Further refinement of the nature of the communication impairment in Cornelia de Lange syndrome.

by

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Abstract

Despite evidence suggesting significant impairment, information regarding communication in Cornelia de Lange Syndrome (CdLS) is limited. In this study we used the Pre-Verbal Communication Schedule (Short Form; Kiernan & Reid, 1987) to evaluate communication skills in individuals with CdLS (N=14), aged 5 to 14 years, and a contrast group of individuals with Cri du Chat syndrome (CdCS; N=14), matched for age and ability. A significant difference was identified in understanding non-vocal communication ($p < .005$) with the CdLS group showing a greater deficit. The findings indicate a syndrome specific deficit in understanding non-verbal communication in CdLS and dissociation between the processing of verbal and non-verbal information.
Introduction

Recent advances in genetics have been instrumental in enhancing research interest in behavioural phenotypes. To date, the focus of research into specific genetic syndromes has been on describing and delineating the presence and nature of psychological disorder and difference in this population. This has given rise to increased awareness of associations between genetic disorders and a range of conditions including challenging behaviour, autism spectrum disorders (ASD) and attention deficit disorders (see Arron, Oliver, Berg, Moss & Burbidge, 2011; Oliver, Berg, Moss, Arron & Burbidge, In Press). These developments in the field of behavioural phenotypes have contributed to the understanding of the aetiology and development of these conditions within the general population and are revealing gene-brain-behaviour-environment relationships that are of interest to mainstream developmental psychology, particularly with regard to different and delayed developmental trajectories (Thomas & Karmiloff-Smith, 2005; Cornish, Turk & Levitas, 2007).

The focus on describing psychological disorder of clinical importance within genetic syndromes has understandably overshadowed the study of other aspects of development in this population. In particular, little research in the field of behavioural phenotypes has focused specifically on the nature and development of communication skills. As evidenced in the wider intellectual disability population, understanding the nature and development of communication skills in genetic syndromes may have important implications for our understanding of a range of behavioural difficulties observed within this population, including the presence of challenging behaviour, ASD related characteristics and broader social interaction deficits. Cornelia de Lange syndrome (CdLS) is a relatively rare but well-known multiple malformation disorder (Kline et al., 2007), with numerous organs and systems affected during development (Liu & Krantz, 2009). CdLS is characterised by typical
facial features, growth retardation, upper limb defects and ID (Liu & Krantz, 2009). However, there is a broad range in the severity of ID associated with the syndrome (Kline et al., 2007). CdLS is caused by a deletion on one of three single genes. 20-50% of cases are accounted for by deletion on the NIP-BL gene on chromosome 5 (Gillis et al., 2004; Tonkin et al., 2004), while approximately 5% show mutations in SMC1A and SMC3 genes on chromosomes 10 and X respectively (Musio et al., 2006; Deardorff et al., 2007).

Many individuals with CdLS show comparatively poor expressive communication, evidenced principally by limited or absent speech (Goodban, 1993; Sarimski, 1997; Oliver, Arron, Sloneem & Hall, 2008). However, speech and language difficulties in CdLS have been described in general terms only (Kline et al, 2007; Liu & Krantz, 2009). A positive correlation between ID and communication impairments has been described in CdLS, which may help to explain the variability in communicative ability reported across individuals with the syndrome (Liu and Krantz, 2009). Other factors, such as birth weight, social relatedness, hearing impairment, upper limb malformations, and developmental ages for sitting up and walking, have also been reported to show an association with the acquisition of speech and language skills in individuals with CdLS (Goodban, 1993). However, there has been very little study of how specific communication difficulties manifest in this syndrome.

A number of behavioural difficulties have been described in CdLS which might be associated with these deficits in communication. Challenging behaviour, specifically self-injurious behaviour, has been reported to occur in approximately 70% of individuals with CdLS (Arron et al., 2011). Arron et al (2006) described the role of environmental factors in the behaviour of some people with CdLS. ASD symptomatology occurs in approximately 60% of individuals with CdLS (Berney, Ireland & Burn, 1999; Moss, Oliver, Berg, Kaur & Jephcott,
2008) and selective mutism, extreme shyness and social anxiety are reported to be particularly characteristic of the syndrome, occurring more frequently than would be expected in the wider intellectual disability population (Goodban, 1993; Collis, Oliver & Moss, 2006; Richards, Moss, O’Farrell, Kaur & Oliver, 2009; Moss et al., 2008). These social deficits are considered to play a role in the communication impairments observed in CdLS (Goodban, 1993). The study of early social-communication skills in CdLS has also demonstrated that poor social relatedness (including compromised use of eye contact and joint referencing) is highly characteristic of young children with CdLS (Sarimski, 2007; 2002). Skills in social relatedness are considered to underlie the development of pragmatic functions of communication, such as commenting on an object or act of interest (Abbeduto, Warren & Conners, 2007) and thus these early social difficulties in CdLS may have a significant impact on the development of communication.

In summary, there is little known about the nature of the communicative impairment in CdLS. This is the case despite evidence to suggest the presence of difficulties with expressive language, challenging behaviour and ASD symptomatology in the syndrome, all of which are known to be relevant to language and communicative ability. Increased information on the specific language and communication profile in CdLS will help to provide an insight into the difficulties that this group might experience and subsequently any strengths and needs may be recognised so that a successful communication environment may be optimised. In this study we aim to further evaluate pre-verbal communication skills of individuals with CdLS.

The widely accepted definition of behavioural phenotypes proposed by Dykens (1995) emphasises the importance of description of a phenotype relative to those without the
syndrome, normally a CA and MA comparable group. In this study, we compare individuals with CdLS to a matched contrast group of individuals with Cri du Chat syndrome (CdCS). Individuals with CdCS share several characteristics with CdLS such as associated degree of disability, level of receptive and expressive language skills, and expressive–receptive communicative discrepancies (Cornish & Bramble, 2002; Cornish, Bramble, Munir, & Pigram 1999; Cornish & Munir, 1998; Neihbur, 1978). The range of shared characteristics between these two syndromes makes them well-suited for comparison, as has been shown in previous studies (Moss et al., 2008; Sarimski, 2002).

CdCS is a rare chromosome disorder that affects approximately 1 in 50,000 live births (Cornish & Munir, 1998). It is caused by a deletion on the short arm of chromosome 5 (5p12) (Goodart et al., 1994; Overhauser et al., 1994). CdCS is associated with severe and profound intellectual disability (Cornish et al., 1999). Behavioral characteristics associated with the syndrome include hyperactivity and self-injurious, aggressive, and stereotyped behavior (Collins & Cornish, 2002). In particular, attachment to objects and sensitivity to sensory stimuli are common (Cornish & Pigram, 1996; Moss, Oliver, Arron, Burbidge & Berg, 2009). Although, communication skills have not been evaluated in detail, verbal communication skills are reported to be delayed (Cornish & Munir, 1998; Cornish et al., 1999). This is thought to be accounted for by congenital abnormalities of the larynx and poor motor skills (Neihbur, 1979; Sohner & Mitchell, 1991). However, nonverbal communication skills and social interaction skills are reported to be a relative strength associated with this syndrome (Cornish & Pigram, 1996; Cornish et al., 1998; Dykens, Hodapp & Finucane, 2000; Sarimski, 2002).
In this study we examined data collected from the Pre Verbal Communication Schedule – Short Form (PVCS- Short Form; Kiernan & Reid, 1987) in children with CdLS aged 5 to 14 years and a matched contrast group of children with CdCS who were matched according to chronological age and intellectual ability.

Method

Participants

Data were collected as part of a larger project evaluating ASD in individuals with CdLS and CdCS (Moss et al., 2008). 86 individuals with CdLS were contacted directly by the research team from a pre-existing participant database. Individuals with CdCS were contacted by the Cri du Chat Syndrome Support Group UK. Families attending one of three national conferences held by either the Cri du Chat Syndrome Support Group or the Cornelia de Lange Syndrome Foundation (UK and Ireland) were also invited to participate. Criteria for inclusion were as follows: individuals were between five and nineteen years of age, had a confirmed diagnosis from a paediatrician or clinical geneticist and lived within reasonable travelling distance from the research base. 35 (40.7% response rate) individuals with CdLS and 25 (46.3% response rate) individuals with CdCS agreed to participate. Three participants (one with CdLS and two with CdCS) were later excluded due to additional or questionable diagnoses. All participants received an information sheet, consent form and a questionnaire pack.

A subsample of 28 individuals (14 with CdLS and 14 with Cri du CdCS) were selected for analysis. These individuals were selected based similarity of chronological age and adaptive behaviour age equivalence (as measured by the Vineland Adaptive Behavior Scale; Sparrow, Balla & Cicchetti, 1984). Selected participants were five males and eight females with CdLS.
and five males and nine females with CdCS. All participants were aged between 5 -14 years. Table 1 describes the participant characteristics. No significant differences between the groups were identified for chronological age ($t(26) = .13, p = .90$), adaptive behaviour age equivalence ($t(26) = -1.44, p = .16$), verbal ability (Fisher’s exact $= .10$) or mobility (Fisher’s exact $= .68$). The CdCS group had better receptive language skills relative to the CdLS group ($U=45.50; p = .01$) as measured by the BPVS.

+++Insert Table 1 about here+++}

Measures:

*Primary measure - Pre-Verbal Communication Schedule – Short form (PVCS - Short form; Kiernan & Reid (1987)):* The PVCS was developed to identify early communication skills such as imitation, joint attention and understanding of language in people with intellectual disability. The PVCS (Short Form) evaluates the functional use of communication, e.g. whether the individual communicates simply (e.g. getting needs met, or rejecting unwanted items or people), or alternatively whether he/she communicates in more flexible or sociable way. The schedule consist of 82 checklist items which relate to eight subscale scores which evaluate how the person uses his/her means of communication and two subscale scores which evaluate imitation skills including: 1. Attention Seeking; 2. Need Satisfaction; 3. Simple Negation; 4. Positive Interaction; 5. Negative Interaction; 6. Shared Attention; 7. Understanding of Non-Vocal Communication; 8. Understanding of Vocalization of Speech; 9. Vocal Imitation and 10. Motor Imitation.

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1 One item, which was part of the Need Satisfaction subscale was omitted, resulting in a maximum score of 7 and not 8 in that section.
The method of scoring is intended to highlight where the participant has strengths, where skills are only partially established and where there are very limited skills and abilities (Kiernan & Reid, 1987). Scoring is achieved by awarding 1/0 for a ‘yes/no’ answer to directly observable items or as a numerical score (0-3) i.e. the number of times a participant makes the correct response and recorded under ‘Usually/Rarely/Never’. Usually is the participant’s typical pattern of behaviour, requiring a spontaneous action expected to occur at least once or twice a week. Rarely is not typical of the participant but he/she has shown the behaviour on at least one occasion. Never is scored when the participant has never been known to behave in a way described in a specific situation.

Items included in the Short Form are reported to have good reliability. Kiernan and Reid (1987) generated inter-rater reliability data for the items in the Schedule with 48 individuals with intellectual disability. The majority of items were reported to have % agreement of 70% and above (maximum 95.83%). There is limited information available regarding the validity of the Schedule, although Kiernan and Read (1987) describe a small validity study which indicated moderate reliability.

**Demographic Questionnaire:** The demographic questionnaire provided information regarding chronological age (CA), gender, mobility (able to walk unaided), verbal ability (more than 30 signs/words) and diagnostic status (the precise diagnosis made, when and by whom it was given).

**Vineland Adaptive Behavior Scale–Survey Form (VABS; Sparrow, Balla, & Cicchetti, 1984).** The survey form of the VABS is a semi-structured interview designed to assess adaptive behavior for use with individuals up to the age of 18 years. The interview is conducted using
open-ended questions regarding what the individual “usually” does. Items comprise four domains: Communication Skills, Daily Living Skills, Socialization Skills, and Motor Skills, and there is an overall Adaptive Behavior Composite (ABC). Standard scores and age equivalence scores, derived from a sample 3,000 children, can be calculated for each domain and ABC score. A severity classification (borderline, mild, moderate, severe, and profound) can be determined from the ABC score. Inter-rater, test–retest reliability, construct validity, content validity, and criterion-related validity are robust.

*British Picture Vocabulary Scale–2nd ed (BPVS; Dunn, Dunn, Whetton, & Burley, 1997).* The BPVS is used to assess receptive vocabulary for Standard English. Each item has four simple black and white pictures. The participant is asked to select the picture considered to illustrate the best meaning of a stimulus word presented orally by the examiner. Split-half reliability and internal consistency are good.

*Procedure:*

The measures were completed by the primary caregiver or teacher who was very familiar with the participant.

*Data Analysis:*

Independent t tests (following checks for normality of the data) were conducted in order to identify any significant differences between the CdLS and CdCS groups on each subscale score of the PVCS. The p-value was adjusted using a Bonferroni correction of .005 in order to avoid type 1 errors. A clinical interpretation of the scores is also described.

*Results:*
Findings from data analysis:

Table 2 describes the CdLS and CdCS group scores on each subscale of the PVCS and the results of the independent $t$ test comparisons. A significant difference was identified between the two groups on the Understanding Non-Vocal Communication subscale in which the CdLS group scored significantly lower than the CdCS group indicating greater impairment. A difference on the Motor Imitation subscale approached significance, with the CdLS group scoring lower than the CdCS group. No other significant differences were identified between the groups.

+++ Insert Table 2 about here+++

Findings from clinical interpretation:

Clinical interpretation of the scores suggests that neither group achieved scores indicating established skills in any subscale. Attention seeking, need satisfaction and simple negation appear to be in place, to a degree, in both groups, although need satisfaction is slightly weaker in CdLS. Difficulties with shared attention are evident in both participant groups. Both groups evidence use of communication in very simple ways (scores on imitation skills are low and the first three categories of each subscale are reported to be present but total subscale scores are low) and show difficulties with understanding language at more than a simple level, although the CdCS show more abilities in understanding non-vocal communication.

Discussion:

In this study we aimed to explore aspects of communication that might impact on the communicative development of CdLS compared to individuals with CdCS who were
matched for chronological age and adaptive behaviour skills. The PVCS (Short Form; Kiernan & Reid, 1987) is useful in exploring specific aspects of communication via questioning people who know the individual well and these measures allow comparison of skills and domains in communication. The two syndrome groups are well suited for comparison as individuals with both syndromes are known to have compromised expressive language and a receptive-expressive language discrepancy has been described in both groups (Goodban, 1993; Cornish & Munir, 1998; Cornish et al., 1999).

Statistical analysis revealed no differences between the groups on the majority of comparisons. However, a significant difference between the groups on understanding non-vocal communication was clearly evident. The CdLS group were significantly more impaired in this area relative to the CdCS group. Since these two groups were matched on chronological age and ability (as measured by adaptive behaviour skills), the findings may be considered to reflect a syndrome specific deficit in interpreting and understanding nonverbal communication offered by others in individuals with CdLS. It is notable that this deficit was specific to understanding non-vocal communication while skills in understanding vocal communication did not differ between the groups, suggesting dissociation between the processing verbal and non-verbal information within the syndrome, rather than an overall impairment in processing communication. The apparent deficit in understanding nonverbal communication in CdLS might help to explain some of the impairments in social interaction and social-relatedness that have been reported to be characteristic of individuals with CdLS, particularly the heightened levels of social anxiety and extreme shyness (Sarimski, 2007; Goodban, 1993; Moss et al., 2008).
A difference between the two groups on the Motor Imitation subscale approached significance ($p = .03$) with the CdLS group showing a greater deficit in this area. Interestingly, Vocal Imitation did not differ between the groups ($p = .15$). As with the findings regarding understanding non-vocal communication, the pattern of scoring in the CdLS group suggests a dissociation between motor and vocal imitation rather than a general deficit in imitation. However, it should be noted that problems such as motor, oral-motor and verbal dyspraxia (difficulty with the voluntary aspect of motor, oral motor and speech movements) and general difficulties in mobility are unlikely to have been identified or taken into consideration using this assessment. Such difficulties are known to be problematic in both syndrome groups (Cornish & Munir, 1998; Cornish et al., 1999; Goodban, 1993) and therefore future studies in imitation deficits in these groups should take these difficulties into account.

Clinical interpretation of PVCS scores indicated that neither group achieved scores demonstrating established skills on any subscale. Scores reflecting imitation skills and shared attention were low in both groups. Imitation and shared attention skills are important for demonstrating the ability to learn language (Kiernan & Reid, 1987) and restricted or no imitation and impairments in shared attention have been listed amongst other social impairments, as an early indication of ASD symptomatology (Baird, Cass & Slonims, 2003; Crane & Winsler, 2008; Charman et al., 2000). These difficulties certainly need to be considered in the light of previous studies highlighting characteristics of ASD in CdLS (Basile, Villa, Selicorni & Molteni, 2007; Moss et al., 2008; Oliver et al., 2008). Interestingly, ASD symptomatology is not considered to be strongly characteristic of individuals with CdCS (Moss et al., 2008; Oliver et al., in press). Social interaction is, in fact, thought to be a particular strength of individuals with CdCS (Cornish & Pigram, 1996; Cornish et al., 1998; Dykens et al., 2000; Sarimski, 2002). Taken together, these findings
suggest that in individuals with CdCS, imitation and shared attention skills may not be fundamental to social and communicative development, as is considered in other populations. It is possible that compensation may occur in other areas which enable successful development of these skills. Further assessment, including direct observation is needed to ascertain why there might be difficulties in imitation and shared attention in both groups and to further evaluate the impact of these early deficits on later development of social and communication skills.

The findings suggest that using either signs or symbols to reinforce language in teaching communicative responses to satisfy immediate needs e.g. asking for a drink might be useful in these two syndrome groups. The prompting and modelling involved is meaningful imitative training in itself (Kiernan & Reid, 1987). Furthermore, individuals may need to be taught to draw attention to objects or events for the sake of sharing the experience (Kiernan & Reid, 1987). Since shared attention is considered to be important in language outcomes and pragmatic functions (Abbeduto, Warren & Connors, 2007), intervention in this skill should receive priority (Sarimski, 2007). Such interventions aimed at increasing children’s use of pre-linguistic communication, are thought to have long-term language benefits (Brady, Marquis, Fleming & McLean, 2004).

Both the CdLS and CdCS groups were reported to use communication in very simple ways. Attention seeking, need satisfaction and simple negation appear to be in place, to a degree, in both groups, although need satisfaction is slightly weaker in CdLS. There may be various reasons for these difficulties. With regard to low scores for need satisfaction, Kiernan & Reid (1987) query whether the environment is set up to meet the individual’s needs and, if so, there is no need for the individual to learn to ask; and/or the individual may not have existing
methods of communicating needs successfully. Ensuring that the environment is appropriately adapted and that the individual has effective means and opportunity for communicating their needs to others is clearly important in order to ensure the best possible opportunity for communicative development.

While understanding of non-vocal communication was impaired in the CdLS group relative to the CdCS group, individuals with CdLS appeared to show slightly better understanding of non-vocalization compared to vocalization, although this was not tested statistically for significance. This discrepancy might be related to hearing difficulties (Kiernan & Reid, 1987) which are known to be problematic in CdLS (Goodban, 1993; Marchisio et al., 2008). As hearing impairments are often unrecognized in CdLS (Marchisio et al., 2008), gaining information about hearing abilities is an important aspect to consider in order to ensure performance on any task is not misinterpreted or disadvantaged due to hearing difficulties. This study is limited by the fact that this information was not available for the study sample and should be considered in future research in which communication skills are evaluated in this syndrome group.

The sample sizes of the CdLS and CdCS groups were small and it would be useful to conduct comprehensive speech and language assessments with a wider range of ages and abilities to form a developmental picture of communication skills and broader view of environmental issues, which might affect communication in these syndromes. However, the groups in this study were carefully matched for age and ability, resulting in a well controlled evaluation of these difficulties in CdLS and CdCS. It should be noted that the groups did differ on receptive language skills despite this level of matching. This is unlikely to have influenced the finding of a syndrome specific deficit in understanding non-verbal communication since
the groups performed similarly in all other areas of the PVCS and the BPVS measures ability to understand verbal language rather than non-verbal communication.

Using the shortened version of the PVCS in isolation may lead to a lack of information regarding hearing, listening, vision, use of hands and detailed information regarding functional communication. More detailed information in these areas may help to answer some of the questions posed by the findings in this study. Furthermore, the PVCS does not include questions regarding understanding means-end relations and make-believe play, which might be seen as crucial in the assessment of communicative and language skills (Kiernan & Reid, 1987). Other assessments would be needed for this purpose. Since individuals may communicate using different means in different environments (Kiernan & Reid, 1987), in future studies it may be useful to complete this questionnaire in different situations that the individual experiences. Finally, since carers tend to underestimate their own use of verbal communication and overestimate their use of non-verbal communication (Bradshaw, 2001) and consistently overrate the comprehension levels of the person with learning disabilities (Bartlett & Bunning, 1997), direct observation would be a useful addition in forming a comprehensive and objective view of the communication environment as a whole (Kiernan & Reid, 1987).

In summary, the findings indicate that in many ways, these two syndrome groups are not dissimilar in terms of their communication skills. However, individuals with CdLS show a syndrome specific deficit in understanding non-vocal communication relative to the CdCS group. Given the careful matching of the two participant samples, this deficit is unlikely to be accounted for by degree of intellectual disability. The fact that understanding vocal communication does not differ between the two groups, indicates the presence of a
dissociation between the processing of vocal and non-vocal information in CdLS. A similar pattern was observed in relation to motor and vocal imitation in CdLS with a specific deficit in motor imitation, rather than a general deficit in imitation skills. This might have implications for how communication training is approached in each syndrome and suggests that some aspects of communication may require a syndrome weighted perspective. Clinical interpretation of the findings also highlighted that both syndrome groups showed a deficit in imitation and shared attention. This may be important in understanding the difficulties in social interaction and ASD symptomatology that are characteristic of individuals with CdLS. Since difficulties in social interaction and ASD symptomatology are not typically evident in individuals with CdCS, this finding suggests that imitation and shared attention abilities may not be crucial to later social and communicative development in this group. Moreover, it may suggest that some level of compensation in other areas may occur which enables successful social development in individuals with CdCS. Further investigation will help to provide the information necessary to begin to understand the individual qualities of communicative abilities within these two syndromes and the impact that these early difficulties have on later social and communicative development

References


Table 1. Mean, standard deviation and range of chronological age, adaptive behaviour age equivalence and receptive language age equivalence in CdLS and CdCS. Rates of mobility and level of verbal ability are also reported.

<table>
<thead>
<tr>
<th>Variable</th>
<th>CdLS (n=14)</th>
<th>CdCS (n=14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Mean</td>
<td>(SD)</td>
</tr>
<tr>
<td>Chronological Age¹</td>
<td>9.43</td>
<td>(2.90)</td>
</tr>
<tr>
<td>(Range)</td>
<td>5.00 – 14.0</td>
<td>5.00 – 14.0</td>
</tr>
<tr>
<td>Adaptive Behaviour Age Equivalence²</td>
<td>17.70</td>
<td>(7.73)</td>
</tr>
<tr>
<td>(Range)</td>
<td>10.00-33.25</td>
<td>10.50-38.00</td>
</tr>
<tr>
<td>Receptive language age equivalence³</td>
<td>28.35</td>
<td>(1.34)</td>
</tr>
<tr>
<td>(Range)</td>
<td>28.00-33.00</td>
<td>28.00-56.00</td>
</tr>
<tr>
<td>&gt;30 words or signs %</td>
<td>14.30</td>
<td>50.00</td>
</tr>
<tr>
<td>(N)</td>
<td>2</td>
<td>(7)</td>
</tr>
<tr>
<td>Mobile (walks unaided) %</td>
<td>78.60</td>
<td>64.30</td>
</tr>
<tr>
<td>(N)</td>
<td>11</td>
<td>(9)</td>
</tr>
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</table>

¹ In years
² In months. Scores based on four domains of the Vineland Adaptive Behavior Scales.
³ In months. Scores based on the BPVS
Table 2. Means, SDs and statistical analyses of differences between groups on PVCS Subscales

<table>
<thead>
<tr>
<th>PVCS subscale and total scores (possible maximum score)</th>
<th>CdLS (n=14) Mean (SD) Range</th>
<th>CdCS (n=14) Mean (SD) Range</th>
<th>t/(df)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention Seeking (5)</td>
<td>2.29 (1.27) 0.00-4.00</td>
<td>2.73 (1.50) 0.00-5.00</td>
<td>-.85</td>
<td>.41</td>
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<tr>
<td>Need Satisfaction (7)</td>
<td>2.50 (1.34) 0.00-5.00</td>
<td>3.47 (1.41) 1.00-6.00</td>
<td>-1.85</td>
<td>.08</td>
</tr>
<tr>
<td>Simple Negation (5)</td>
<td>2.21 (1.12) 1.00-4.00</td>
<td>2.54 (1.27) 1.00-5.00</td>
<td>-.72</td>
<td>.48</td>
</tr>
<tr>
<td>Positive Interaction (6)</td>
<td>2.50 (1.91) 0.00-6.00</td>
<td>3.02 (2.22) 0.00-6.00</td>
<td>-.67</td>
<td>.51</td>
</tr>
<tr>
<td>Negative Interaction (6)</td>
<td>1.59 (1.41) 0.0-4.00</td>
<td>1.45 (1.26) 0.0-4.00</td>
<td>.28</td>
<td>.79</td>
</tr>
<tr>
<td>Shared Attention (5)</td>
<td>1.33 (1.26) 0.00-4.65</td>
<td>1.67 (1.71) 0.00-5.00</td>
<td>-.59</td>
<td>.56</td>
</tr>
<tr>
<td>Total Understanding Non-vocal Communication (10)</td>
<td>4.20 (1.93) 1.00-7.00</td>
<td>6.35 (2.73) 0.00-10.00</td>
<td>-3.40</td>
<td>&lt;.005</td>
</tr>
<tr>
<td>Total Understanding Vocalization (14)</td>
<td>4.47 (4.61) 0.00-13.00</td>
<td>6.68 (1.38) 0.00-13.00</td>
<td>-1.48</td>
<td>.15</td>
</tr>
<tr>
<td>Total Motor Imitation (10)</td>
<td>1.96 (2.63) 0.00-8.00</td>
<td>4.47 (3.77) 0.00-10.00</td>
<td>-2.32</td>
<td>.03</td>
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<tr>
<td>Total Vocal Imitation (13)</td>
<td>2.29 (3.26) 0.00-9.00</td>
<td>4.04 (3.89) 0.00-9.33</td>
<td>-1.50</td>
<td>.15</td>
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