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The Relationship Development Assessment - Research Version: Preliminary validation of a clinical tool and coding schemes to measure parent-child interaction in autism.

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Original Article

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Introduction

Autism is a disorder characterised by atypical development in social communication and repetitive behaviour (APA, 2013). In the present study, we investigated how such impairments are manifest in the children's interactions and engagements with their caregivers. Recent developments in the field of autism treatment show an increasing move towards relationship-focussed interventions, which seek to remediate the pivotal features of autism through improving interactions with others, typically engaging with parents as facilitators of their children's development (Dawson et al., 2010; Gutstein, 2009; Green et al, 2010; Green et al., 2013; Kasari, Freeman & Paparella, 2006; Mahoney & Perales, 2003; 2005; Rogers et al., 2006; Wieder & Greenspan, 2003). The growth in these interventions requires simultaneous evaluation of their efficacy. A crucial part of this endeavour is the development of outcome measures that demonstrate reliable and valid assessments of parent-child interaction (Lord et al., 2005). In addition, the endeavour to develop *clinically-useful* evaluation tools has consistently been highlighted as a priority area for the field of autism intervention (Cunningham, 2012; Kasari, 2002; Magiati et al., 2011). Creating more consistency in outcome measurement will allow clearer comparison between treatment studies and contribute to progress in the field of autism intervention research (Bölte & Diehl, 2013).

Autism and Relationship-based Intervention

Increasingly, the influence of parent-child interaction on sociocognitive and linguistic development in children with autism is being recognised (Meltzoff, Kuhl, Movellan & Sejnowski, 2009; Tomasello, Carpenter, Call, Behne & Moll, 2005), with different interaction styles either promoting or hindering development (McArthur & Adamson, 1996; Wan et al., 2013). For example, evidence suggests that parents of children with autism tend to spend more time controlling the child's behaviour (Kasari, Sigman, Mundy & Yirmiya, 1988) and use more physical means to do so (Doussard-Roosevelt, Joe, Bazhenova & Porges, 2003; Gulsrud, Jahromi & Kasari, 2010). This trend may emerge in the infant years, with a recent study of infants at risk for autism showing that the infants elicited a more directive interactive style from parents (Wan et al., 2012). These patterns of interaction may contribute to an increasingly atypical developmental trajectory (Wan et al., 2012). For example, Wan and colleagues (2013) found that qualities of parent-child interaction in infants at risk for autism were associated with autism outcome at three years of age.

This perspective on parent-child factors is complemented by the development of relationship-based interventions for autism, which target the child's interactions with adults or caregivers with the aim of enriching their developmental environment. A theoretical distinction can be drawn here between the concepts of relationship and relatedness: while the concept of relationship refers to enduring ways of relating to others (i.e. parent-child attachment style; siblings; friends) relatedness describes the moment-by-moment interactional style and engagement quality of interacting partners (see Beurkens, Hobson & Hobson, 2013). The interactional processes promoted in interventions are those demonstrated through research to be integral to child development (Kasari, 2002). These can include promoting *responsive parental teaching* (i.e. Green et al., 2013; Mahoney & Perales, 2003; 2005) or sensitive and *responsive parental communication* (i.e. Green et al., 2010); focussing on creating an *affectively-warm*, rich and positive social environment for the child-adult interaction (i.e. Denver Model: Rogers et al., 2006; Vismara & Rogers, 2008); promoting *guided engagements* and *experience-sharing* between children with autism and their caregivers (i.e. RDI: Gutstein, 2009; Gutstein, Burgess and Montfort, 2007); or directly promoting *contingent interaction* and joint attention (i.e. DIR/Floortime: Solomon, Necheles, Ferch & Bruckman, 2007, RDI: Gutstein, 2009). While these more recent approaches are less well supported than traditional behavioural approaches, empirical evidence for their efficacy is building (Odom et al, 2010; Rogers & Vismara, 2008; Dawson et al., 2010). In light of recent suggestive findings, for example that *parent-child synchrony* was a strong mediating factor on the positive effects of a communication-focussed intervention (Aldred, Green, Emsley & McConachie, 2012), and that parent-child interaction quality at baseline was a moderator of treatment gains as measured by the ADOS Severity Index (Author reference withheld for blind review), there is a pressing need to develop complementary measures of parent-child interaction.

Measurement of Interactions

With this focus on promoting intersubjective or interpersonal processes between parent and child, it is increasingly necessary to measure these dimensions reliably and validly. Traditional methodologies for assessing parent-child interaction have tended to focus on the individuals' separate contributions to the interaction, quantifying discrete acts (e.g. number of verbalisations, eye contact) rather than examining the

sharedness of interactions (Angellilo et al., 2007). However, when seeking to understand interpersonal processes, particularly in the areas of social engagement, intersubjectivity or relatedness, coding schemes should focus on the interactive *processes* of interest. For example, García-Pérez, Lee & Hobson (2007) found that 'objectively' quantifying nonverbal behaviours in the conversation of children with autism revealed few differences compared to children without autism, whereas 'subjective' ratings of the warmth and fluidity of the conversation between the speakers revealed marked group differences. The difficulty with this approach lies in obtaining reliable and valid quantitative ratings of the *quality* or *qualities* of social interaction, which can be considered diffuse or elusive aspects of an exchange (Gillis et al., 2011; Author reference withheld for blind review). Furthermore, while state-by-state coding using computer software is often employed in research settings, this carries a number of disadvantages in being both time- and resource-intensive, particularly for clinicians, and also in tending not to capture more nuanced, qualitative aspects of an interaction (Adamson, Bakeman, Deckner & Nelson, 2012; Merrell, 2001).

An alternative means of judging interactional quality is the assignment of global ratings based on an extended interaction (Adamson et al, 2012). Currently a gold-standard tool for assessing social relatedness with an unfamiliar examiner in autism is the standardised measure, the Autism Diagnostic Observation Schedule (ADOS: Lord, Rutter, DiLavore & Risi, 2001). Qualitative aspects of the interaction, such as the nature of social initiations and responses and the level of rapport between tester and child, are measured on a scale from 0-3. Users of the ADOS are required to undergo training, demonstrate an understanding of the coding criteria, and prevent rater drift through attendance at reliability meetings. With precautions such as these, qualitative judgements regarding an interaction can be made with sufficient reliability and validity (Gotham, Pickles & Lord, 2009). A further tool, the ADOS-C, is currently under development, and is designed to provide a measure of change in autism symptomatology during relatively unstructured interactions with other people, including parents (Lord, Carr & Grzadzinski, 2013). Adamson and colleagues (Adamson et al, 2012; Adamson, Bakeman & Rogers, 2013) have recently used a similar approach for parent-child interactions in order to investigate the emergence and development of joint attention. Adamson et al (2012) applied global ratings to a video-taped observation, focussing on qualitative dimensions such as how attention is shared, fluency of the conversation and the level of parental scaffolding, using ratings from 1 to 7. They found very high correspondence between

global and state codings as well as very good inter-rater reliability. This methodology was also recently employed by Wan and colleagues, who made global ratings of *caregiver sensitive responsiveness* and *dyadic intensity of engagement* during caregiver-child interaction (Wan et al., 2012). The appeal of such global observational ratings is their greater practicability within a clinical setting, their ability to capture higher-order qualities of an interaction, and their efficiency in terms of coder time (Adamson et al, 2012; Angellilo et al, 2007; Beurkens et al., 2013; Lord, Carr & Grzadzinski, 2013). Development of systematic, clinician-friendly, observational parent-child coding schemes is of key importance in investigating differences in parent-child interaction, informing treatment approaches and monitoring intervention outcomes (Adamson et al., 2013; Wan et al. 2012, 2013).

The current study

Beurkens, Hobson and Hobson (2013) used video-taped interactions of 25 dyads consisting of a parent and their child with autism, coded using the Dyadic Coding Scales (DCS: Humber & Moss, 2005), and found that the more severe a child's autism on the Autism Diagnostic Observation Schedule (ADOS: Lord et al, 2001), the poorer their interaction with their parents on qualities such as their shared communication, coordination of their actions and the ease of emotional expression between the pair. This study thereby supported the reliability and aspects of the validity of the DCS in assessing the quality of parent-child interaction. (Author reference withheld for blind review) then took a further sample of 18 dyads made up of a parent and their child with autism and replicated the findings of Beurkens and colleagues (2013), reporting that autism severity was closely related to interaction quality on the DCS. They also utilised two further coding schemes known as the Relationship Development Assessment (RDA) Coding Scales, which analysed the moment-by-moment quality of parent-child interaction, investigating two processes that they argue to be fundamental to the social impairments of autism. These processes are central to the therapeutic work undertaken throughout the family consultation programme of Relationship Development Intervention (RDI) and are used as the building blocks for a relationship incorporating 'guided participation' (see Gutstein, 2009; also Rogoff, 1990). The Relationship Development Assessment is a semi-structured evaluation of parent-child interaction utilised in RDI. In addition to more fine-grained analyses, the RDA is coded using the RDA Coding Scales. However, research is required to establish the reliability and validity of this approach.

(Author reference withheld for blind review) used state or 'micro-level' coding to analyse the two processes in the RDA Coding Scales using the labour-intensive Observer XP coding system. The first process is the capacity of a dyad to regulate an interaction, collaborating to maintain a connected, fluid exchange. This collaboration or *Interactive Regulation* involves two aspects: how contingent each person's behaviour is on the other's (e.g. if the child bounces a ball towards the parent, will the parent catch and pass it back?) and the quality of elaboration each provide, by introducing variations that enhance the interaction (e.g. the parent then passing the ball backward over their head to generate more interest and fun). The second process is the capacity to engage affectively with the other, that is, the level and depth of *Intersubjective Engagement* - experience-sharing and affective contact that takes place between members of the dyad. Of relevance is whether the pair seem attuned to each others' emotional or intentional state (i.e. sharing a joke or sharing the intention to start a game 'Oh yeah, let's do it that way'), or whether the interactions are more directive or disengaged (e.g. 'Go stand there, catch the ball'). (Reference withheld for blind review) found that ratings of these processes corresponded to the global ratings, were sensitive to the severity of autism, were sensitive to change following treatment and could be evaluated with excellent inter-rater reliability.

As such, the RDA Coding Scales may represent a useful tool for use within the context of relationship-based intervention in order to guide interventions and evaluate outcomes. However the state-based coding used in (Author reference withheld for blind review) study required specialist Noldus Observer® XP computer software. While this software is widely used in research settings, within a clinical setting it is generally impractical due to the expense and the time necessary to learn and effectively use this method. The current study focuses on improving the clinical utility of the coding schemes, by assigning global ratings rather than state-based ratings based on the interaction, thereby creating a clinical tool that is accessible, practicable and appropriate for the practicing clinician (Smart, 2006). We include a measure of shared attention between parent and child, based on the work of Lauren Adamson and colleagues (Adamson et al, 2004), who have recently investigated global ratings as a complement to state-based rating systems (Adamson et al., 2012; Adamson et al., 2013). We investigate whether this clinical tool, consisting of the parent-child interaction and three coding schemes with simplified rating systems demonstrates validity against other measures,

discriminates between children with and without autism, corresponds with individual differences in social functioning, and whether inter-rater reliability can be established. As well as examining the Overall scores assigned through the global rating systems, we investigate which aspects of the coding schemes demonstrate the strongest psychometric properties, in order to better evaluate the tool (Gillis et al, 2011). We also examine 'treatment utility', that is, how informative the tool is within clinical settings to guide and evaluate clinical interventions (Nelson-Gray, 2003).

Hypotheses

We predicted that the processes of attention (Coding Scheme 1), based on the work of Adamson and colleagues (2004), interactive regulation (Coding Scheme 2) and intersubjective engagement (Coding Scheme 3) would be compromised between children with autism and their parents as compared to children without autism and their parents, as these represent key interpersonal processes known to distinguish children with autism (Charman, 2003; Hobson, 2002/04; Mundy & Sigman, 2006; Trevarthen & Aitken, 2001; Wan et al., 2012). We also intended to examine the profile of scores across each of the three ratings in an exploratory fashion in order to investigate the strongest discriminating features. Given that the processes measured in the coding schemes are distinctive of autism, it was expected that these ratings would be poorer where autism severity was greater. We also anticipated that the coding schemes would show sensitivity to interactional features measured by a global measure of parent/child interaction quality. Finally because parent-child relationship quality appears to be affected by, but in other ways distinct from, interaction quality (Beurkens et al, 2013; Fogel, 2009), we expected that the quality of parent-child interaction would not be strongly related to parent-child relationship quality.

Method

The study was granted ethical approval by the Research Ethics Committee of the Health Service Executive – South, in the south-east of Ireland. Children were recruited from the waiting list of an autism clinic in the Health Service Executive [HSE], through a private clinic and through mainstream primary schools in Ireland. Potential participants were identified and invited to participate by a clinician or special educational needs teacher and families gave consent before details were passed to the researcher.

Participants

Inclusion criteria for the autism group were 1) cognitive ability in upper range of mild intellectual disability or higher (i.e. IQ >65), 2) no comorbid psychiatric conditions (e.g. ADHD) and 3a) a clinical diagnosis of, or awaiting assessment for, an ASD (n=20). For children awaiting assessment, the research measures (below) formed part of their clinical assessments, in consultation with their clinical team and informed subsequent diagnoses. Children in the comparison group had to satisfy the first two conditions, as well as 3b) no clinical concern regarding the presence of an ASD and 4) presence of academic difficulties as evidenced by receipt of learning support hours at school (n=20) (See Table 1). The comparison group was not intended to represent a homogenous diagnostic group, but to investigate whether the parent-child interaction coding schemes would differentiate between dyads of children with ASD and parent, from dyads of children without autism and parent (See Table 2 for learning difficulties of comparison group). Children who had difficulties with learning were selected in order to ensure close matching with the ASD group, who also tend to have learning difficulties (Baron-Cohen, 2008). This broad profile of comparison children allowed closer matching with the ASD group on verbal and nonverbal cognitive ability as well as chronological age, than would comparison with a typically-developing group. In this respect, any difficulties among children with autism on measures of interest could be attributed to social-communication – rather than learning – difficulties.

INSERT TABLE 1 AND TABLE 2 AROUND HERE

All participants were administered the Autism Diagnostic Observation Schedule (ADOS: Lord et al., 2001) and the Social Responsiveness Scale (SRS: Constantino & Gruber, 2005).

The *Autism Diagnostic Observation Schedule* (ADOS: Lord et al., 2001) is considered a gold-standard tool in the diagnosis of autism and autism spectrum disorders. The assessment consists of a 30-45 minute interaction between the child and an examiner, using particular tasks such as reading a story from a book and creating a story using objects. Revised scoring procedures for the ADOS have been introduced since 2009 in order to calculate an autism severity metric, which quantifies severity of core autism symptomatology

(Gotham, Pickles & Lord, 2009). This ADOS-Severity Index was used for analyses in this study. The administrator and coder of the ADOS was trained to a standard of 80% reliability by a certified trainer.

The *Social Responsiveness Scale* (SRS: Constantino & Gruber, 2005) is a 65-item parent report that assesses the domains of social awareness, social cognition, social communication, social motivation and autistic mannerisms. T-scores above 60 are indicative of the presence of an ASD. The SRS has been used widely in studies of autism (Aldridge, Gibbs, Schmidhofer & Williams, 2012; Charman et al., 2007; Pine, Guyer, Goldwin, Towbin & Leibenluft, 2008).

On the basis of these diagnostic measures, expert clinical judgement of the research team (which included a clinical psychologist and trainee clinical psychologist), and consultation with the diagnosing clinical team for cases undergoing an ASD assessment, participants were classified as either having an autism spectrum diagnosis (n=20), or as non-ASD (n=20). Only children who met DSM-IV criteria for Autism Spectrum Disorders were included in the ASD group. Where diagnostic measures conflicted, clinical judgement was used to establish diagnostic group: one child in the ASD group had an SRS score below 60, and 9 children in the comparison group had SRS scores above the diagnostic cut-off of 60. The inclusion of these children in the respective groups was justified based on their clinical presentation, parent-reported concerns, and based on a caution that the SRS can show low specificity in clinical populations (Aldridge et al, 2012). An independent samples t-test confirmed that the ADOS severity score and the SRS Total Score were significantly different between the two groups, ADOS: $t(38)=-13.6$, $p<.001$; SRS: $t(38)=-6.4$, $p<.001$ (See Table 1 for descriptive data).

As well as chronological age and gender, groups were matched on verbal and non-verbal cognitive ability, as measured by the *Kaufman Brief Intelligence Test - Second Edition* (KBIT-2: Kaufman & Kaufman, 2004). The KBIT-2 is a brief, individually-administered measure of the verbal and nonverbal intelligence of a wide range of children, adolescents, and adults which yields three scores: Verbal, Nonverbal and the overall score, known as the IQ Composite (Table 1). An independent samples t-test showed no significant difference between the two groups on Full Scale IQ, $t(38)=-.54$, $p=0.59$, Verbal IQ, $t(38)=-.99$, $p=0.32$ or Nonverbal IQ $t(38)=.08$, $p=0.94$.

Measures

Parent Child Relationship Inventory (PCRI: Gerard, 1994). This is a 78-item self-report measure used to assess a wide range of parental attitudes towards parenting and parenting behaviour. Higher scores indicate positive attitudes and behaviour. The PCRI has been used in previous studies of parent-child relationship in autism (Beurkens et al., 2013; Osborne et al., 2008), and was used in the current study as a standardised measure of the quality of the relationship between parent and child. It was predicted that the PCRI would show a weak relationship with the codings of parent-child relatedness, in keeping with Beurkens et al (2013), which would thus evidence divergent validity.

CLINICAL TOOL UNDER RESEARCH

INSERT TABLE 3 AROUND HERE

Relationship Development Assessment – Research Version. In order to observe parent-child interaction, an abbreviated version of the Relationship Development Assessment (RDA), the observational assessment session used during RDI treatment, was administered and video-taped. This abbreviated assessment was developed with the supervision and input of the third author, a trainer expert in the use of this assessment tool. In this assessment, the parent and child are videotaped interacting over a standard set of activities to observe their degree of collaboration, joint attention and experience-sharing (Gutstein, 2000). Three specific tasks were chosen to provide an overview of the child and parent in different kinds of interaction – in collaborating over a shared task (e.g. joint construction), in a more fun, unstructured task (e.g. ball play) and in a task in which joint engagement would require greater structure (e.g. discovery box) (See Table 3). Parent and child were instructed to "Play with each other the way you would at home", the researcher left the room and returned briefly after 10-minute intervals to present the next activity.

Coding Schemes. The following three coding schemes were applied to the RDA-RV videotapes:

- *Attention Engagement States* (Adamson et al., 2004). This is a rating of joint attentional episodes between parent and child that has been adapted from a coding scheme by Adamson et al. (2004). In the current study, a simplified version was used to indicate how well children with autism shared attention with parents during interaction. In this study, this rating was assigned to

characterise the focus of the child in relation to both objects and their parent. It was predicted that the AES would differ significantly between groups, and would correlate with autism severity and another measure of parent-child interaction (DCS), but would not correlate with parent-child relationship scales on the PCRI.

- *RDA-RV Coding Scales*: These scales were developed by the third and fourth authors, with the coding revised for the current project (see also Author reference withheld for blind review). Two novel coding schemes were included:

  Interactive Regulation (IR) : These are judgments regarding collaboration within the dyad, and the amount of work each person does to maintain the coordination of their interaction.

  Intersubjective Engagement (IE): These are judgements regarding the degree of affective contact between the pair, and the level and depth of experience-sharing they show.

It was predicted that the RDA Coding Scales would distinguish the groups, and would correlate with a background measure of parent-child relatedness (DCS). It was also predicted that the RDA Coding Scales would correlate negatively with autism severity (ADOS and SRS).

INSERT TABLES 4, 5 AND 6 AROUND HERE

Coding Procedures. Global ratings of Attention Engagement States and the RDA Coding Scales were assigned based on the entire 30-minute RDA interaction, representing global judgements of the interactive processes at play rather than moment-by-moment ratings. The global ratings each described four levels of engagement, with better quality engagement indicated by higher scores (See Tables 4, 5 and 6). Raters made a judgement regarding how characteristic each level was of the dyad observed. Each level was judged to feature *Usually (code 3), Often (code 2), Sometimes (code 1)* or *Not at All (code 0);* these codes were multiplied by the values of the levels of engagement, and summed overall, to produce an overall rating between -8 and +8 (See Table 7). The coding schemes were presented and completed within an Excel spreadsheet which was formatted to automatically calculate the overall score. Coding of a 30-minute session typically took 45 minutes. [RDA Coding Scales and coding manuals are available from first author.]

INSERT TABLE 7 AROUND HERE

Dyadic Coding Scale (Humber & Moss, 2005): The Dyadic Coding Scale (DCS) was also applied to the videos to serve as a comparative measure of interaction quality. The DCS was developed to assess qualities of parent-child interaction in school-aged children, and focuses on aspects of secure attachment behaviour in typical development, as observed during a video-taped interaction. The domains measure the way in which the dyad negotiate their interaction, the affective qualities observed and a general rating of the relationship dynamic. A higher score on all domains indicates better interaction quality. For the current study, a DCS Total Score was also generated by adding the 9 scores between 1 and 7, resulting in a score between 9 and 63. We expected that the DCS Total Score would differ between groups, and correlate with standardised measures of autism severity (ADOS and SRS). We specifically predicted that the DCS Total Score would positively correlate with the Attention Engagement States and RDA Coding Scales ratings.

Coding Training and Reliability. Three raters (Raters 1, 2, 3) were blind to hypotheses, predictions and diagnoses, and coded all of the RDA-RV videos using either the DCS, AES or RDA Coding Scales. Rater 4 coded one-third (12) of the videos using each of these coding procedures. Reliability was established between Rater 4 and each of the other raters through discussion and joint coding on four videos and coding manuals were developed to guide subsequent independent coding. We calculated inter-rater reliability with intra-class correlations, applied to the overall scores, each of which had a possible range of -8 to +8 (Shrout & Fleiss, 1979). On the basis of the 12 videos, each rated independently by two separate coders, overall inter-rater reliability was excellent for Attention Engagement States (ICC = .82), and on the RDA Coding Scales, inter-rater agreement was good for Interactive Regulation states (ICC=.75) and excellent for Intersubjective Engagement (ICC=.82).

Results

INSERT TABLE 8 AROUND HERE

Descriptive Analyses on Global Ratings

Descriptive data on the coding schemes can be seen in Table 9. Performance on Attention was relatively high (possible range -8 to 8), while dyads showed more difficulty with the capacity to regulate the interaction and engage affectively. To investigate the normality of the coding scheme data, skewness and kurtosis values and histograms were examined. A normal distribution was indicated, therefore parametric analyses were used throughout.

INSERT TABLE 9 AROUND HERE

Discriminant Validity

Overall Codes. This analysis was undertaken to examine whether the global rating Overall Codes could differentiate between the groups of children with and without autism. As can be seen in Figure 1, on the Overall *Attention* score, both groups showed similar levels of proficiency at sharing attention during interaction on the AES (M_{ASD} = 5.4, SD_{ASD} = 1.3; $M_{COMPARISON}$ = 5.8, $SD_{COMPARISON}$ = 1.0, $t(38) = 1.08$, p=.29). Within the RDA Coding Scales, on the *Interactive Regulation (IR)* Overall rating the ASD group showed significantly lower levels on the balance of contingency and elaboration within the dyad (M_{ASD} = 0.80, SD_{ASD} = 2.66; $M_{COMPARISON}$ = 2.65, $SD_{COMPARISON}$ = 2.68, $t(38) = 2.18$, p=.035. On the *Intersubjective Engagement (IE)* Overall rating, there was no group difference on levels of affective engagement between parent and child (M_{ASD} = 1.60, SD_{ASD} = 2.18; $M_{COMPARISON}$ = 2.85, $SD_{COMPARISON}$ = 2.68, $t(38) = 1.61$, p=.114). In summary, the IR Overall rating from the RDA-Coding Scales discriminated between groups and the IE and Attention Engagement Overall ratings were similar between the groups.

INSERT FIGURE 1 AROUND HERE

Profiles of Global Ratings. The profiles of scores within the coding schemes, rather than the Overall codes, were compared to examine whether there were different trends in performance between the groups, and how these trends related to measures of autism severity and parent-child interaction quality. Group comparisons were made where possible differences were evident.

1. Attention Engagement States. Analysis of the AES codes revealed that the vast majority of dyads (75%, n=29) were scored as 'mostly' in a state of coordinated joint attention, the highest level of engagement on this rating. However, on further analysis the ASD group showed significantly higher levels of Supported Joint Attention, where the partners directly prompt or scaffold each other to engage in the interaction, $M_{ASD} = 1.80$, $SD_{ASD} = 0.89$; $M_{COMPARISON} = 1.05$, $SD_{COMPARISON} = 0.22$; $t(38)=-3.6$, $p=.001$. (See Table 10). This suggests that it was more difficult for the dyads with autism to engage spontaneously in shared exchanges.

2. RDA Coding Scales, Interactive Regulation. An independent samples t-test showed that the ASD group obtained significantly higher scores for the level of 'Contingency without Elaboration', $M_{ASD} = 1.85$, $SD_{ASD} = 0.75$; $M_{COMPARISON} = 1.35$, $SD_{COMPARISON} = 0.67$; $t(38)=-2.23$, $p=.032$, indicating that they spent more time at this level of engagement than the comparison group (See Figure 2). This describes an interaction that is fixed and rigid, with few variations to increase the enjoyment and excitement for the interactants (Table 10).

INSERT FIGURE 2 AROUND HERE

3. RDA Coding Scales, Intersubjective Engagement. As Figure 3 shows, the ASD group were scored as showing significantly more 'Coordination of Actions' (M=1.9, SD=0.8) than the comparison group (M=1.3, SD=0.8, $t=-2.38$, $p=.022$), where partners engage by telling each other what to do, and attempt to control each other's actions, rather than engage with each other's intentions or feelings. Twenty-five percent of the ASD group were rated as 'mostly' at this level, whereas none of the comparison group obtained a code of 'mostly' on this rating, (*p=.02, Fisher's Exact test, one-tailed*) – by contrast 55% of the comparison group were rated as 'mostly' engaged in Coordination of Intentions, where partners reference each other's intentions and movements so as to anticipate and share activity (See Table 10).

INSERT FIGURE 3 AROUND HERE

INSERT TABLE 10 AROUND HERE

Convergent Validity

This analysis was undertaken to examine whether the Overall global ratings and the profiles would cohere with measures of similar (DCS) and related constructs (ADOS and SRS), and thereby demonstrate convergent validity. Analyses were conducted both across the two groups and within the autism group.

Attention Engagement States Across Group Analyses. In line with our prediction, as Table 10 shows, Overall Attention ratings correlated significantly with the DCS Total, indicating that a better quality of parent-child interaction was associated with better coordination of attention. This was a moderate correlation in magnitude explaining 16% of the variance in the data. However, contrary to our prediction, the Attention ratings did not significantly correlate with standardised measures of autism severity: ADOS or SRS Total. As described above, Overall Attention ratings tended to be similar between groups, and did not pick up group differences in interaction, as both groups appeared to be proficient at coordinating attention to materials. However within the profiles the level of Supported Joint Attention correlated significantly with ADOS, $r(40)=0.44$, $p=.002$, and SRS, $r(40)=0.31$, $p=.025$, indicating that children with more impairment in social-communication and their parents found it more difficult to share attention spontaneously.

Attention Engagement States Within Group Analyses. Within the autism group, the Overall Attention score again did not correlate with ADOS or SRS, but the correlation between DCS Total and Attention remained significant, and moderate in magnitude, $r(20)=.45$, $p=.02$, one-tailed, indicating that among the children with autism, the capacity to share attention was associated with a better quality interaction.

RDA Coding Scales Across Group Analyses. In line with our prediction, *Interactive Regulation (IR)* and *Intersubjective Engagement (IE)* showed moderate correlation with the Dyadic Coding Scale (DCS) Total Score, explaining 31% and 39% of the variance respectively, indicating that the quality of parent-child interaction was

associated with co-regulation and affective engagement within the dyad (See Table 11). IR and IE were also found to correlate weakly to moderately with ADOS and SRS Total scores. This indicates that more severe levels of social communication impairment tended to be associated with difficulties in establishing or sustaining balanced, coordinated interactions within a dyad and in establishing affective engagements (See Table 10).

RDA Coding Scales Within Group Analyses. Within the autism group, *Interactive Regulation (IR)* again correlated moderately with the Dyadic Coding Scale (DCS) Total Score, indicating that severity of autism was associated with the quality of the interaction, an association accounting for 25% of the variance. No significant correlation was found between IR and ADOS, or between IR and SRS Total, contrary to prediction. Within the autism group, the *Intersubjective Engagement (IE)* rating again showed a significant and strong correlation with the DCS Total Score, indicating that for children with autism, a poorer ability to engage on an affective level was associated with poorer interaction quality with the parent. This association accounted for 49% of the shared variance in scores. No correlation was found between IE and ADOS or SRS, contrary to prediction. This may have been due to the high-functioning level of the autism sample. Amongst the profiles the level of 'Lack of Contingency' was found to correlate strongly with ADOS, $r(20)=.55$, $p=.006$, one-tailed, indicating that children with more severe autism were less able to coordinate with their parent to engage in a reciprocal exchange. This difficulty with coordination and the establishment of mutually-rewarding play is vital clinical information – this level of specificity may be important to understand and support remediation of social interaction difficulties in verbally-fluent children with autism.

INSERT TABLE 11 AROUND HERE

Divergent Validity

This analysis was undertaken to examine whether the Overall codes would deviate from a measure of parent-child relationship, which is a theoretically distinct construct. Correlations were run between the seven Parent Child Relationship Inventory (PCRI) scales and the Overall codes. There was one exception, a significant

correlation between Role Orientation on the PCRI, and the *Interactive Regulation* rating (See Table 12), and this represented a low to moderate positive correlation, accounting for 15.7% of the variance in the data. These low correlations suggest a weak relationship between parent-child relationship and the global ratings, which was in line with predictions, and supports the distinction between relationship and relatedness as found by Beurkens et al (2013). In summary, divergent validity was supported, as by and large the coding schemes did not correlate with a measure of parent-child relationship.

INSERT TABLE 12 AROUND HERE

Discussion

The clinical tool in this study consisted of a semi-structured observational assessment (the Relationship Development Assessment – Research Version) and coding schemes adapted for ease of use in clinical settings, focussing on three interpersonal processes between parent and child: shared attentional focus, the capacity to co-regulate an interaction, and the capacity to share emotional experiences. Increasingly research on autism has focussed on parent-child interaction, measuring interactive qualities such as *dyadic mutuality* (Wan et al., 2013). However, there is a shortage of reliable and valid measures for assessing parent-child interaction in research settings (Lord et al., 2005) and fewer still that are appropriate to clinical settings (Merrell, 2001). The gap is particularly wide for measures appropriate for school-age, verbally-able children and their parents, for whom parent-infant interaction tasks are not applicable.

The current study found preliminary support for a clinical tool measuring parent-child relatedness. The inter-rater reliabilities of the coding schemes were sound, while evidence for validity provided a more nuanced picture. The *Interactive Regulation* Overall rating showed the strongest evidence of validity and reliability across the groups. Detailed profile reviews of the coding schemes provided information that is applicable to clinical practice, both in terms of assessment of parent-child interaction and in terms of guiding subsequent remedial intervention, while also giving direction to the further development of the coding schemes. The semi-structured interaction, the RDA-RV, provided a useful and easily-replicable context within which to observe parent-child dynamics. As Lord et al (2013) point out, observation and coding of naturalistic exchanges provides an important means of measuring subtle changes in core autism symptoms.

Clinical Practice. Fine-grained analysis of the quantitative data revealed a number of discriminating features of interaction between children with autism and their parents that represent potential targets for intervention. For example on the *Interactive Regulation* rating, the information that parent-child dyads in which there is a child with autism spend greater amounts of time in rigid, unchanging patterns of interaction is consistent with previous research (Brigham et al., 2010; Doussard-Roosevelt et al., 2003; Wan et al., 2012). To illustrate, in one of the dyads in this study a mother and son played a game of 'thumb wrestling' repeatedly without variation at the boy's request, and this was followed by the mother becoming uninterested and slightly disengaged. Such forms of interaction may reduce the child's opportunities to learn flexible and dynamic ways of relating with others and with their environment. Therefore, this represents a key area for intervention, so as to increase the appeal and quality of parent-child interaction and thereby motivate the partners to engage with each other, facilitating the *guided participation* relationship so integral to development (Rogoff, 1990; Gutstein, 2001).

These practical, therapeutic ideas generated by the clinical tool suggests that it demonstrates 'treatment utility' – which is the degree to which an assessment contributes to treatment outcome (Nelson-Gray, 2003). In the time-limited work of a clinician, assessments that are meaningful for intervention, rather than those which are purely diagnostic, are essential: assessments should ideally be functional and lead to clinical application (Merrell, 2001). This clinical tool was relatively time-efficient, taking 45-minutes to code a 30-minute interaction, and requires less time and expertise to administer than an ADOS assessment. Furthermore, using the same measure to evidence change following treatment can be an important and powerful tool for use with families, and regular outcome monitoring can also help therapists to fit their interventions to the particular needs of a client (Nelson-Gray, 2003). The RDA-Coding Scales have been demonstrated to be sensitive to change following treatment in a previous study (Author reference withheld for blind review), thus they may operate well in this regard.

Because of the stigma generated by historical theories that autism was the consequence of neglectful or aloof parenting, interest in the relationship or interaction quality between parent and child has been neglected (Siller & Sigman, 2002). Contemporary research has identified patterns of parent-child interaction that can either hinder or promote development (Adamson et al., 2010; Wan et al, 2012), and as such,

interventions can now seek to empower the parent to engage with their child in sensitive and responsive ways so as to encourage their growth (Green et al., 2013; Kasari et al., 2010). The approach described in this paper helps to deepen our understanding of the facilitative aspects of parent-child interaction, which ultimately has implications for considering the nature of approaches to autism remediation.

Measure Development. Understanding which individual items are the strongest discriminators of group membership is an important consideration in a detailed examination of an assessment tool (Gillis et al., 2011). It may be the case that the Overall codes, generated by a weighted coding procedure, do not best reflect the differential performance of the dyads. One potential revision would be to refine the coding schemes to focus more closely on the areas with the greatest magnitude of group difference: this might follow a format like that used for the ADOS coding, where more salient codes relevant to diagnosis are included in the diagnostic algorithm. Procedures for establishing inter-rater reliability amongst clinicians should be outlined, which is common practice with other observational ratings (i.e. ADOS: Lord et al, 2001; Marschak Interaction Method Rating System, O'Connor, Ammen, Backman & Hitchcock, 2001).

Limitations. One limitation relates to the functioning level of the sample: the participants with autism in this project were relatively high-functioning, as evidenced by a mean Full-Scale IQ score in the Average range, and by their verbal fluency, as evidenced by the administration of Module 3 of the ADOS to all participants. It is important to investigate in future research whether these coding schemes are equally applicable to younger and/or less verbally-able children. It may be the case that the interactional difficulties highlighted in this study are more specific to this higher-functioning group. Furthermore, for the purposes of validation of the coding schemes, this study had quite a small sample size, which limits the confidence of the conclusions. However, as a preliminary validation it suggests areas for refinement and replication.

Methodological Implications. Traditionally, observing features of the 'functioning unit' of parent and child has been considered 'elusive', and difficult to code (Adamson et al., 2012). This study highlighted the fact that with adequate training and the use of a coding manual, abstract concepts related to interpersonal engagement can be operationalised and measured reliably. This is particularly pertinent since measurement of outcome for

autism intervention has begun to focus on interpersonal processes (Aldred et al., 2012; Green et al., 2010; Gutstein, 2009; Kasari, 2002; Kasari et al, 2006; Rogers & Vismara, 2008). This methodology straddles the traditional divide between qualitative and quantitative approaches: while a level of interpretation of interactional features is required, this can reliably be obtained through careful operational definitions and coder training (Angellilo et al., 2007). It also acknowledges and operationalises the bidirectional nature of the exchange, and the emergent qualities that arise out of interactional patterns (Chalmers, 2006), for instance, superordinate qualities of warmth, fun or balance in the dyad. As Vygotsky emphasises – to understand the compound *water* our level of interest should be in the qualities of the compound H_2O, rather than the component parts of Hydrogen and Oxygen. Water has qualities which neither hydrogen nor oxygen alone contain, so similarly to understand social development we must look at the social and interpersonal processes themselves (Vygotsky, 1978). Applying this insight to methodology in psychology and clinical psychology is a challenge, but the current and recent studies support this approach.

The broad field of social skills interventions is yet in its infancy (Odom et al, 2010; Rogers & Vismara, 2008). Relationship-based interventions are newer still, and as such, research on relevant outcome measures is an underdeveloped area of research (Kasari, 2002; Lord et al., 2005; Odom et al., 2010). This area of research remains at an exploratory stage, in which measure refinement is critical (Lord et al., 2005; Merrell, 2001). Results of this study are applicable in both research and clinical contexts, and contribute to the burgeoning field of investigating the influence and remediating effects of parent-child interaction on the development of children with autism.

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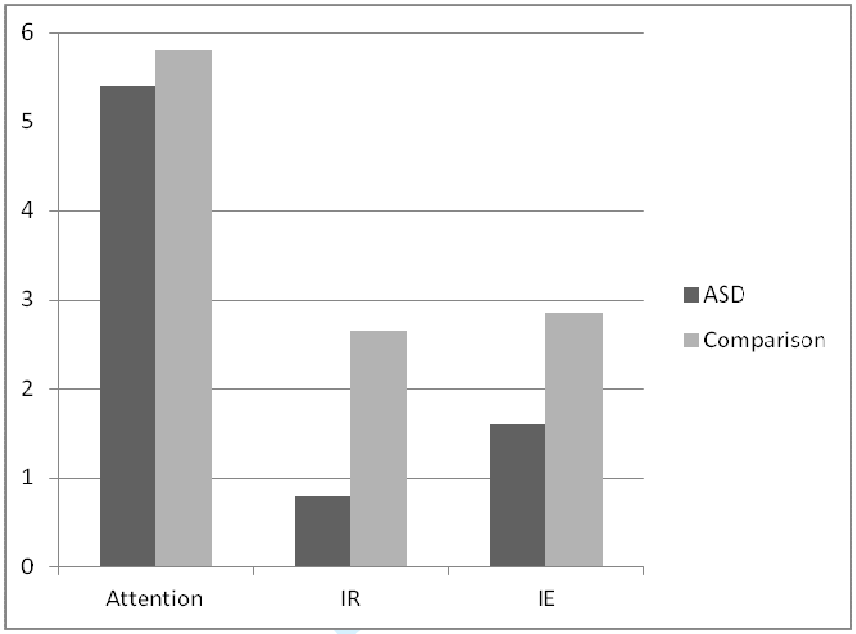

IR: Interactive Regulation; IE: Intersubjective Engagement

Figure 1. Mean group scores on Global Ratings Overall Codes.

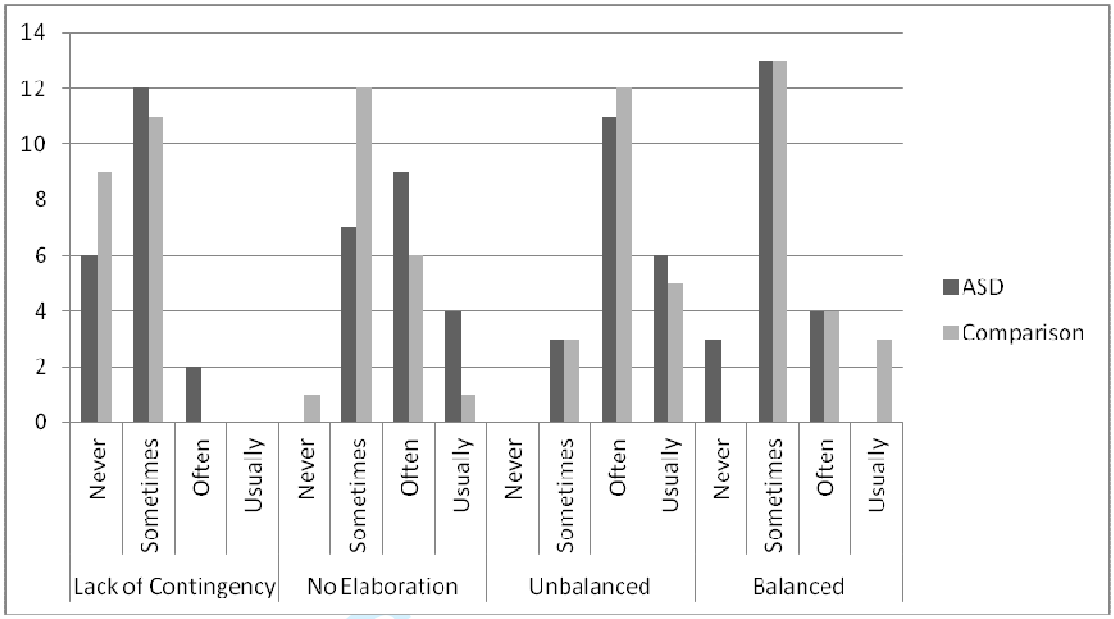

Figure 2. Profiles of IR Ratings By Group.

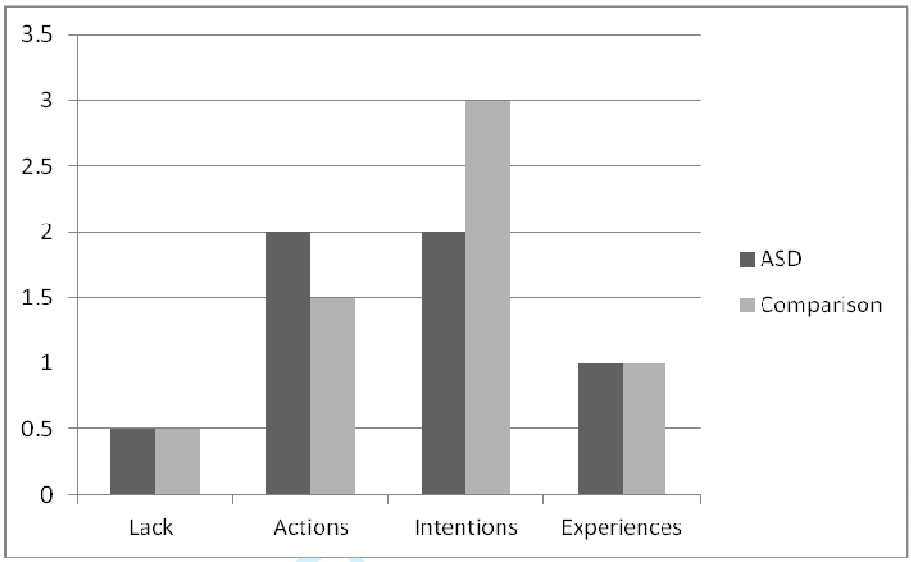

Figure 3. Median ratings on Levels of Intersubjective Engagement.

Table 1. Descriptive Data for ASD and Comparison Groups.

	ASD group (n=20) M (SD, Range)	Comparison group (n=20) M (SD, Range)
Age	9;10 (21 months, 6;0 – 14;6)	9;6 (11 months, 7;4 – 11;0)
Gender	16 male, 4 female	16 male, 4 female
ADOS severity score	7.1 (1.7, 4-10)	1.3 (0.6, 1-3)
SRS Total score	80.9 (10.5, 54-90)	56.5 (13.4, 42-81)
Participating parent (n)	Mother (18), Father (2)	Mother (17), Father (3)
Ethnicity (n)	Caucasian (20)	Caucasian (18), Mixed race (2)
Verbal IQ	92.2 (13.7, 63-117)	87.3 (17.3, 58-117)
Nonverbal IQ	92.9 (17.5, 59 – 126)	93.3 (16.3, 58-124)
Full Scale IQ	91.6 (15.1, 62-117)	88.9 (16.1, 53-118)

Table 2. Diagnoses for Comparison group.

Diagnosis	n=20
No diagnosis	5
Dyslexia	9
DAMP: Deficits in Attention, Motor control and Perception	1
Specific language impairment	1
Mild ID	1
Congenital deafness	1
Language impairment and dyspraxia	2
In receipt of additional supports at school (SNA, learning support, resource hours)	18

Note: Diagnoses do not sum to 20 due to multiple diagnoses in some participants.

Table 3. Materials for RDA-RV

ACTIVITY	MATERIALS	DESCRIPTION
Joint Construction Task		Parent and child were offered a choice of three joint construction tasks (building figures with straws, building a motorbike with a specialised set, or building mosaic patterns using a board and multi-coloured pieces).
'Keeping the Ball in Play':		An assortment of coloured balls was provided and the parent and child could create their own games with them.
'Discovery Box'		A locked box was presented to the child, and the parent was given a key. Inside the box were a number of toys, including a set of 'thumb war' characters, a jigsaw, playing cards, a jumping toy, toy cars, toy battle figures and stickers.

Table 4. Attention Engagement States (Adapted from Adamson et al, 2004)

Level	Value	Description	Example
U	-2	The child is uninvolved with other people, objects or events.	*Child ignores all toys and adult's overtures.*
SE	-1	The child is engaged with objects only.	*Child constructs car while parent watches silently.*
SJA	1	The child and parent are engaged with the same object, but the child is not actively acknowledging the parent's participation.	*Child makes patterns with mosaics while parent comments or assists, but child does not acknowledge what the parent says.*
CJA	2	The child and parent are actively engaged with the same object and each other.	*Child asks parent to provide instructions in construction task, and refers back to parent for guidance.*

U: Unengaged; SE: Solitary Engagement; SJA: Supported Joint Attention; CJA: Coordinated Joint Attention.

Table 5. RDA Coding Scales - Interactive Regulation States.

Level	Value	Description	Example
Lack	-2	The dyad may be experiencing disruption; absent joint engagement or uncoordinated engagement.	*Child talks obsessively about a topic, parent ignores and tries to introduce an activity the child is not interested in.*
Static	-1	The dyad remain coordinated but at the price of eliminating all variability and elaboration of their joint activity.	*Parent and child throw a ball over and back to each other with no chat or variations.*
Unbalanced	1	Contingency and elaboration are both present but all contingent adjustments and/or elaborations are made by one member of the dyad.	*The parent tells the child to turn around to elaborate a game of catch.*
Balanced	2	There is a sense of mutual sensitivity and responsiveness, as well as shared goals and intentions. Both partners add variations that enhance the collaboration.	*Parent and child both introduce variations into a game of catch.*

Lack:Lack of Contingency; Static:Contingency without Elaboration; Unbalanced: Contingency without Elaboration; Balanced: Balanced Contingency and Elaboration.

Table 6. RDA Coding Scales - Intersubjective Engagement States.

Level	Value	Description	Example
None	-2	No connection between the pair, or only physical contact with no pattern of interaction.	*Child holds on to parent but ignores her introductions to games or toys and does not answer her questions*
CA	-1	Instrumental communication: partners influence each other for discrete actions.	*Child asks for an object they want from the parent, but there is no eye contact or movement towards a planned joint activity*
CI	1	Partners anticipate each other's actions and move towards joint goals	*Parent and child pass each other pieces to complete a puzzle, discussing their strategy*
CE	2	Partners show affective engagement, show interest in the other's reactions, and may share opinions or memories, or use objects in a symbolic manner.	*Child shows an object to their parent and recalls a similar toy they played with on holiday*

CA: Coordination of Actions; CI: Coordination of Intentions; CE: Coordination of Experiences.

Table 7. Examples of Scoring Procedure.

Interactive Regulation Rating				**Intersubjective Engagement Rating**			
Label	Value	Code	Sum	Label	Value	Code	Sum
Lack	-2	Not at all (0)	(-2 x 0)	*None*	-2	Usually (3)	(-2 x 3)
Static	-1	Sometimes (1)	(-1 x 1)	*Actions*	-1	Sometimes (1)	(-1 x 1)
Unbalanced	1	Sometimes (1)	(1 x 1)	*Intentions*	1	Not at all (0)	(0 x 1)
Balanced	2	Often (2)	(2 x 2)	*Experiences*	2	Not at all (0)	(0 x 2)
Total			**4**				**-7**

Table 8. Objectives, Hypotheses, Predictions and Statistical Procedures

Objective	Hypothesis	Prediction	Statistical Procedures
Description	n/a	*n/a*	*Means, Standard Deviations and tests of normality on each rating.*
Discriminant validity	Children with autism and their parents have greater difficulty in sharing attention, co-regulating an interaction and with intersubjective engagement relative to children without autism and their parents.	*Children with autism will show significantly lower scores in parent-child relatedness on these coding schemes.*	*One-tailed t-tests on Overall Codes.* *Exploratory t-tests and Fisher's Exact tests on profile patterns within the ratings.*
Convergent validity	The severity of autism will be associated with more difficulty in parent-child interaction. The coding schemes of shared attention, coregulation and intersubjective engagement will show sensitivity to interactional features also measured by a global measure of parent/child interaction quality.	*The coding schemes will negatively correlate with standardised measures of autism severity and will positively correlate with an existing global measure of parent-child interaction within and across the groups.*	*1-tailed Pearson correlations across both groups and within the autism group.*
Divergent validity	The three coding schemes of parent-child relatedness measure a related but distinct construct to parent-child relationship quality.	*There will be a weak relationship between the coding schemes and a measure of parent/child relationship.*	*2-tailed Pearson correlations.*

Table 9. Descriptive Analysis for Coding Schemes on Whole Sample, n=40.

	Attention Engagement	RDA Coding Scales	
		Interactive Regulation	Intersubjective Engagement
Range	3 to 7	-6 to 7	-2 to 7
M(SD)	5.6 (1.2)	1.73 (2.8)	2.22 (2.5)
Skewness	-.756	-.181	.397
Kurtosis	-.089	-.738	-.738

Table 10: Illustrative qualitative descriptions from coding schemes

Coding Scheme and Code	Qualitative Description
Attention Engagement States: *Supported Joint Engagement*	A mother and daughter play together. The child sings repetitive songs with her teddy bear, following her own interest and ignoring the balls that the examiner has left for them to play with. The mother draws her attention to a game of football she is setting up. The child participates passively but tends to hug the mother excessively after each goal and the mother has to continually redirect the girl's attention to the game to avoid her talking continuously or wandering around the room.
Interactive Regulation: *Contingency without Elaboration*	A mother and son build a construction toy together. The mother sits attentively while the son independently follows the instructions and builds the toy. While she is available to him and responsive to his actions, she does not become actively involved as the child resists her attempts to point out where different pieces should go by moving the toy away from her. He occasionally points out what he is doing for her but does not seek her input. His rigidity is evident and the mother appears unhappy at being rejected.
Intersubjective Engagement: *Coordination of Actions*	A mother and son play with a selection of balls. The child tells the parent to blow up a balloon for him. She does, and then uses the balls to offer educational instruction on the solar system, and tells him to watch what she is doing. The child moves about the room, taking occasional interest. He tells the mother he wants to play with another toy, but she tells him to put it away.

Table 11. Whole Sample and Within Autism Group Correlations of DCS, ADOS and SRS with Attention, Interactive Regulation and Intersubjective Engagement Overall Ratings.

	DCS Total	ADOS	SRS Total
Attention Whole sample n=40	0.41**	-0.08	-0.06
Attention ASD group n=20	0.45*	0.26	0.21
IR Whole Sample n=40	0.56**	-0.36*	-0.44**
IR ASD group n=20	.50*	-.22	-.22
IE Whole Sample n=40	0.63**	-0.28*	-0.32*
IE ASD group n=20	.70**	-.19	-.04

*** p<0.01, * p<0.05, one tailed.*

Table 12. Correlations of PCRI with Global Ratings.

	Supp	*Satis*	*Inv*	*Comm*	*Lim*	*Aut*	*Role*
AES	*.035*	*-.169*	*-.098*	*.022*	*-.013*	*.061*	*-.059*
IR	*.23*	*.008*	*-.064*	*.224*	*.161*	*.244*	*.397**
IE	*.012*	*-.02*	*-.127*	*.121*	*.168*	*.036*	*.218*

**, p<0.05, one-tailed.*

Supp: Support; Satis: Satisfaction; Inv: Involvement; Comm: Communication; Lim: Limit Setting; Aut: Autonomy; Role: Role Orientation