z-score of N170 ERP latency to emotional faces. SEL = Stories from Everyday Life – Mental Inference. SCT = Social Creativity Task.

Table 13, continued
HLM Models Predicting Change in Quality and Quantity of Social Interactions Based on Interactions between Condition Assignment and Social Knowledge and Performance-Related Variables

SIOS Low-Level Interaction – During Activity	**Parameter**	**Fixed Effects**				σ^2	τ
		Coefficient	**SE**	**T-ratio**	**p-value**		
Intercept	β_{00}	1.263	.099	12.722	<.001	.023	.166
Condition	β_{01}	.093	.199	.466	.648		
Low-Level Interaction (pre-test)	β_{1}	.161	.218	.736	.477		
FSIQ	β_{2}	-.025	.009	-2.786	.018		
ADOS	β_{3}	-.090	.031	-2.887	.015		
CABS	β_{4}	-.042	.020	-2.112	.058		
CABS x Condition	β_{41}	-.062	.016	-3.868	.003		
DMQ	β_{5}	-.025	.012	-2.122	.057		
DMQ x Condition	β_{51}	-.023	.023	-1.007	.336		
SIPS – Face	β_{6}	-.078	.036	-2.196	.050		
SIPS – Face x Condition	β_{61}	.098	.084	1.169	.267		
SCT	β_{7}	.060	.049	1.222	.247		
SCT x Condition	β_{71}	.347	.163	2.124	.057		

SIOS = Social Interaction Observation Scale. FSIQ = Full Scale IQ. ADOS = Autism Diagnostic Observation Schedule. CABS = Children's Assertive Behavior Scale. DMQ = Dimensions of Mastery – Social Persistence with Peers. SIPS – Face = Z-score of N170 ERP latency to emotional faces. SEL = Stories from Everyday Life – Mental Inference. SCT = Social Creativity Task.

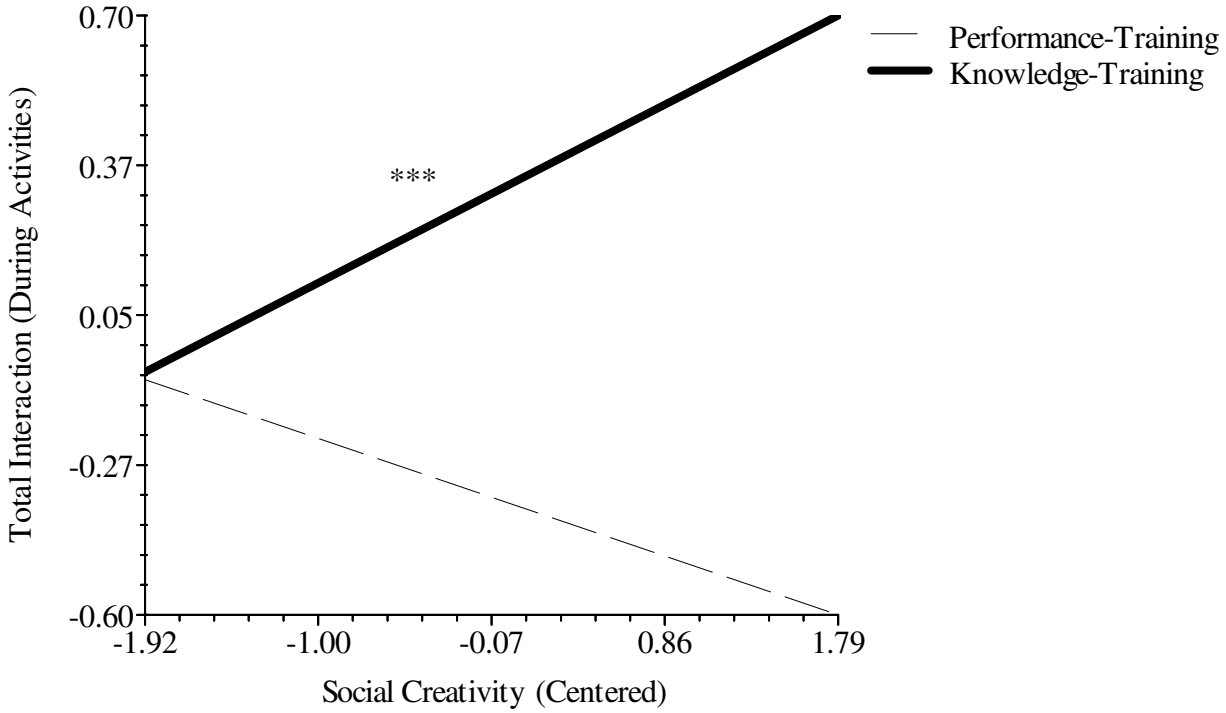

Figure 16. *** p < .001. Interaction demonstrating that social creativity had no effect on change in Total interaction in the performance-training condition, but was associated with a relative increase in Total interaction in the knowledge-training condition. Model controls for IQ, ASD severity, pre-test Total interaction, and all performance-related variables and interactions.

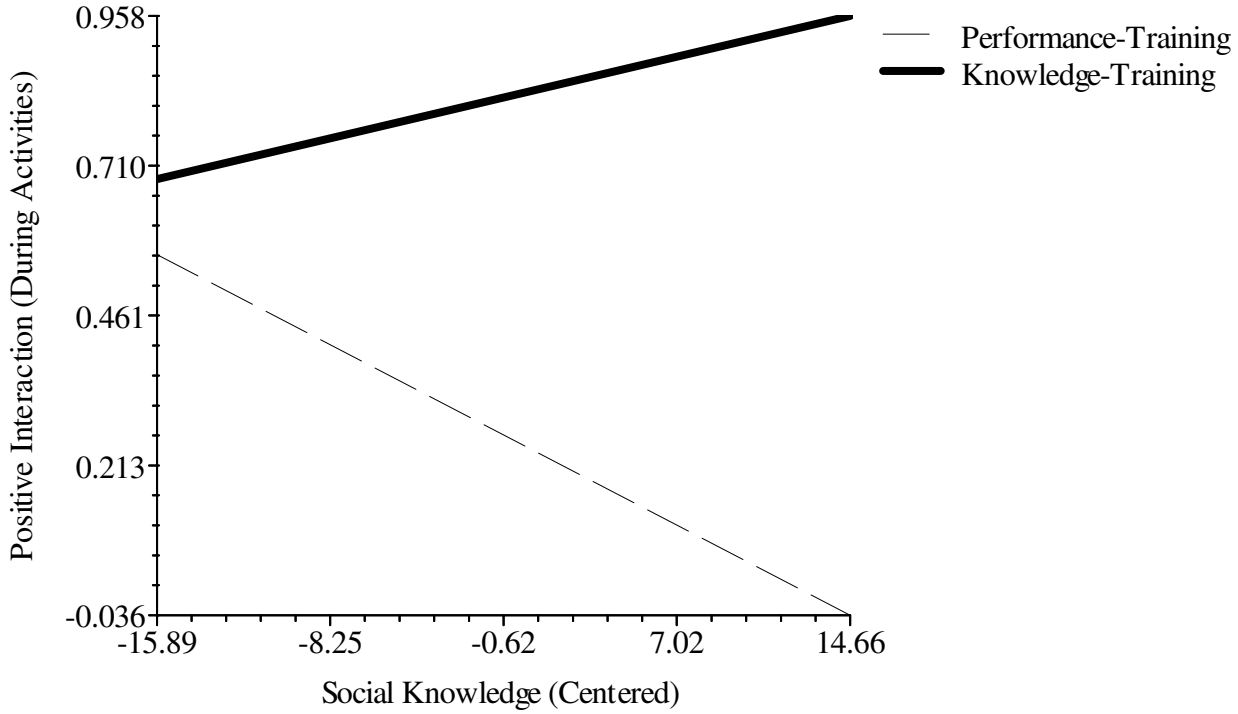

Figure 17. Interaction demonstrating that greater social knowledge presented a relative decrement in Positive interaction during training activities in the performance-training condition as compared to the knowledge-training condition. Model controls for IQ, ASD severity, pre-test Positive interaction, and all performance-related variables and interactions.

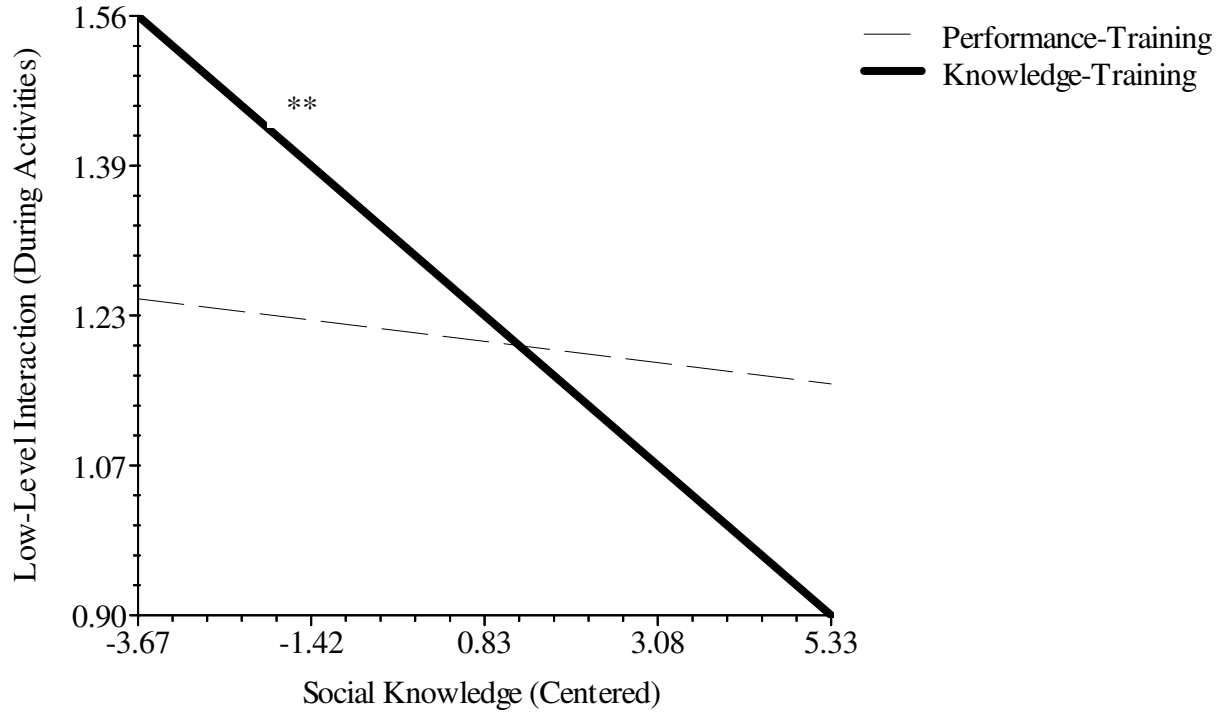

Figure 18. ** p < .01. Interaction demonstrating that social knowledge had no effect on change in Low-Level interaction in the performance-training condition, but was associated with a relative decrement in Low-Level interaction in the knowledge-training condition. Model controls for IQ, ASD severity, pre-test Low-Level interaction, and all performance-related variables and interactions.

Post-hoc: Effects of Past Intervention

Inclusion of current medication and previous intervention status (binary) and number of previous interventions (continuous) did not appreciably alter any significant results, except for reducing the main effects of social motivation and SIPS on change in Total interaction at post-test to non-significance (both $p > .27$); nevertheless, the effects of medication and past intervention status were themselves nonsignificant in this model (all $p > .15$). However, number of previous interventions was a significant predictor of change in Low-Level interaction at step 1 (controlling for FSIQ, ADOS, and pre-test Low-Level interaction) such that having had more previous social skills interventions predicted a decrease in Low-Level interaction during training activities ($\beta_6 = -.09$, $p = .04$).

Discussion

This study presents the first examination of proximal effects of brief social knowledge- and performance-training intervention modules on various social functioning outcomes among youth with HFASD. Participants were randomly assigned (in dyads) to each condition, with conditions successfully matched on all pre-test and demographic characteristics except for social knowledge (for which the knowledge-training condition was significantly higher than the performance-training condition at pre-test).

On average, regardless of training condition, participants demonstrated significant decreases in total interaction during training activities, as well as in positive interaction during and after training activities. However, controlling for IQ and ASD severity, those in the performance-training condition experienced large, significant increases in total and

positive social interaction during the training sessions relative to those in the knowledge-training condition. Thus, hypothesis 1, that performance-training would yield relatively greater increases in social outcome variables, was partially supported. This indicates that social performance-training strategies may represent preferred, fast-acting ingredients for promoting in-session peer interaction in youth with ASD. However, this evidence does not suggest that social performance-training strategies yield generalized effects. Given the brief length of these sessions, this also suggests that 20 minute sessions may not provide a sufficient dose of the intervention conditions, providing a "floor" for future studies.

In terms of hypothesis 2, that higher levels of social performance-related factors may promote responsiveness to opportunities for peer interaction regardless of condition assignment, youth with more social creativity demonstrated large increases in total social interaction during training activities, but small decreases in Theory of Mind. Additionally, those with faster SIPS demonstrated very large, robust increases in total, positive, and low-level social interaction during training activities, which generalized to total post-test social interaction. Furthermore, those with more social motivation demonstrated medium increases in positive interaction *during* training activities, but small decreases in total interaction *after* training activities. There was no relation between baseline social knowledge and change in outcomes. Thus, hypothesis 2 was partially supported, indicating a consistent (if short-lived) relation between performance-related factors and accumulative social behavior in the presence of peer interaction. This supports the finding in Study 2 that youth with ASD may experience primary

performance-related deficits, and suggests that performance-related factors measured here may help predict in-session response to existing intervention packages. However, aside from SIPS, they appear to not as effectively predict generalized effects.

This study also provides some support for hypothesis 3, the exploratory hypothesis that there may be a consonance (either positive, reflecting divergent learning styles, or negative, reflecting deficient "aptitudes" in the given domain) between baseline social knowledge and performance-related factors and response to knowledge- and performance-training interventions. Results for social knowledge supported the learning style model, as social knowledge at pre-test was associated with a large decrease in low-level (i.e. poor quality) interaction during training activities in the knowledge-training condition, as well as a relative increase in positive interaction during the knowledge- as compared to the performance-training condition. This indicates that those with more social knowledge came to engage in relatively more (and less poor) interaction when exposed to knowledge-training. Meanwhile, results for social creativity (a performance-related factor) also support the deficient "aptitudes" model. Youth with more social creativity (a social performance factor) received greater benefit from knowledge-training relative to performance-training, in the form of increased total interaction in session. Similarly, whereas youth with more social creativity were observed to *decline* in vocal emotion recognition in the performance-training condition, this decline was not evident in the knowledge-training condition. Taken together, these findings suggest that youth with more social creativity may have benefited more overall in the KT condition relative to the

PT condition. Overall, these findings provide clues for matching participants to optimal treatment conditions based on pre-test variables.

Social Depletion in ASD

Overall, the finding that participants interacted less over time, regardless of condition, suggests that engagement in unstructured social interaction and social training activities appears to deplete resources for social behavior in youth with ASD. This finding bears considerable attention, as the activities used in this study are highly representative of those used in "real world" social skills interventions. Thus, even activities otherwise designed to promote social interaction in youth with ASD may rapidly and sharply tire participants. This is consistent with lay theories of ASD suggesting that they are especially easily exhausted by social behavior (e.g., Attwood, 2008). It is also consistent with the social motivation model, which posits that social interactions are less rewarding for individuals with ASD (Chevallier et al., 2012); in the absence of such reward processes, sustained social interactions may become increasingly tiring to maintain. However, little previous empirical work has demonstrated this effect over time. Thus, results of this study demonstrating effects on change in observed social interaction (either via condition assignment or levels of pre-test variables) may be seen as revealing compensatory and buffering factors that prevent or slow this depletion process and allow individuals with ASD to sustain more effective social behavior and social learning.

It is notable, then, that those in the performance-training condition did not experience the same degree of decreases in total and positive social behavior during

training activities as compared to those in knowledge-training. In some ways, this represents a simple manipulation check on condition assignment, as the performance-training activities were meant to be more active (i.e. playing games as opposed to didactically learning). This nonetheless suggests that observed in-session effects within larger treatment packages (Barry et al., 2003; Matson et al., 2007) may be attributable to social performance-training components. Finally, it indicates that, social performance-training may represent a buffer against social depletion in ASD.

Social Knowledge and Performance-Related Factors as Predictors of Change

Turning to predictor variables, it is notable that, as in Study 2, social knowledge did not produce greater increases in social interaction, Theory of Mind, or emotion recognition when children were given opportunities to interact with peers, regardless of condition. This partially supports Hypothesis 2, as it indicates that more social knowledge does not promote a "snowballing" effect in the presence of opportunities for social interaction. However, more social knowledge did appear to suppress low-level interactions and marginally encourage positive interactions in the knowledge-training condition. This supports the hypothesized consonance via learning styles between training modules and pre-test factors. That is, it appears that those with more intact social knowledge may have benefitted from a system of explaining rules that matched their learning style. However, these benefits did not appear to generalize beyond the training session. As such, youth with more social knowledge may not necessarily experience relative benefits from existing social skills intervention packages.

In terms of social motivation, regardless of condition, those who were more motivated engaged in increased positive interaction *during* activities, but decreased total interaction *afterwards*. This suggests that their motivation may have been able to successfully propel them to take advantage of opportunities for prosocial interaction during training activities, irrespective of what those activities were; they may have simply been especially primed to take advantage of the chance to interact with their peers in a supported environment. Thus, at least briefly, social motivation may have potentiated the hypothesized "snowball" effect. However, these results also suggest that this engagement may have been especially tiring for them, leading to relatively greater social exhaustion in the generalized setting. As such, youth with more social motivation are also not likely to experience relative benefits from existing social skills intervention packages.

Those with higher social creativity may have experienced a similar overall effect in terms of their increased total interaction *during* activities, but decreased Theory of Mind *afterwards*. That is, they may have been able to use their capacity to generate a varied social repertoire to capitalize on social training activities in both conditions (i.e. the "snowball" effect); however, doing so may have led to a social-cognitive "burn-out," yielding their decrement in Theory of Mind. This may also explain the condition-specific effects in performance-training. That those with higher social creativity experienced decreased emotion recognition in voices in performance-training may be because performance-training allowed them to use their creative repertoire more readily, leading to a more rapid "burn-out" in their emotion recognition. On the other hand, social creativity appeared to facilitate more interaction during knowledge-training activities.

This was, however, the condition that demonstrated considerably less total interaction overall. Thus, the richer social environment of performance-training may have, among those with high social creativity, precluded the need to employ effortful strategies to proactively seek out more interaction; conversely, these same participants may have worked harder to produce more social behavior in the more impoverished knowledge-training condition. Overall, the Aptitude x Treatment findings for social creativity are complex, but tend to support a model wherein there is a deficit consonance (i.e. greater deficit in a performance-related factor predicted better response in the performance-training condition).

Conversely, faster SIPS was robustly related to more total social behavior during and after activities. Thus, it provided perhaps the best predictor of generalized social interaction (regardless of training condition) of all variables studied here. It may be, then, that the ability to rapidly and efficiently process social information is an especially crucial ability to help youth with ASDs experience the hypothesized "snowball" effect and benefit from existing social skills training packages. This is an important finding for several reasons. First, it is among the first studies to relate a basic neural marker of social perception to online social behavior in individuals with ASD, a crucial step in the development of interventions for this population (Lerner, White, et al., in press; McPartland & Pelphrey, in press). Second, the early ERPs used to index SIPS are *obligatory* (automatic, prior to voluntary or effortful, not cognitively-mediated) posterior processes underlying social perception (see Nelson & McCleery, 2008), while the other variables less consistently related to increases in social behavior or cognition (social

knowledge, motivation, and creativity) are more *effortful* (cognitively-mediated, likely prefrontal) processes. As such, it appears that, as in other work that contrasts effortful, prefrontal with more obligatory, posterior neural processes (Cabeza & Nyberg, 2000; Sarter, Gehring, & Kozak, 2006), effortful, attentionally-mediated processes are especially easily "burned-out" and exhausted; this is notable given systematic abnormalities (and consequent inefficiencies) found in prefrontal networks in individuals with ASD (Courchesne & Pierce, 2005), in contrast with otherwise structurally intact (though functionally abnormal) posterior brain regions (Pelphrey et al., 2007). Promisingly, recent research suggests that such obligatory electrophysiological processes may indeed be amenable to intervention in this population (Faja et al., 2012). Thus, these findings suggest that more value may be achieved from targeting and capitalizing on these systems as a means of facilitating more enduring, effective social interactions in the context of social skills interventions.

Additionally, while only exploratory, the post-hoc probing effect of previous intervention experience was intriguing. It suggests that having received more social skills interventions may have lead participants to demonstrate decreased low-level interaction during training activities. This is a somewhat mixed finding. On the one hand, less low-level interaction (without a concomitant increase in total or positive interaction) may be seen as negative, as it indicates that participants did not engage in as many behaviors reflecting an attempt to interact (even if it may have been a poor-quality attempt). Thus, those with more intervention experience may more easily give up on interacting with peers during intervention activities. On the other hand, since low-level interactions reflect

poor-quality social bids, perhaps those with more previous intervention experience had learned that they should not engage in low-level interaction behaviors during social skills activities (but yet had not learned what alternate behaviors they should use instead). Thus, past interventions may have succeeded for these participants in reducing their less effective social behaviors in hopes that they could then learn to replace them with more effective behaviors. Importantly, though, these inferences are highly speculative, as I did not take data on type or length of these previous interventions. However, future research should examine such factors more closely, as well as whether they may provide insight into whether participants may be best "matched" to a given condition based on their previous intervention experience.

Limitations

This study has several limitations that bear mentioning. First, the training sessions under investigation, while designed to be conservative and "pure" versions of each condition, were only 20 minutes. Thus, while this study aimed to address the modular structures of social skills interventions, the considerably longer duration of even the shortest interventions (see Lerner & Mikami, in press) limits generalization of these findings. Future research should vary the length of such conditions to see whether longer administrations begin to approximate the effects found in larger treatment packages. Second, there was no control condition where children did not receive any training activities. Thus, while this study permitted comparison between components of social skills interventions via a dismantling approach (Kiesler, 2004), it did not provide insight into whether condition-specific changes in social behavior and cognition were different

than those that would be seen in the absence of any putative intervention. Third, it is not certain that the conditions optimally differentiated between knowledge- and performance-training approaches. Future research should employ observational coding of community- and clinic-based interventions to better identify conditions that maximize these differences. Fourth, the presence of only one peer (especially one who also had ASD) also affects generalization of results. While the construction of all-ASD social skills groups is common in the intervention literature (Lerner, Hileman, et al., in press; Rao et al., 2008; White et al., 2007), these groups usually contain at least four participants. Additionally, while the presence of another child with ASD was designed to produce "purer" effects (i.e. in the absence of social prompting or modeling from TD peers), it limits the ability to determine whether the training conditions improved youths' ability to pick up on and respond to such prompting when it was present. Future research would be well-served to examine whether differing training conditions improve youths' responsiveness to TD peers. Fifth, the sample size was somewhat small for the statistical procedures used here. Thus, there is a possibility of Type II error, especially with the interaction effects. Finally, the somewhat narrow age range, in conjunction with known developmental trajectories associated with the variables under investigation here (both predictors and outcomes), limits generalization of these findings beyond adolescence.

Clinical and Theoretical Implications

Overall, however, this study has important implications for social skills and intervention research. First of all, it suggests that minimizing "social fatigue" may be a crucial goal of social skills interventions, as it appears that reductions in spontaneous

social interaction may set in within a very brief period of time. Speculatively, it may be valuable for future research to consider self-regulatory processes in individuals with ASD as possible moderators of this effect (i.e. some youth may be able to "slow themselves down" to modulate this fatigue). Second, it appears that social performance-training activities may provide a better venue in which to achieve this goal, as social knowledge-training may exacerbate (or performance-training may mitigate) the observed decrement in positive behavior during session. Thus, even in knowledge-focused interventions, interspersing of performance-training activities may bolster youths' ability to access intervention content. Third, it appears that, greater *a priori* social knowledge may actually help youth to capitalize on interventions that are knowledge-focused, yet only for the duration of the provided intervention. This finding may help explain the inconsistent (often treatment setting-specific) effects of social skills interventions that largely focus on social knowledge-training (Matson et al., 2007; White et al., 2007), as differences in pre-existing knowledge found here may have permitted some participants to demonstrate skills in-session, while others could not. Meanwhile, the lack of generalized social behavior and learning in the knowledge-training condition accord well with the larger literature suggesting that content-specific training may have little effect on targeted outcomes of complex behavior (Hambrick & Meinz, 2011).

Fourth, it appears that social performance-related variables (i.e. social creativity and motivation) may produce short-term benefits (via a "snowball" effect) but longer-term drawbacks, as they may lead to accelerated social depletion when participating in training activities. That they appear to elicit these short-term gains, however, is

promising, and suggests that interventions may benefit from identifying and cultivating such creativity and motivation, while simultaneously helping youth with ASD to be more planful and measured in their execution. Thus, this provides a novel direction for improved intervention content and structure.

Finally, this study found that the speed of an obligatory perceptual neural response to social input may be a uniquely powerful predictor of ability to capitalize on social interaction in this population – regardless of training type. While running somewhat contrary to the goals of identifying condition-specific differences in this dismantling study, this finding is nonetheless exciting for intervention. Not only does it identify one of the first neural predictors of change in complex social behavior in individuals with ASD, it suggests that this predictor may help participants benefit from already-existing interventions, which include both knowledge- and performance-training components. That this component may be directly amenable to intervention itself (Faja et al., 2012) is especially exciting, as it points the way towards future behavioral intervention research that capitalizes on enduring capacity for neuroplastic change in youth long past putative critical periods (Bryck & Fisher, 2012; Lillard & Erisir, 2011; McPartland & Pelphrey, in press).

In sum, this study provides an important step forward for social skills intervention and theory. It identifies both perceptual (SIPS) and cognitive (social knowledge, motivation, and creativity) predictors of change in social behavior and cognition. It also specifies that these predictors may produce change in response to opportunities for peer interaction, and in response to specific brief training conditions. These results begin the

process of empirically disentangling the array of factors that may facilitate complex social behavior in youth with ASD (Koenig et al., 2009), and provide direction for intervention research to target, optimize, and improve treatments for social deficits.

General Discussion

This investigation represents the first multi-method examination of the relative role of social knowledge and performance-related variables in both describing social deficits in ASD populations and constructing interventions. Through three studies, it addressed the role of several novel performance-related predictors (social creativity, social motivation, and SIPS), as well as a direct measure of social knowledge, in predicting social functioning in a well-characterized sample of youth with HFASD according to several key outcomes (observed social interaction, Theory of Mind, emotion recognition). These assessments were taken both cross-sectionally and after brief knowledge- and performance-training conditions. This design permitted the examination of change over a brief window of time, as well as whether such change differed according to training conditions. As such, this investigation allowed for robust examination of the hypothesis, underlying the majority of social skills interventions for ASDs (White et al., 2007), that deficits in social knowledge represent the core problem impeding competent social functioning. It also permitted fine-grained analysis of the proximal efficacy of brief training sessions designed to train either social knowledge or performance-related factors.

In terms of broad effects of these training sessions, it was found that, while participants overall decreased in their interactions across the study paradigm, those in the performance-training condition showed relatively less decrease in total and positive interaction *during* training sessions relative to those in the knowledge-training condition. This is consistent with the theory that performance-training interventions provide somewhat more “enriched” social environments, facilitating greater in-session peer interaction (Lerner, Hileman, et al., in press; Lerner & Levine, 2007); this also suggests

that it may be fruitful to consider that the process by which performance-training activities effect more enduring change in longer interventions (Legoff & Sherman, 2006; Lerner et al., 2011) may indeed accord with neuroplastic models of learning and intervention (Bryck & Fisher, 2012; Lillard & Erisir, 2011; Robertson & Murre, 1999; Rosenzweig, 2007). However, neither condition demonstrated generalization of effects to post-test unstructured social interaction or change in Theory of Mind or emotion recognition; this is somewhat unsurprising, as even four 90-minute sessions of these conditions failed to produce generalized results (Lerner & Mikami, in press). This result suggests that these brief, "pure" 20 minute sessions may not provide a sufficient dose to produce change in generalized social behavior or social-cognitive processes, providing a "floor" for future intervention research to consider. Nonetheless, it suggests that, in terms of providing sustained opportunities for positive interactions with peers, social performance- and knowledge-training components of existing intervention can be meaningfully differentiated. Further, that the social performance-training condition did appear to present an "enriched" social environment suggests that it may be responsible for observed effects on in-session behavior in larger intervention packages (Kransny et al., 2003; Matson et al., 2007).

In terms of the effects of target variables across studies, I turn first to social knowledge. This ability to "know the right thing to do" evinced no main effects across studies. Indeed, though there was no direct TD comparison group, examination of TD youths' performance in past studies on the social knowledge measure used in the present investigation (Maedgen & Carlson, 2000; Wojnilower & Gross, 1988) suggests that a

large proportion of youth with HFASD in this sample did not evince social knowledge deficits.

However, social knowledge did appear to exert a modulatory influence on other variables, as in its moderation of SIPS such that SIPS predicted vocal emotion recognition among those with relatively greater knowledge. Additionally, interventions designed to train social knowledge provided a poorer environment for *in vivo* interaction; however, this somewhat impoverished environment may be partially ameliorated by individual differences in social creativity and social knowledge itself. Thus, there is some evidence that a subset of youth may experience a "match" with this training condition (i.e. an Aptitude x Treatment interaction; Smith & Sechrest, 1991) as well as some evidence that social knowledge may help other variables facilitate skilled social behavior. That said, this investigation provided no evidence for a pure social knowledge deficit in youth with HFASD.

In terms of SIPS, this investigation represents the first time an EEG-indexed neural process has been comprehensively examined with reference to a wide array of social outcomes. Study 1 found that SIPS appears to be a truly multimodal (face and voice perception) perceptual construct that can predict intact emotion processing more effectively than subsequent evaluative neural processes. In Studies 2 and 3, not only did this effect hold, but it was also found that faster SIPS predicted increased social interactions, even in unstructured interaction. These results suggest that SIPS may allow individuals to "catch" and key into opportunities to interact successfully with others. Indeed, these studies paint a picture of SIPS as a very important variable for subsequent

study, as it appears to represent a predictor requiring little prefrontal resource expenditure in positive social functioning in HFASD populations.

Social motivation produced more mixed results across studies. Specifically, it predicted poorer emotion recognition, more low-level interaction, and brief increases in positive interaction during structured activities, but decreases in total interaction afterward. This suggests, then, that those youth with HFASD with more social motivation either initially work harder to interact, but then "burn out" or deplete over time, or benefit from the structure of the activity-based interaction setting more than from opportunities for unstructured interaction. Either way, at least as measured here, social motivation may represent a variable that, without the clear scaffolding of highly structured interaction, may lead to poorer interactions and missed opportunities for social learning.

Social creativity also presented mixed findings. Specifically, those with higher social creativity demonstrated increased interaction during training activities (especially during knowledge-training activities). Thus, youth with HFASD with more social creativity may have the ability to create more novel opportunities for themselves to interact with peers, and may use this ability to compensate for the more structurally-limited social opportunities in knowledge-training. However, high-creativity youth also demonstrated decreased Theory of Mind over time; thus working hard to find opportunities to interact might deplete their social-cognitive abilities. They also demonstrated decreased emotion recognition in performance-training; hence, this depletion effect may be especially the case in performance-training, where such "burn-out" may lead to poorer emotion recognition. However, overall, as this is the first

investigation of social creativity in this population, these results suggest that this is a variable of importance to HFASD social functioning that bears further investigation.

Social Knowledge vs. Performance - Revisited

Turning now back to Gresham's (1997) taxonomy, I now consider whether this investigation provides evidence for a primary social knowledge deficit as the source of social dysfunction in ASD populations, as suggested by much of the intervention literature (Laugeson et al., 2009; Matson et al., 2007). Considering that no analyses found significant main effects for social knowledge, it appears that, at least as measured in the present sample, the primary social knowledge deficit model is not supported for HFASD. Indeed many participants with HFASD often do seem to "know what to do."

Overall, performance-related variables (especially basic SIPS) appear to exert a much stronger influence on multiple indicators of social functioning. However, social knowledge does appear to exert a top-down (i.e. requiring cognitive effort) influence both concurrently and prospectively on these variables. As such, it is not simply the case that social knowledge is irrelevant to social functioning for ASD populations. Rather, it appears that social knowledge should be considered in tandem with performance-related variables in attempting to describe and remediate social functioning in this population.

It may be, then, that accounts of lack of social knowledge may be artifacts from when ASD more generally was characterized by poorer verbal ability (Carter et al., 2005). Conversely, it may be that "not knowing what to do" represents an intuitively-appealing way to characterize social functioning among HFASD individuals who otherwise appear to have intact social abilities; indeed, such an approach leads to

considerably more straightforward intervention design ("just make sure they know what to do!"), as evinced by the knowledge-training condition employed here. Nonetheless, just as the knowledge-deficit supposition was jettisoned a decade ago (Maedgen & Carlson, 2000) in the ADHD literature to make way for more effective predictors of social functioning in that population, so too may this deficit ultimately been seen as an overly-simple approach to describing problems in a complex domain of functioning (Koenig et al., 2009). Thus, in future research, it will be fruitful for models of social functioning in ASD to directly consider the factors that impede execution of known social behavior in this population, rather than simply contend that youth with ASD lack the knowledge of those behaviors. Likewise, interventions should consider whether they are providing youth with ASD knowledge they already have, as well as whether provision of said knowledge is truly doing them good.

Theoretical Models of Social Functioning in ASD

How, then, do these findings accord with other existing models of social functioning in ASD? One may first consider the Hacking Hypothesis (Dissanayake & Macintosh, 2003), that youth with HFASD have "hacked out" something that looks like social-cognitive ability, but does not function as fluidly as it does for TD peers. Based on this hypothesis, one may predict that youth with HFASD would a) display relatively intact knowledge of what to do in certain social scenarios, but that this knowledge would not relate to display of competent social behavior with peers, and b) social-cognitive outcomes (e.g., Theory of Mind) would not be predicted by factors that otherwise would be thought to do so. The first criterion is supported by these data, as many youth with

HFASD appeared to have intact social knowledge, but this did not seem to relate to use of that knowledge to produce fluid interactions with peers. Additionally, participants varied in the degree to which they displayed intact Theory of Mind as compared to peers, but (cross-sectionally) this did not seem to relate to factors (e.g., rapid SIPS; social motivation) that might be expected to undergird it. Thus, one may conclude that these data preliminary support the Hacking Hypothesis. Conversely, considering emotion recognition as a social-cognitive outcome, the strong relationship with SIPS suggests that, at least in this domain, less deliberatively "hacked" (i.e. more automatic, obligatory) social-perceptual processes may undergird some domains of social functioning in ASD.

I now consider the attentional hypothesis (Jeste & Nelson, 2009), which suggests that youth with ASD do not preferentially attend to social stimuli, and that the degree to which this is the case is predictive of social outcomes. As SIPS was the best index of such selective attention (i.e. how quickly do individuals with ASD attend to a face and "pick up" that it is indeed a face), it may be used to consider this hypothesis. With the robust SIPS effects in mind, this investigation appears to provide somewhat strong support for this hypothesis. That is, those for whom social information does not "catch" their attention appear to do poorer on emotion recognition tasks.

The attentional hypothesis may also be seen as a component of the larger social motivation hypothesis (Chevallier et al., 2012; Dawson et al., 2005). The social motivation hypothesis suggests that youth with ASD fail to be sufficiently engaged by social stimuli (and, downstream, are not motivated to engage in interaction). Thus, social information may fail to capture their attention because they are not motivated by it.

Prima facie, it appears that these results fail to directly support this hypothesis, as social motivation (as measured here) did not positively relate to most outcomes, and even seemed to predict poorer performance. However, as noted in Study 2, this may be a measurement issue, as the present tool (the DMQ) appears more likely to measure social *persistence*. The social motivation hypothesis, on the other hand, also suggests a much more basic failure to be engaged (i.e. aroused) by social information. With this in mind, similar to the attentional hypothesis conclusion (above), the SIPS results may be seen as a secondary indicator of this impaired engagement. That is, failure to be engaged (motivated) by social stimuli may make one less selectively attentive and alert to such stimuli, leading to a failure to quickly "catch" faces and voices when they appear (i.e. SIPS); thus, slower SIPS may provide a clue that basic social motivation is impaired (Dawson et al., 2005). Likewise, the depletion effect experienced by participants over time also provides some support for this model, as underlying reward processes do not appear to allow social behavior to beget more social behavior ("snowball") among youth ASD, as seen in TD youth.

Enactive Mind. What, then, can one make of the fact that each of the above hypotheses is lent some support by these findings? One approach is to identify and elaborate a comprehensive model that contains features of each of the above hypothesis. The concept of the Enactive Mind (Klin et al., 2003; Klin et al., 2005) presents just such a model. The Enactive Mind model is based in the notion of embodied social cognition (De Jaegher, Di Paolo, & Gallagher, 2010; Gallese & Sinigaglia, 2011) – that human social-cognitive processes (and consequent social behavior) arise from basic processes of

physical (including visual and auditory) interaction with the world, and that these basic processes are derailed early on in ASD. This model subsumes the attentional hypothesis, as it suggests that failure to selectively attend to and be motivated by normative social information arises from earlier difficulties assessing *relevant details* of social information. For instance, Klin, Lin, Gorrindo, Ramsay, and Jones (2009) showed that very young children with ASD were more drawn to *motion* – rather than *social/emotional* – cues in visual scenes. While the Klin et al. study does not provide information on whether this focus on socially irrelevant details arises from aversion to emotional cues, lack of arousal in their presence, or some other factor, it remains consonant with the social motivation hypothesis (since the results could plausibly be explained by lack of arousal in the presence of social stimuli; Chevallier et al., 2012). Next, the Enactive Mind model also suggests that seemingly intact performance on cognitively-mediated Theory of Mind tasks among individuals with ASD emerges from the ability to use intact cognitive abilities to cobble together appropriate answers, even in absence of the correct underlying automatic processes. This is, of course, remarkably similar to the Hacking Hypothesis. Finally, the Enactive Mind model also predicts that when youth with ASD do know what to do in a given scenario, their inefficiently-derived (i.e. "hacked out") models of social behavior may yield difficulties in fluid application of social knowledge to interactions with others (Koenig et al., 2009).

The Enactive Mind model, then, accords well with these findings. Most clearly, the SIPS findings provide a somewhat direct assessment of the purported mechanism of this model. That is, youth with slower SIPS may simply be those who fail to attend to

socially-relevant facial features, and instead naturally attend to irrelevant details (Dawson et al., 2005; McPartland et al., 2011; Pelphrey et al., 2002). Thus, the robust relationship between SIPS, emotion recognition and increased social behavior seems to suggest that those who do attend to more socially-relevant details exhibit substantial benefits in terms of social cognition and behavior; indeed, that SIPS was even able to distinguish between intact and impaired subgroups in Study 1 further supports this interpretation. Second, there does indeed appear to be a disconnect between social knowledge and behavior in this sample inasmuch as there is little univariate relation between social knowledge and social outcomes. This model also helps explain the social motivation findings, as if youth are not attending to the correct details, then their motivation (or persistence) may point them in the wrong direction (i.e. towards the wrong details), and thereby impede them from learning emotion-related information (e.g., emotion recognition). This model is also useful for augmenting the social motivation hypothesis to explain the observed social depletion effects. For instance, if youth with ASD fail to attend to the correct social information, then they may not, on average, be capturing the information that would be propulsive, motivating, and enriching, even if they would otherwise be appropriately engaged by it. That this failure to be engaged by opportunities to interact with peers appears to be ameliorated somewhat by participating in activities designed to draw attention (not just knowledge) to rewarding social behaviors lends further support to this explanation, as well as to a purported mechanism of performance-training intervention.

That positive interaction appears to be affected negatively by approach-related variables (i.e. variables that theoretically reflect a tendency to advance rather than

withdraw or stay neutral in a social situation; Dawson et al., 2005) such as social creativity and motivation accords with the Enactive Mind model as well. These variables may, again, push children to interact more, but do so in a way that leads them to continue to miss critical inputs (and, consequently, social opportunities). Additionally, that top-down processes (i.e. cognitively-involved processes such as knowledge and creativity) led to relatively more – and less poor – interactions in the knowledge-training condition also makes sense, especially in light of the overall greater amounts of interaction during performance-training. That is, these processes may accord with the explicit nature of knowledge-training to help youth with HFASD to "hack together" a somewhat appropriate behavioral response despite failing to naturally attend to correct cues. However, doing so appears to primarily help in enactment of "correct" behaviors during structured interaction opportunities, not improved ability to actually identify social cues to exhibit greater emotion recognition or positive interaction during unstructured times. Conversely, such top-down processes may actually interfere with a condition designed to facilitate rapid, selective attention to social cues (performance-training), leading to poorer emotion recognition and relative decreases in positive interaction. Thus, future studies examining the relation of knowledge- and performance-training to variables identified in the Enactive Mind model (i.e. eye-tracked attention to incorrect social variables; Klin et al., 2003; Klin et al., 2009) would be valuable for further assessing the plausibility of this promising framework.

Implications for Larger Models of Social Functioning

How do these results accord with larger models of social functioning beyond ASD populations? I consider here the SEL and SOCIAL models (Beauchamp & Anderson, 2010; Lipton & Nowicki, 2009; McKown et al., 2009).

The SEL model suggests social knowledge, Theory of Mind, and emotion recognition, predict prosocial behavior; it also suggests that self-regulation may play an adjuvant role (McKown et al., 2009). This investigation provides mixed support for the SEL model in this population. These results demonstrate no correlation between these variables (social knowledge, Theory of Mind, and emotion recognition) and social interactions, suggesting that these processes may be more disconnected in ASD relative to other populations. Perhaps, then, different rates and trajectories of development of these skills in youth with ASD lead to their dissociation over time, again as predicted by the Hacking Hypothesis (Dissanayake & Macintosh, 2003) and Enactive Mind model (Klin et al., 2003). However, the SEL model also implicates self-regulation in social functioning. As speculated in Study 3, it may be valuable to consider self-regulation as a factor to help mitigate the observed depletion effects I observed in the presence of social interaction. While this possibility clearly requires further study, the potential value of self-regulation for social behavior in youth with ASD, along with its role in the trans-diagnostic SEL model, suggest that it may be a key variable of consonance in the development of social functioning in youth with ASD and other populations with social deficits.

SOCIAL predicts reciprocal effects between neural markers (such as SIPS) and social cognitive and behavioral functioning (Beauchamp & Anderson, 2010). Certainly,

the robust impact of SIPS across studies supports this component of SOCIAL. However, the applications of so-called social-communicative and social-emotional aspects of this model are less clear. For instance, SOCIAL predicts that there are reciprocal relationships between factors such as emotion recognition, Theory of Mind, social cognition, executive functioning, and more basic abilities such as joint attention, and that all these add up to skilled social functioning. The data presented here cannot inform this possibility. Nonetheless, they do support a relationship between social-cognitive abilities (e.g., social knowledge, social creativity) and outcomes across these domains (emotion recognition, Theory of Mind, skilled social behavior). However, SOCIAL omits potentially important arousal-related variables such as social motivation in predicting social interaction. That these seem crucial for individuals with ASD (if not always in the expected directions) suggests that further research is needed to assess whether the comprehensive SOCIAL model is applicable to this population, or if, in support of the social motivation model (Chevallier et al., 2012), such social arousal-related variables are uniquely important for ASD populations.

Implications for Intervention

This investigation has several implications for social skills interventions. As noted above, it suggests that, at least for HFASD youth in the age range of 9 to 16, social knowledge-training need not be a core component of intervention. Rather, a focus on addressing and remediating more basic deficits, such as SIPS, and on prioritizing highly engaging activities, may be warranted. The emergence of this focus highlights the promise of social learning being a neuroplastic process in ASDs (McPartland & Pelphrey,

in press). As such, then further consideration of social skills intervention research through the lens of neuroplastic approaches to intervention (i.e. enriched environments leading to altered neural mechanisms) may be fruitful. However, this investigation also suggests that youth with ASD are easily socially fatigued, and that engagement can only somewhat ameliorate this effect. Thus, it may be valuable to examine whether incorporating breaks into training sessions may be a simple, straightforward way to augment the effects of social skills interventions. This investigation also highlights the importance of assessing and targeting individual differences in pre-test knowledge and performance-related factors. Doing so can help to determine whether certain participants (i.e. those with faster SIPS) are likely to be "responders" regardless of condition. More importantly, this investigation provides some evidence that such pre-test assessment may allow for the identification of Aptitude x Treatment interactions (Smith & Sechrest, 1991), and creation of prospective treatment response and group composition profiles (i.e. social creativity facilitating more interaction when training social knowledge). Consideration of such profiles will aid in design and selection of more optimal treatments to improve social skills across outcome domains among children and adolescents with ASDs.

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Appendix A

Parent and Child Informed Consent and Assent Documents

Parent/Guardian Informed Consent Agreement
Please read this consent agreement carefully before you decide to participate in the study. Your child will also receive an assent form; please review the assent form with your child.

Purpose of the research study: The purpose of the study is to evaluate the ways in which adolescents with autism spectrum disorders (ASDs) understand social information and the way that understanding relates to their social behavior. Through the use of questionnaires, testing, structured activities, electroencephalogram (EEG), and videotape, we would like to investigate different ways in which adolescents with ASDs perceive and engage with their social world and respond to different activities meant to help them do so more effectively.

What your child will do in the study: Your child will attend two visits as part of this study. At the first visit, s/he will complete interactive and diagnostic activities totaling approximately 45 minutes. After the visit, s/he will take home and complete a questionnaire requiring 15 minutes. During the second visit, your child will complete a sequence of several activities over approximately 2 hours. First, while wearing a non-invasive cap to measure brainwave activity, your child will watch, listen, and respond to questions about other people's thoughts and feelings. Next, s/he will be videotaped while playing games with a peer as well as with a research assistant. Finally, s/he will again put on the non-invasive cap and again watch, listen, and respond to questions about other people's thoughts and feelings.

What you will do in the study: You will complete a packet of questionnaires over the course of the two visits requiring approximately 50 minutes to finish.

Time required: The packet of questionnaires you will complete will take approximately 50 minutes. Your child's first visit will require approximately 45 minutes while his/her second visit will require 2 hours. His/her questionnaires will require approximately 15 minutes to complete. Overall, the study will require about 50 minutes of your time and three hours of your child's time.

Risks: The main risk is a loss of confidentiality. We will take steps to protect your confidentiality as described in the "Confidentiality" section below.

Benefits: There are no direct benefits to you for participating in this research study. However, the study may help us understand the relationship between how children with ASDs perceive the social world and how they interact with others. Also, if you request it,

we will be able to generate a report based upon your child's results, which you may use however you see fit.

Confidentiality: Only research staff will see your data, including video tapes. All your information will be kept in a locked office, and labeled with a code number (not your name). The list connecting your child's name and your name to this code will be kept in a locked file separate from the information. The data will be kept indefinitely to allow further inspection of the questionnaires administered and of video tapes. If your child indicates on a questionnaire or verbally expresses any serious intent to do harm to him/herself or others, we will inform you and give you a referral for help.

Voluntary participation: Your child's participation and/or your participation in the study is completely voluntary.

Right to withdraw from the study: You have the right to withdraw your child and yourself from the study at any time without penalty. Your child also has the right to withdraw him/herself at any time. If you or your child withdraw from the study, all questionnaires about your child will be destroyed unless you tell us not to do so.

How to withdraw from the study: If you and your child want to withdraw from the study, whether it is during the study or after the study has been completed, tell Matthew Lerner (434-243-4838, mlerner@virginia.edu). There is no penalty for withdrawing.

Payment: You and your child will receive a $50 gift certificate upon completion of the study.

If you have questions about the study, contact:

Amori Yee Mikami, Ph.D.
Department of Psychology
102 Gilmer Hall/P.O. Box 400400
University of Virginia
Charlottesville, VA 22903
Telephone: (434) 243-2321

Matthew D. Lerner
Department of Psychology
102 Gilmer Hall/P.O. Box 400400
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Charlottesville, VA 22903
Telephone: (434) 243-4838
mlerner@virginia.edu

If you have questions about your rights in the study, contact:

Tonya R. Moon, Ph.D.,
Chair, Institutional Review Board for the Social and Behavioral Sciences
One Morton Dr Suite 500
University of Virginia, P.O. Box 800392
Charlottesville, VA 22908-0392
Telephone: (434) 924-5999
Email: irbsbshelp@virginia.edu
Website: www.virginia.edu/vprgs/irb

Agreement:
I agree to allow my child to participate in the research study described above. I agree to participate in the research study described above.
Signature: _____ Date: _____
You will receive a copy of this form for your record

Agreement:
I agree to allow my child to be videotaped as part of the research study described above.
Signature: _____ Date: _____
You will receive a copy of this form for your record

Minor Informed Assent Agreement 7-12
Please read this paper with your Mom or Dad.

Purpose of the research study: We want to learn more about kids your age, how they see the world, and play with other kids.

What you will do in the study: You will come in for two visits. At your first visit, you will do some activities that involve thinking and playing with a Research Assistant. This visit will take about 45 minutes. You will be given a questionnaire at the end of this visit to fill out at home. This questionnaire should take about 15 minutes to finish. Finally, you will come in for your second visit. At this visit, you will first be asked to wear a special cap, which won't hurt you. While wearing this cap, you will be asked questions about how people think and feel. Next, you will spend time with another kid your age and play some games with this kid and a Research Assistant. Finally, you will put the cap back on and be asked some more questions about people's thoughts and feelings. This visit should take about two hours.

Risks/Benefits: Being in this study will not hurt you. On the other hand, it won't help you in any way. It will hopefully help us learn more about kids your age, how they see the world, and play with other kids. The main risk is a loss of confidentiality. We will take steps to protect your confidentiality as described in the "Confidentiality" section below.

Confidentiality: Your answers to our questions will be kept private. Your name will not be used, and no one who reads about our study will know it was you. We keep things locked up so only our research staff sees them. We will also lock up copies of the video tapes, and no one who sees them will know you. Your answers to our questions will not have your name on them, so we won't know what answers you gave.

You don't have to be in this study.

You can stop doing the study at any time.

If you want to stop doing the study, tell your parents or group staff. If you choose to stop before we are done, any answers you already gave will be destroyed unless you tell us not to. There is no penalty for stopping. If you decide that you don't want your answers in the study but you already turned them in, or that you don't want us to keep the tapes you are in, contact Matthew Lerner.
You will receive $50 at the end of this study.

If you have questions about the study, contact:

Amori Yee Mikami, Ph.D.
Department of Psychology
102 Gilmer Hall/P.O. Box 400400

Matthew D. Lerner
Department of Psychology
102 Gilmer Hall/P.O. Box 400400

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If you have questions about your rights in the study, contact:
Tonya R. Moon, Ph.D, Chair, Institutional Review Board for the Social and Behavioral Sciences
One Morton Dr Suite 500
University of Virginia, P.O. Box 800392
Charlottesville, VA 22908-0392
Telephone: (434) 924-5999
Email: irbsbshelp@virginia.edu
Website: www.virginia.edu/vprgs/irbsbs.html

Agreement:
I agree to be part of this study.

Signature: _____ ***Date:*** _____

I agree to be videotaped as part of this study.

Signature: _____ ***Date:*** _____

Appendix B

Developmental History Form

IDENTIFYING INFORMATION

All information on this form is confidential and voluntary. It helps us better understand your child and to see if the program works better for some types of children than for others, so that we can improve our services.

Child's full name_____

Child's sex: M F

Child's age: _____

Child's date of birth: _____/_____/_____

Child's primary language: _____

Child's racial/ethnic background:
1 Caucasian/White non-Hispanic …….
2 African American/Black ……..
3 Asian/Asian American ……
4 Hispanic/Latino ……
5 Native American/American Indian ……..
6 Mixed (please specify) _____ ..

Initials of person completing form:
_____

Relationship to the child (circle one):

Biologic mother ……...1 Adoptive mother …….5 Grandmother ……9
Biologic father …….2 Adoptive father ……6 Grandfather ……. 10 :
Stepmother ……..3 Foster mother ……7 Aunt …….. 11
Stepfather ……...4 Foster father ……8 Uncle ……. 12
Other ……13 Please specify: _____

FAMILY INFORMATION

Information on Primary Household (the one in which child lives most of the time)
Who else lives in the Primary Household with this child?

	Name(s)	Relationship to Child (e.g., biologic mother, adoptive father, grandmother, adoptive sister, step-brother, aunt)	Age(s)
Parent #1			
Parent #2			
Siblings (includes half-siblings and step-siblings)			
Other Children			
Other Adults			

Please answer the questions below about the child's Primary Household, for yourself (Parent #1). If there is a second parent (Parent #2) living with you in the Primary Household, please complete the information for that parent as well.

Parent #1's education (circle one):
Eighth grade or less …….. 1
Some high school …….. 2
High school graduate or GED ……3
Some college or post-high school……4
College graduate ……5
Advanced graduate or professional degree ……6

Parent #2's education (circle one):
Eighth grade or less ……..……1
Some high school ……..…… 2
High school graduate or GED ……..…….. 3
Some college or post-high school ……..…..4
College graduate ……5
Advanced graduate or professional degree ……6

Parent #1's employment status:
Working full time …….. 1
Working part time …… 2
Unemployed, looking for work …… 3
Unemployed, not looking for work …… 4
Stay-at-Home Parent ……5
Disabled …… 6
Retired ……7
Student, full-time …… 8
Student, part-time ……..9
Other, please specify: ……10

Parent #1's occupation (please be specific):

Parent #2's employment status:
Working full time …… 1
Working part time …… 2
Unemployed, looking for work …… 3
Unemployed, not looking for work ……...4
Stay-at-Home Parent ……5
Disabled …… 6
Retired ……7
Student, full-time ……8
Student, part-time ……9
Other, please specify: ……10

Parent #2's occupation (please be specific):

Total household income (from all sources) for past year:

Less than $10,000 1
$10,000 to $20,000 2
$21,000 to $30,000 3
$31,000 to $40,000 4
$41,000 to $50,000 5
$51,000 to $60,000 6
$61,000 to $70,000 7
$71,000 to $80,000 8
$81,000 to $90,000 9
$91,000 to $100,000 10
$101,000 to $150,000 11
More than $150,000 12

Current residence:

Subsidized housing 1
Mobile home 2
Rented or leased apartment, condo, house…… 3
Self-owned apartment, condo, house...…….. 4
Military quarters..... 5
Other, please specify: …… 6

Any income received from
public assistance, welfare,
or social security income (SSI)? Y N

Current relationship status of parent(s) or parental figures(s) in Primary Household:
Married (Heterosexual)……..…...… 1
Same sex domestic partnership ……..…… 2
Separated, Divorced, or relationship annulled……. 3
Widowed ……4
Never married, living with heterosexual partner….. 5
Never married, not living with partner……. 6
Other (please specify)…….. 7

Not counting the child being assessed here today, does anyone in this child's family have problems with Developmental Disorders (circle all that apply):

Biologic mother ……..….....1
Biologic father ……..…… 2
Step- or Adoptive parent ……..….. 3 If YES, number _____
Grandparent……...4 If YES, number _____
Biologic full sibling…… 5 If YES, number _____
Half-sibling…… .6 If YES, number _____
Step- or adoptive sibling…….. 7 If YES, number _____
First cousin, aunt, uncle……... 8 If YES, number _____
Other (please specify)…….. 9 _____

SCHOOL INFORMATION

Grade: _____ (last grade completed)
City of school: _____
Type of School: Public……1 Private…… 2 Parochial/religious… 3

Has the child ever repeated a grade? _____ If YES, which grade(s): _____

MEDICAL/DEVELOPMENTAL INFORMATION

Currently, does your child have significant medical problems? _____ If YES, please specify:
_____

During or after the delivery (optional, please fill out all you can remember):	Yes, no, or don't know		
Baby was born early (_____ weeks)	Y	N	DK
Baby was born on time (_____ weeks)	Y	N	DK
Baby was born late (_____weeks)	Y	N	DK
Baby had low birth weight (_____ lbs _____ oz)	Y	N	DK
Baby had normal birth weight (_____ lbs _____ oz)	Y	N	DK
Baby had high birth weight (_____ lbs _____ oz)	Y	N	DK
Vaginal delivery	Y	N	DK
Assisted delivery (specify: forceps _____ or vacuum _____)	Y	N	DK
C-section delivery (specify: planned _____ or emergency _____)	Y	N	DK
Baby needed help breathing	Y	N	DK
Baby was born addicted or very exposed to alcohol or drugs (please specify):	Y	N	DK
Baby had to be in an incubator (how long? _____)	Y	N	DK
Baby had extended hospital stay (how long? _____)	Y	N	DK
Baby had other problems (please specify):	Y	N	DK

Please mark primary diagnosis with a "**P**" and secondary with an "**S**" (include **only** diagnoses given via previous formal psychological or medical assessment)

____ Asperger's Syndrome
____ PDD/NOS
____ Autism
____ Non-verbal Learning Disorder
____ Behavioral Disorder (please specify): _____
____ Other:_____
____Visual Impairments
____ Hearing Impairments
____ ADD/ADHD
____ Psychiatric Disorder (please specify): _____
____ Learning Disorder (please specify): _____

PREVIOUS EVALUATIONS AND INTERVENTIONS

Please list any medications that the child is currently taking.

Medication	Reason for taking	Date started	Dosage		
			am	noon	pm

If the child has ever received any interventions (for example, psychotherapy or counseling, early intervention) please provide the following information:

Intervention	Date started	Still involved? Yes or no		If not, date ended	How often?	Type of professional
		Y	N			
		Y	N			
		Y	N			
		Y	N			
		Y	N			
		Y	N			

Appendix C

Social Communication Questionnaire

(Sample)

1. Is she/he now able to talk using short phrases or sentences?
   If *no*, skip to question 8. ..... yes no
2. Can you have a to and fro "conversation" with her/him that
   involves taking turns or building on what you have said? ..... yes no
3. Has she/he ever used odd phrases or said the same thing over and
   over in almost exactly the same way (either phrases that she/he
   has heard other people use or ones that she/he has made up)? ..... yes no

LIFETIME

Social Communication Questionnaire (SCQ)

AutoScore™ Form

Michael Rutter, M.D., F.R.S., Anthony Bailey, M.D.,
Sibel Kazak Berument, Ph.D., Catherine Lord, Ph.D.,
and Andrew Pickles, Ph.D.

Published by
WESTERN PSYCHOLOGICAL SERVICES
wps 12031 Wilshire Boulevard
Los Angeles, CA 90025-1251
Publishers and Distributors

Name of Subject

Date of Birth

Date of Interview

Chronological Age ____F ____M Gender

Name of Respondent

Relation to Subject

Clinician Name

School/Clinic

Directions

Thank you for taking the time to complete this questionnaire. Please answer each question by circling *yes* or *no*. A few questions ask about several related types of behavior; please circle *yes* if *any* of these behaviors have ever been present. Although you may be uncertain about whether some behaviors were ever present or not, please answer *yes* or *no* to every question on the basis of what you think.

Additional copies of this form may be purchased from WPS.
Please contact us at 800/648-8857, Fax 310/478-7838, www.wpspublish.com.

W-381B

2 3 4 5 6 7 8 9

Appendix D

Dimensions of Mastery Questionnaire (Peer Social Motivation Scale)

Child ID: _____ **Gender (circle one)**: Boy Girl **Today's date: _____**

Rater's Relationship to Child: Mother ___ Father___ Other (Specify)_____

	Not at all Typical				**Very Typical**
1. Gets very involved in pretend play with friends.	1	2	3	4	5
2. Tries hard to make friends with other kids.	1	2	3	4	5
3. Likes to talk with other children.	1	2	3	4	5
4. Tries to get included when other kids are playing.	1	2	3	4	5
5. Tries to keep play going for a long time when around other kids.	1	2	3	4	5
6. Avoids getting involved with other children.	1	2	3	4	5

Appendix E

Social Responsiveness Scale

(Sample)

SOCIAL RESPONSIVENESS SCALE AUTOSCORE™ FORM | John N. Constantino, M.D. | **PARENT REPORT**

DIRECTIONS
For each question, circle the number that best describes the child's behavior *over the past 6 months.*

Child's Name: _____ Chronological Age: _____

Gender (required): ☐ Female ☐ Male Ethnicity: _____

Respondent's Name: _____ Administration Date: _____

Relationship to Child: ☐ Mother ☐ Father ☐ Other _____

PLEASE PRESS HARD WHEN MARKING YOUR RESPONSES.

1 = NOT TRUE 2 = SOMETIMES TRUE 3 = OFTEN TRUE 4 = ALMOST ALWAYS TRUE

1. Seems much more fidgety in social situations than when alone. 1 2 3 4
2. Expressions on his or her face don't match what he or she is saying. 1 2 3 4
3. Seems self-confident when interacting with others. 1 2 3 4

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Appendix F

Diagnostic Analysis of Nonverbal Accuracy-2 (Screenshot)

Appendix G

Stories from Everyday Life

1a) Castles in the air (Figurative Speech)

The architect Ken Peterson is known as a person rich in ideas. He works with Solnes, a master builder who has his office in the town. He goes to Solnes almost daily with new ideas about how to build bigger and better buildings.

The idea rich architect uses steel and glass as construction materials, because they are the materials that can give the most protection against storms and bad weather. With these materials it is possible to build fine, big buildings. Wooden material and roof tiles are well suited for the construction of normal single-floored dwellings, he says.

Many of the people who hear of Peterson's many building plans regard them as quite unrealistic. Solnes, the master builder is also normally skeptical to the architect's ideas.

One day Peterson arrives and says that he has begun drawing the town's new planned city hall. He will build it high, he says, 35 floors - because this will save on land area. Solnes the master builder thinks that this and a number of Peterson's other recent ideas are totally unrealistic. Solnes says: "Peterson, now I think you are building castles in the air."

Questions:

1. What is an architect?
2. What is architect Peterson known for?
3. Who does he work together with?
4. What is a builder?
5. What do most people think of Peterson's ideas?
6. What does master builder Solnes think of them?

7. Why doesn't architect Peterson use wooden material and roof tiles when projecting high buildings? (PI)

Answer:……
Response time:……sec.

8. How many floors does Peterson intend the new Town Hall to have?
9. What is Solnes opinion of building so high?
10. Does Solnes really mean that Peterson is planning to build a castle of only air? YES/NO/DON´T KNOW

11. What does Solnes mean when he says that Peterson builds castles in the air? (MI)

Answer:……
Response time:……sec.

Prompt questions:……
Response time inclusive prompt questions:……sec.

2a) Tidying the room (Irony)

Tom and Adrian are brothers. Tom is 8 years old and Adrian 14. Their mother is very strict and always makes sure that their rooms are tidy. One day she says that they must both tidy up their rooms. Tom, the youngest of the brothers, is always making a mess, and his room is usually very untidy. His mother often complains about the mess. Adrian seldom has to hear such remarks, but his mother says that he should occasionally help his father tidying their villa garden.

Both Tom and Adrian go to their rooms to begin tidying. After a while their mother shouts and asks if they will soon be finished. Adrian replies that he is finished.

But, eight years old Tom hasn't began to tidy up at all! Adrian's mother asks if he can look in Tom's room to check if he has tidied up. Adrian opens the door to Tom's room, peers in and sees that the room appears as it normally does. He shouts to his mother: "Mother, Tom has as usual done a splendid job tidying up!"

Questions:

1. What are Tom and Adrian?
2. How old is Tom?
3. How old is Adrian?
4. What does their mother one day say they must do?
5. How does Tom's room look?
6. How does Adrian's room looks? (PI)

Answer:……
Response time:……sec.

7. What does Tom and Adrian's mother want to know after a while?
8. What does Adrian answer?
9. What is Adrian meant to check when he is asked to look into Tom's room?
10. Do you think Tom has tidied up his room? YES/NO/DON´T KNOW

11. Adrian says to his mother that Tom has as usual done a splendid job tidying up. Is what he says true? YES/NO/DON´T KNOW

12. Why does Adrian say this? (MI)

Answer:……
Response time:……sec.

Prompt questions:……
Response time inclusive prompt questions:……sec.

3a) A new job (Contrary Emotions)

Emily Peters is 27 years old, educated as an architect and has worked in an architect's office. She greatly enjoyed working there, and couldn't imagine working in another place. But, because of few commissions the half of its employees were made redundant.

In the last couple of years Emily has applied for a number of positions as architect, but without success.

Emily has recently had a son called Andy. He is now three months old, and Emily is now at home looking after the child. She is of the opinion that little Andy will still need her at home for a while.

One day however she is offered a very well paid job in an architect firm in town. Emily tells her husband about the offer and is very happy about it. Her husband means that she is lucky to have received such an offer in a time with such high unemployment among architects. He says she ought to take the chance and accept the job. Emily agrees, and says that she is happy about the opportunity.

The next day Emily's mother pays a visit. Emily tells her mother about the new job she has been offered, but adds: "I don't want to take the job I have been offered. Little Andy still needs me at home".

Questions

1. What has Emily trained as?
2. What is an architect?
3. **Why has Emily applied for several architect positions in recent years? (PI)**

Answer:……
Response time:……sec.

4. How old is Andy?
5. Why does Emily believe that Andy will still need her at home for a while?
6. What offer does Emily receive one day?
7. Is she happy about the offer?
8. What does Emily's husband think about the offer, and what advice does he give to her?
9. What does Emily say to him?
10. What does Emily say to her mother when she pays a visit the next day?
11. Is it true what Emily says to her mother? YES/NO/DON´T KNOW
12. Is it true what Emily has earlier said to her husband that she is happy about the new job offer? YES/NO/DON´T KNOW

13. **Why does Emily say to her husband that she is happy about the job offer, but says to her mother that she has no desire to take it? (MI)**

Answer:……
Response time:……sec.

Prompt questions:……
Response time inclusive prompt questions:……sec.

4a) At the clock makers (Mistaken Intentions)

Henry Olson, is in his 40s, has trained as clock maker and runs a small shop. He thinks that many of those who come into his shop ask about the strangest of things. As a busy watchmaker he doesn't think he can waste his valuable time on people who only want to talk to him or ask pointless questions. Some days when people want to visit the shop they

find that the doors cannot be opened - with the following notice attached to it: "The shop will be open to-morrow".

One day an 18 year old comes into the shop and says that his watch has stopped: "I think the battery has run down, so I must be given a new one". Henry, who has few customers and doesn't sell much, answers: "Given a new one, do you think I just stand her and give away batteries?" The boy is irritated and leaves the shop.

Later in the day a second customer enters the shop, a young lady. She would like to look at an elegant, expensive gold watch, the customer looks at it for a while and then says: "This is expensive, is it not?"Yes", replies Henry. The customer looks at Henry in a questioning manner for some time. Henry means that he has answered the customer's inquiry, and returns to his workshop to repair a clock for collection in a few hours time. The busy watchmaker hears the lady exclaim as she leaves the shop: "This is a strange shop; you don't get an answer when you ask a question!"

Questions

1. What kind of business has Henry?
2. What is a clock maker?
3. What are talkers?
4. What does Henry do to prevent talkative customers coming into his shop and taking up his time? (PI)

Answer:……..
Response time:……sec.

5. What does the young gentleman who comes into the shop one day say?
6. What does the man mean by saying that he should be given a new battery for his watch?
7. What does Henry say to the young man?
8. What does the young lady who comes into the shop later in the day want: to inspect and perhaps make a purchase?
9. What does she ask Henry?
10 What is Henry's reply?
11. Has Henry really provided an answer to what she wants to know about the watch? YES/NO/DON´T KNOW

12. What does she really want to know? (MI)

Answer:……..
Response time:……sec.

Prompt questions:……..
Response time inclusive prompt questions:……sec.

1b) In the same boat (Figurative Speech)

One day Kevin and Kenny borrow the rowing boat belonging to Kevin's father and go out fishing. It is windy and rainy, but Kevin and Kenny have been out fishing before, so they aren't afraid. At sea they reel up one fish after another. By 1 p.m. they have caught 50 fish, and this is more than they can eat or put in the freezer at home. Soon they begin to row homewards.

To reach home they have to row over the Storhavet. The wind has got up, and the waves are soon quite high. In the strong wind they lose control of the boat, which is tossed back and forwards by the high waves. The spray from the sea is against them and they can't see that they are making for a little island in the sea. Kevin and Kenny begin to become afraid.

Soon they hear a braking sound as the boat hits the ground and is smashed to pieces against a large stone on the small island. Kevin and Kenny luckily come to no harm. They shout for help, but nobody can hear them.

They seek shelter from the wind behind some large stones, and try as best as they can to keep warm and keep in good spirits. Kevin says: "Now we are in the same boat, Kenny!"

Questions
1. Where do Kevin and Kenny row one day to fish?
2. What is the weather like when they set out?
3. How many fish do they catch?
4. Why do Kevin and Kenny begin to row home again at about one o'clock? (PI)

Answer:……
Response time:……sec.

5. What do they have to cross on the way home?
6. What happens to their boat in the strong wind?
7. Why are they now afraid?
8. What does the boat hit?
9. What happens to their boat?
10. Where do they seek shelter?
11. What do they try to do to the best of their ability?
12. Is it actually the case, as Kevin says, that they both find themselves in the same boat?
YES/NO/DON´T KNOW

13. What does Kevin mean when he says that they are now in the same boat? (MI)

Answer:……
Response time:……sec.

Prompt questions:……
Response time inclusive prompt questions:……sec.

2b) The polite lady (Irony)

Carol, who is a very polite and friendly lady, is invited to a coffee evening at Anne's, her sister-in-law. Around the coffee table there are several of Britt ´s relatives; they are talking pleasantly to each other. Carol's uncle, George Strand, is also present. He is a general in the army, and is himself a very polite person, who expects that other people also behave like him.

One day Carol is in town, and she passes uncle George while she is cycling along the High Street. It is in the middle of rush hour, and she has to concentrate on the large

amount of traffic and the many pedestrians. She doesn't see uncle George as she cycles by him, while he is walking along the pavement only meters away from her.

At the coffee evening Carol tells the other guests that she cycled to the town a few days ago, and that it was a far from pleasant experience because of the busy traffic. Her uncle, who is sitting beside her at the table, interrupts her and says while smiling: "Carol is a very friendly lady. The other day I met her while she was cycling in town, she smiled at me and politely said hello".

Questions

1. Who has Carol received an invitation from to celebrate her 40th birthday?
2. What do Carol and her relatives do when they are sitting around the coffee table?
3. What is Carol's uncle's occupation?
4. What is uncle George himself and what does he expect of others?
5. Who does George pass one day when she is in town?
6. **Why doesn't Carol greet uncle George as she cycles past him in town? (PI)**

Answer:……
Response time:……sec.

7. What does Carol tell the others around the coffee table?
8. Does uncle George mean what he says, that Carol smiled and greeted him politely when they met each other the other day in town?
YES/NO/DON´T KNOW

9. Which intention has uncle George by saying what he does to Carol? What do we see he is? (MI)

Answer:……
Response time:……sec.

Prompt questions:……
Response time inclusive prompt questions:……sec.

3b) A difficult choice (Contrary Emotion)

Peter Miller is a furniture dealer and he has owned several furniture shops; he has just sold them. He is 60 years old and wanted to sell his business to have more time for his hobbies.

While Peter's parents lived some years ago, he showed that he cared for them by visiting them often in the old people's home. They were both very ill, but appreciated greatly each of Peter's visits. With Peter not having had his parents to visit in recent years, he has had more time for himself. Six months ago he moved in with Nina, who has known since his school days.

Peter has always had sympathy for those in society who have a difficult life. With the sale of his business he has a large fortune. Without telling anyone, he has thought of giving his fortune of 7-8 million NOK to a centre for those injured in traffic accidents. The centre plans to modernize its old building and this would use up almost the entire sum.

Peter has asthma and problems when it is cold and damp in the air. One day Nina shows him a newspaper advertisement of a large, elegant villa worth 8 million NOK. It is

for sale outside Barcelona in Spain. She says that they ought to buy the property and move to Spain. "It would be good for your health, Peter", she says. Peter agrees that Nina's idea is good.

The following day, Peter's good friend and head of the centre for traffic injuries, Gary Hagen, pays a visit. While Peter and Gary are sitting together and talking about the modernization plans for the centre, Peter says that he wants to give the whole of his fortune to the cause. Nina, who is sitting at the other end of the lounge reading can't avoid hearing their conversation.

After Gary has left, Nina says to Peter: "You just said to me that it would be a good idea to buy the house in Spain. To Gary Hagen you now say that you will give away your fortune to the centre for traffic injuries". Peter finds what Nina says problematic, but answers: Yes indeed, I would like to help other people, but at the same time I regret that perhaps there won't be a new villa in Spain".

Questions
1. Why does he want to sell his furniture business?
2. Who did Peter often visit in the old people's home?
3. Why hasn't Peter been to the old people's home in the last year? (PI)

Answer:……
Response time:……sec.

4. Who moved in with Peter six months ago?
5. How much money has Peter earned with the sale of his business?
6. How much money does the centre for traffic injuries need to modernize its buildings?
7. How does Peter suffer when it is cold?
8. What does Nina propose one day after having read a newspaper advertisement?
9. How much does the villa in Spain cost?
10. What does Peter think of Nina's idea of buying the house in Spain?
11. Who pays a visit one day?
12. What do Peter and Gary talk about?
13. How does Nina know what Peter and Gary talk about?
14. What does she say to Peter after Gary has left?
15. Is it correct that Peter wants to give his money both to the centre for traffic injuries and to use it in the purchase of a Villa in Spain? YES/NO/DON´T KNOW
16. What does Peter feel when he expresses pleasure about being able to help other people, but at the same time feels regret that he might not be able to buy the villa in Spain? (MI)

Answer:……
Response time:……sec.

Prompt questions:……
Response time inclusive prompt questions:……sec.

4b) The heavy bag (Mistaken Intentions)

Tina and Charlotte are in the 2nd grade at school; they are friends and often go to school together. Tina has been to the library and borrowed many books, so her school bag is very heavy. Her arm becomes very tired with the weight. Charlotte on the other hand, has

not been to the library today. In her rucksack she has only her pencil case and two exercise books.

Charlotte is a kind and helpful friend, especially when she understands that somebody needs her help. But, she doesn't say so much.

Just before they are to begin going home Tina says: "Can you wait a moment for me by this flag pole, while I go to the toilet?" "Yes", says Charlotte, "I can". But, Charlotte doesn't wait for Tina, and when Tina comes out from the toilet, Charlotte has already begun going home. Tina runs after her as fast as she can, while carrying the heavy bag in her right hand. After a while when she catches up with Charlotte she says: "You promised to wait for me, why did you just go?", asks Tina. But, Charlotte just looks in a questioning manner.

Tina is now very tired in her arm and says to Charlotte: "Can you carry my bag?" "Yes, I can", replies Charlotte. Tina stops and waits for Charlotte to take her bag, but Charlotte just carries on going.

Questions

1. In which grade are Tina and Charlotte?
2. Why is Tina's school bag heavy today?
3. Why is Charlotte's rucksack light to carry? (PI)

Answer:……
Response time:……sec.

4. What is Charlotte's reply when Tina asks her if she knows the name of the new teacher?
5. What does Tina ask Charlotte when they are about to begin going home from school?
6. What does Charlotte do?
7. What does Tina say to Charlotte when she has caught up with her?
8. How does Charlotte react to what Tina says?
9. Why does Tina want Charlotte to carry the heavy school bag?
10. Why doesn't Charlotte stop to take Tina's bag when Tina is so tired in her arm? (MI)

Answer:……
Response time:……sec.

Prompt questions:……
Response time inclusive prompt questions:……sec.

Appendix H

Children's Assertive Behavior Scale (Social Knowledge Version)

You are going to answer some questions about what *the right thing to do* is in various situations. For example, a question might be:

"What do you do if someone does not listen to you when you are talking to them?" You have to choose the answer which is what you think the *right thing to do* is. The right thing to do is:

a) Tell them to listen.
b) Keep on talking.
c) Stop talking and ask them to listen.
d) Stop talking and walk away.
e) Talk louder.

From these 5 answers, you decide which one is the right thing to do. Now circle the letter on the answer sheet for each question.

DO NOT WRITE ON THE TEST. WRITE ON THE ANSWER SHEET ONLY.

Now answer each of the following questions by circling the letter (a, b, c, d, e) beside each question. After you have marked your answer for the question, go on to the next one.

If you cannot understand a word, question, or answer feel free to ask your parent or a Research Assistant and you will be helped. Remember to answer honestly about how you would act. There is no time limit, but you should answer as quickly as possible.

1. Someone says, "I think you are a very nice person." The right thing to do is:
    a) Say, "No, I'm not that nice."
    b) Say, "Yes, I think I'm the best."
    c) Say, "Thank you."
    d) Say nothing and blush.
    e) Say, "Thanks, I am really great."

2. Someone does something you think is really great. The right thing to do is:
    a) Act like it wasn't that great and say "That was alright."
    b) Say "That was alright, but I've seen better."
    c) Say nothing.
    d) Say "I can do much better than that."
    e) Say "That was really great!"

3. You are working on something you like and think it is very good. Someone says, "I don't like it!" The right thing to do is:
    a) Say "You're a dummy!"
    b) Say "I think it's good."

c) Say "You are right," although you don't really agree.
d) Say "I think this is great; besides what do you know!"
e) Feel hurt and say nothing.

4. You forgot something you were supposed to bring and someone says, "You're so dumb! You'd forget your head if it weren't screwed on!" The right thing to do is:
   a) Say "I'm smarter than you any day; besides what do you know!"
   b) Say "Yes, you're right, sometimes I'm done."
   c) Say "If anybody is dumb, it's you!"
   d) Say "Nobody's perfect. I'm not dumb just because I forgot something!"
   e) Say nothing or ignore it.

5. Someone you were supposed to meet arrives 30 minutes late, which makes you upset. The person says nothing about it when they are late. The right thing to do is:
   a) Say "I'm upset that you kept me waiting like this."
   b) Say "I was wondering when you'd get here."
   c) Say "This is the last time I'll wait for you!"
   d) Say nothing to the person.
   e) Say "You're a jerk! You're late!"

6. You need someone to do something for you. The right thing to do is:
   a) Not ask for anything to be done.
   b) Say "You gotta do this for me!"
   c) Say "Would you please do something for me?" and then explain what you want.
   d) Give a small hint that you need something done.
   e) Say "I want you to do this for me."

7. Someone asks you to do something which would keep you from doing what you really want to do. The right thing to do is:
   a) Say "I did have other plans, but I'll do what you want."
   b) Say "No way! Find someone else."
   c) Say "OK, I'll do what you want."
   d) Say "Forget it, shove off!"
   e) Say "I've already made other plans, maybe next time."

8. You see someone you would like to meet. The right thing to do is:
   a) Yell at the person and tell them to come over to you.
   b) Walk over to the person, introduce yourself, and start talking.
   c) Walk over near the person and wait for him to talk to you.
   d) Walk over to the person and start talking about great things you have done.
   e) Not say anything to the person.

9. Someone you haven't met before stops and says "hello" to you. The right thing to do is:
    a) Say "What do you want?"
    b) Not say anything.
    c) Say "Don't bother me. Get lost!"
    d) Say "Hello," introduce yourself, and ask who they are.
    e) Nod your head, say "hi," and walk away.

10. You know that someone is feeling upset. The right thing to do is:
    a) Say "You seem upset; can I help?"
    b) Be with them and not talk about their being upset.
    c) Say "What's wrong with you?"
    d) Not say anything and leave them alone.
    e) Laugh and say, "You're just a big baby!"

11. You are feeling upset, and someone says, "You seem upset." The right thing to do is:
    a) Turn your head away or say nothing.
    b) Say "It's none of your business!"
    c) Say "Yes I'm upset, thank you for asking."
    d) Say "It's nothing."
    e) Say "I'm upset, leave me alone."

12. Someone else makes a mistake and someone blames it on you. The right thing to do is:
    a) Say "You're crazy!"
    b) Say "That wasn't my fault; someone else made the mistake."
    c) Say "I don't think it was my fault."
    d) Say "Wasn't me, you don't know what you're talking about."
    e) Take the blame or say nothing.

13. Someone asks you to do something, but you don't know why it has to be done. The right thing to do is:
    a) Say "This doesn't make any sense, I don't want to do it."
    b) Do what they ask and say nothing.
    c) Say "This is dumb, I'm not going to do it."
    d) Before doing it, say "I don't understand why you want this done."
    e) Say "If that's what you want" and then do it.

14. Someone says to you they think that something you did was terrific. The right thing to do is:
    a) Say "Yes, I usually do better than most."
    b) Say "No, that wasn't so hot."

c) Say “That’s right, because I’m the best.”
d) Say “Thank you.”
e) Ignore it and say nothing.

15. Someone has been very nice to you. The right thing to do is:
    a) Say “You have been really nice to me, thanks.”
    b) Act like they weren’t that nice and say, “Yea, thanks.”
    c) Say “You have treated me alright, but I deserve even better.”
    d) Ignore it and say nothing.
    e) Say “You don’t treat me good enough.”

16. You are talking very loudly with a friend and someone says, “Excuse me, but you are being too noisy.” The right thing to do is:
    a) Stop talking immediately.
    b) Say “if you don’t like it, get lost!” and keep on talking loudly.
    c) Say “I’m sorry, I’ll talk quietly” and then talk in a quiet voice.
    d) Say “I’m sorry” and stop talking.
    e) Say “Alright” and continue to talk loudly.

17. You are waiting in line and someone steps in front of you. The right thing to do is:
    a) Make quiet comments such as, “Some people have a lot of nerve,” without actually saying anything directly to the person.
    b) Say “Get to the end of the line!”
    c) Say nothing to the person.
    d) Say loudly, “Get out of this line you creep?”
    e) Say “I was here first; please go to the end of the line.”

18. Someone does something to you that you don’t like and it makes you angry. The right thing to do is:
    a) Shout “You’re a creep, I hate you!”
    b) Say “I am angry, I don’t like what you did.”
    c) Act hurt about it but not say anything to the person.
    d) Say “I’m mad. I don’t like you!”
    e) Ignore it and not say anything to the person.

19. Someone has something that you want to use. The right thing to do is:
    a) Tell them to give it to you.
    b) Not ask for it.
    c) Take it from them.
    d) Tell the person you would like it, and then ask to use it.
    e) Make a comment about it, but not ask to use it.

20. Someone asks if they can borrow something of yours, but it is new and you don’t want to let them use it. The right thing to do is:

a) Say “No, I just got it and I don’t want to lend it out; maybe some other time.”
b) Say “I really don’t want to, but you can use it.”
c) Say “No, go get your own!”
d) Give it to them even though you don’t want to.
e) Say “You’re crazy!”

21. Some people are talking about a hobby you really like, and you want to join in and say something. The right thing to do is:
    a) Not say anything.
    b) Interrupt the people and immediately start telling them how good you are at this hobby.
    c) Move closer to the people and enter into the conversation when you have a chance.
    d) Move closer to the people and wait for them to notice you.
    e) Interrupt the people and immediately start talking about how much you like the hobby.

22. You are working on a hobby and someone asks, “What are you doing?” The right thing to do is:
    a) Say “Oh, just something” or “Oh, nothing.”
    b) Say “Don’t bother me. Can’t you see I’m working.”
    c) Keep on working and say nothing.
    d) Say “It’s none of your business!”
    e) Stop working and explain what you were doing.

23. You see someone trip and fall down. The right thing to do is:
    a) Laugh and say “Why don’t you watch where you’re going?”
    b) Say “Are you alright, is there anything I can do?”
    c) Ask “What happened?”
    d) Say “That’s the breaks!”
    e) Do nothing and ignore it.

24. You bumped your head on a shelf and it hurts. Someone says, “Are you alright?” The right thing to do is:
    a) Say “I’m fine, leave me alone.”
    b) Say nothing and ignore them.
    c) Say “Why don’t you mind your own business.”
    d) Say “No, I hurt my head; thanks for asking.”
    e) Say “It’s nothing, I’m OK.”

25. You make a mistake and someone else is blamed for it. The right thing to do is:
    a) Say nothing.
    b) Say “It’s their mistake!”

c) Say “I made the mistake.”
d) Say “I don’t think that person did it.”
e) Say “That’s their tough luck.”

26. You feel insulted by something someone said to you. The right thing to do is:
    a) Walk away from them, but don’t tell them you feel upset.
    b) Tell them not to do it again.
    c) Say nothing to the person, although you feel insulted.
    d) Insult them back and call them a name.
    e) Tell them you don’t like what they said and tell them not to do it again.

27. Someone often interrupts you when you’re speaking. The right thing to do is:
    a) Say “Excuse me, I would like to finish what I was saying.”
    b) Say “This isn’t fair; don’t I get to talk?”
    c) Interrupt the other person by starting to talk again.
    d) Say nothing and let the other person continue to talk.
    e) Say “Shut up, I was talking!”

Appendix I

Social Creativity Tasks

"Peers" Task

Imagine that during recess you see two children playing an interesting game and you want to play with them. So you go over and ask them: 'can I play with you?' Imagine that they say no. What could you do or say to convince them to let you play with them? Give as many ideas as possible. Try to find ideas that are different from those that everyone can have.

"Dyad" Task

Imagine that one day you are with one of your friends and that he or she wants to play a game but that you want to play a different game. What could you do or say to convince your friend to play the game that you prefer? Give as many ideas as possible. Try to find ideas that are different from those that everyone can have.

Appendix J

Social Interaction Observational Scale (Behavioral Indicators)

1. *Social initiation*: The child begins a new social sequence. This is distinguished from a continuation of a previous sequence by a change in activity.
2. *Social response*: The child responds verbally and/or nonverbally to social stimuli directed toward him/her by peers.
3. *Positive social interaction*: The child exhibits verbal and nonverbal social behaviors that lead to an effective social process with peers. These include behaviors that serve to start or maintain social interaction such as:

- *Eye contact*— The child looks into the eyes of another child.
- *Eye contact combined with smile*— The child looks at and smiles toward another child.
- *Smile with no eye contact*— The child smiles at another child but does not look into the peer's eyes.
- *Affection*— The child expresses affection toward another child, either verbally (e.g., "You're nice," "I like you") or nonverbally (e.g., hugs, touches).
- *Sharing objects*—The child offers his/her objects to another child or shares an object with another child.
- *Sharing experience*—The child talks about an experience to peers or asks them about their experiences (e.g., "What did you do over the weekend?").
- *Social communication*—The child approaches another child with a social (rather than functional) intention (e.g., "Let's play").
- *Talk that reflects an interest in another child*—The child expresses an interest in another child's hobbies (e.g., "What's your favorite game/object?"), mood (e.g., "Are you sad?"), etc.
- *Greeting*—The child says hello to another child or replies appropriately to such a greeting.
- *Giving help* —The child offers help to another child.

4. *Negative social interaction*: The child exhibits unpleasant social behaviors that operate to stop or decrease the likelihood of the development of an adequate social interaction.

- *Physical or verbal aggressiveness*—The child behaves in malicious, intrusive ways toward peers (e.g., yells, screams, makes fun of, hits, pushes, pinches, slaps).
- *Temper tantrum*—The child expresses anger in an extreme way (e.g., screams and shouts, hits other children, hits objects/walls, etc).
- *Teasing*—The child tries to drag another child into a fight or conflict.
- *Controlling*—The child dominates other children without respecting their needs.
- *Avoidance*—The child avoids social overtures made toward him/her by peers.
- *looking away*—The child actively avoids social contact by looking away from the initiator.

5. *Low-Level interaction*: The child exhibits behaviors that indicate social intention, but with minimal social enactment. This includes behaviors such as close proximity to children without initiating a positive social interaction. It also includes behaviors typical of the autistic syndrome (e.g., echolalia, idiosyncratic language).

- *Looking*—The child looks at the other child's face or body, or child's action, without establishing eye contact.

● *Close proximity*—The child stands in close proximity to another child (3 feet or less) but does not approach the peer.
● *"Yes" and "no"*—The child only nods his/her head for yes or shakes it for no.
● *Imitation*—The child imitates another child's talk or activity.
● *Idiosyncratic language*—The child uses utterances with no clear meaning.
● *Repetitive behavior*—The child behaves in a repetitive manner with no clear communication intent, but with close proximity to another child.
● *Functional communication*—The child approaches or responds to another child with an intention to fulfill his/her own needs, and with no social intention (e.g., "It's my turn on the computer now").

Appendix K

Social Knowledge- and Performance-Training Activities

Knowledge-Training

Starting a Conversation

Steps	**Trainer Notes**
1. Say, "Hi" or "How are you?" the first time you see a person during the day.	Say 'hi'; shake hands; choose the right time and place
2. Ask questions about what the person is doing in the PRESENT SITUATION "What are you [doing] [talking about] [eating] [reading]?" "How do you like this [class, lunch, project, game]?" "Where did you get the [shirt, hat, sneakers, watch]?"	Talk about sports, the weather, school events, and so forth.
3. Ask questions about the PAST "How was your [day, week, weekend, vacation, holiday]?" "did you hear about [what happened on the news, the new TV show, a sports game]?"	Check if the other person is listening: looking at you.
4. Questions about the FUTURE "What are you going to do [after school, this weekend, this week, for vacation]?"	
5. Ask about one of THE PERSON'S INTERESTS. "Have you been [doing a favorite activity, playing a favorite game, watching a favorite TV show, working on a favorite project] lately?"	
6. Remember to ask follow-up questions and make on-topic comments. WHO, WHAT, WHERE, WHEN, WHY, HOW, WHAT ELSE..?	

Suggested Content for modeling (Leader may demonstrate, but should *not* solicit role-playing from participants)

School or neighborhood: Main actor starts conversation with secretary in school office.
Home: Main actor discusses allowance and/or privileges with parent.
Peer group: Main actor suggests weekend plans to a friend.

Trading Information

Steps

1. Ask the other person about himself or herself (e.g. his or her interests, hobbies, weekend activities).
    a. Say: One of the first rules for trading information is to ask

the other person about himself or herself. You might ask them about their interests, their hobbies, or what they like to do on the weekend. Why is it important to ask the person about himself or herself?

i. Answer: Because this is how you discover their interests, hobbies, and lines – and if you have **common interests.**

2. After the other person finishes, **answer your own question.**
    a. **Share something related about yourself** (e.g. your interests, likes, hobbies).
    b. Say: Another rule for trading information is that we need to answer our own questions and share something about ourselves. This includes sharing our own interests, likes, or hobbies. Why is it important to answer your own question?
        i. Answer: Because they may not know to ask you the same question and in order to trade information, you have to also share things about yourself.
3. **Find common interests**
    a. Identify things you can talk about.
    b. Identify activities you can do together.
    c. Pay attention to what he or she does not like to do – so you can avoid doing these things.
    d. Say: The most important goal of trading information is to find common interests. We need to find common interests so that we have things to talk about or do together. It's also helpful to pay attention to what people don't like, so we can avoid doing those things when we're together. Why do you think it's so important to find common interests.
        i. Answer: because common interests are the foundation of friendships.
4. **Share the conversation**
    a. Say: Another rule for trading information is to be sure to share the conversation. Why is it important to share the conversation?
        i. Answer: This is how we trade information and get to know one another.
    b. This means you give the person a chance to ask you a question or make a comment.
        i. Pause occasionally to let the other person direct the conversation.
        ii. If the person does not say anything – follow up with another question or comment.
5. **Do not get too personal at first**
    a. Say: A final rule for trading information is not to get too personal at first. Why is it a bad idea to get too personal when you are first getting to know someone?
        i. Answer: this may make the other personal

uncomfortable and they may be less willing to talk to you in the future.

b. Give examples of getting too personal. (For example: What kinds of grades do you get?)
   i. Avoid having teens give examples as this may encourage silliness.

c. Ask: once you've gotten to know someone well, then is it ok to get more personal?
   i. Answer: Yes, if you are good friends.

Staying on Topic

Participants should choose a topic. Then, examples of on-topic and off-topic statements and questions should be solicited.

Topic: _____

On-Topic 	Off-Topic 
ASK Who _____? What _____? When_____? Where _____? Why_____? How _____? What else _____? TELL I like _____? I also _____? I went _____? I am going _____?	

Expressing Your Feelings

Steps	**Trainer Notes**
1. Tune in to what is going on in your body.	
2. Decide what happened to make you feel that way.	
3. Decide what you are feeling.	Possibilities are happy, sad, in a bad mood, nervous, worried, scared, embarrassed, disappointed, frustrated, and so forth (use above list of feelings).
4. Think about different ways to express your feeling and pick one.	Consider prosocial alternatives such as talking about a feeling, doing a physical activity, telling the object of the feeling about the feeling, walking away from

	emotional situations, or delaying action. Consider how, when, where, and to whom the feeling could be expressed.
5. Decide on the best way to do it.	

Suggested Content for modeling (Leader may demonstrate, but should *not* solicit role-playing from participants)

School or neighborhood: Main actor tells teacher about feeling nervous before test.
Home: Main actor tells parent about feeling embarrassed when treated like a child.
Peer group: Main actor hugs friend when learning of friend's success.

Understanding the Feelings of Others

Steps	**Trainer Notes**
1. Watch the other person.	Notice tone of voice, posture, and facial expressions.
2. Listen to what the other person is saying.	Try to understand the content.
3. Figure out what the person might be feeling.	He/she may be angry, sad, anxious, and so on.
4. Think about ways to show you understand what he/she is feeling.	You might tell him/her, touch him/her, or leave the person alone.
5. Decide on the best way to do it.	

Suggested Content for modeling (Leader may demonstrate, but should *not* solicit role-playing from participants)

School or neighborhood: Main actor brings gift to neighbor whose spouse has been ill.
Home: Main actor recognizes parent is preoccupied with financial concerns and decides to leave parent alone.
Peer group: Main actor lets friend know he/she understands friend's discomfort on meeting new people.

Comments

This skill is well known by the term *empathy*. Although difficult to teach, it is most important that many trainees add it to their repertoire of skills.

<u>Performance-Training</u>

(*Starting a Conversation*)

1) Pass the Clap

In this game, all the group members stand in a circle and one member (Person "A") starts. "A" turns to the person next to them (Person B), makes eye contact, and then the two of them clap at once, in unison. "B" then turns to the person next to them ("C") , looks them in the eye, and the two new participants clap at once, in unison. The game continues this way until the clap has successfully made it all the way around the circle.
NOTE: The more complex version of this game involves switching directions suddenly. The key to this game is making sure that the participants are making eye contact with one another before they try to clap in unison. They should not be watching the other person's hands.

(*Trading Information*)

1) Competitive Excuses (see also "Competitive Compliments")

In this game, one person (the group Leader first) asks a question to everyone in the room. For example, "Why don't you have your homework?" Each person must come up with his or her most creative response. For example, "I left my brain in my locker". The person who asked the question is the one who judges the responses, and the person with the best response is the one to ask the next question to the group.
NOTE: Criteria for best excuse is up to the judge; humorous, spot on, cleverness, personal preference, expected response, etc.)

(*Staying on Topic*)

1) Group Story

In this game, everyone sits in a circle. The Leader asks the group for three suggestions of subjects that the story should incorporate. These suggestions should be completely random and not connected to one another. Each person says a phrase or two to build upon the story that is developing. The goal of this game is to have the participants create a relatively coherent story and one that has some sort of flow to the plot.
NOTE: The person who starts the story is NOT able to introduce any of the subjects into the story. After this first person however, the following participants can introduce ONE subject at a time.

(*Expressing Your Feelings*)

1) Emotion Ball

In this game, the participants are all in a circle. Someone holds a ball and acts out an emotion, names the emotion, and passes the ball to someone else. The person who receives the ball has to act out that same emotion in the way that *s/he* would express it, and then act out a new emotion before passing it to the next person. Game play continues in this fashion until everyone has acted out an emotion or until appropriate depending on group momentum and energy level.

(*Understanding the Feelings of Others*)

1) Sausage

In Sausage, one person (the Sausage-sayer) sits in a chair on stage, while everyone else raises their hands to ask the Sausage-sayer a funny question. The only reply that the Sausage-sayer can give is "Sausage," and they must do so WITHOUT laughing. If they laugh, or say something other than "Sausage," the person who asked that particular question becomes the new Sausage-sayer! Sometimes, if participants are very advanced they can become Sausage Master by never laughing! The Leader should help the non-sausage-sayer by reminding them that they should think about what the *other* person thinks is funny, and not what *they* think is funny.
NOTE: It is up to the Leaders to use their discretion as to how many questions need to be answered in this way (or when it's taking too long) before the student becomes a Sausage Master.