Title: Mapping early environment using communication deviance: A longitudinal study of maternal sensitivity towards 6-month-old children

Word count (Abstract): **200**

Word count (Text body): **4919**

Authors: Paulo de Sousa^a, William Sellwood^b, Kirsten Fien^c, Helen Sharp^c, Andrew Pickles^d, Jonathan Hill^e, Kate Abbott^a, Louise Fisher^c and Richard P. Bentall^f

Author affiliations:

^a Doctorate in Clinical Psychology, School of Psychology, University of Liverpool, UK

^b Division of Health Research, Lancaster University UK

^c Department of Psychological Sciences, Institute of Psychology, Health and Society, University of Liverpool, UK

^d Institute of Psychiatry, King's College London, UK

^e School of Psychology and Clinical Language Sciences, University of Reading, UK

^f Department of Psychology, University of Sheffield, UK

Corresponding author: Paulo Alexandre Brito de Sousa, University of Liverpool, School of Psychology, Ground floor, Whelan Building, Quadrangle, Brownlow Hill, Liverpool L69 3GB, UK. Tel.: +0044 0151 794 5530. E-mail address:

sousa@liv.ac.uk

ABSTRACT

The current study explored the association between communication deviance (CD) in a cohort of mothers ($n = 287$) at 32 weeks gestation and maternal sensitivity (MS) to the infant's cues during playful interaction at 6 months into the post-natal period. CD during the antenatal period was a significant predictor of lower MS during play ($B = -0.385$; $p < .001$). The relationship remained significant when maternal age, IQ and index of multiple deprivation (IMD) were accounted for. Further analyses revealed that CD was a significant predictor of MS in the context of infant distress ($B = -0.514$; $p < .001$) but less so in the context of non-distress ($B = -0.311$; $p < .01$). Results suggest that CD may index a complex cross-modal process affecting mother-child interactions.

1. Background

1.1 Communication Deviance (CD)

The concept of CD was developed in early attempts to understand the familial and environmental predictors of psychosis (de Sousa, Varese, Sellwood, & Bentall, 2013) and refers to qualities of communication, usually coded from parental speech, that leave a listener uncertain, puzzled and unable to share a focus of attention with the speaker. The construct reflects a range of perceptual-cognitive and linguistic-verbal reasoning atypicalities that are believed to impair the establishment and maintenance of focus of attention during communication and hence compromise the development of grounding, shared meaning and conversational alignment between interlocutors (Miklowitz & Stackman, 1992; Nuechterlein, Goldstein, Ventura, Dawson, & Doane, 1989; Singer & Wynne, 1965a, 1965b; Wynne, Singer, Bartko, & Toohey, 1977; Wynne & Singer, 1963a, 1963b). These atypicalities are subtle and can range from ambiguous linguistic references (e.g. “Kid stuff that's one thing but something else is different too”; Velligan, et al., 1990, p. 18) or contradictions (e.g. “I didn’t get much sleep last night (interviewer: are you tired?) Yeah, I ain’t tired”, Docherty, 1993, p. 753) to more overarching non-verbal atypicalities at the level of the pragmatics of communication (e.g. mistimed turn-taking, Wynne et al., 1977).

Lyman Wynne and Margaret Singer, who originally coined the term, argued that CD in parents contributes to the development of psychiatric symptoms in children through its pervasive effect on the offspring’s socio-cognitive development during formative years (Wynne et al., 1977). They argued that, children learn to share and sustain foci of attention, and thereby derive meaning from the world around them, through communication with their parents (Wynne, 1981, 1984). It was initially hypothesized that CD in the caregiver, in interaction with genetic vulnerability in the

offspring, would lead to the escalation of the cognitive and affective atypicalities, especially thought disorder, later observed in schizophrenia (Wynne, 1981). Consistent with this hypothesis, Wahlberg and colleagues (1997, 2000) used an adoption study to show that the interaction between adoptees' genetic risk (having a biological mother diagnosed with schizophrenia) and adoptive parents' CD was a significant predictor of thought disorder (TD) in the adoptee. In this study, high genetic risk alone did not predict TD and, in fact, high genetic-risk adoptees when exposed to low CD parents displayed less TD than low risk adoptees. However, it is not yet clear whether parental CD is a risk factor specific to TD, schizophrenia or a wider range of psychiatric conditions (Roisko, Wahlberg, Hakko, & Tienari, 2014). Indeed, it is possible that CD may reflect an important environmental risk for a range of mental health disorders (Wahlberg et al., 2004).

Evidence on mechanisms linking CD to specific developmental processes in childhood is limited. Cross sectional studies have found that CD in the caregiver is associated with poorer social, cognitive and emotional development in 7 and 10 year olds offspring of parents diagnosed with severe mental health disorders (Doane et al., 1982), and with social withdrawal and behavioral problems in 9 year olds (Velligan, Christensen, Goldstein, & Margolin, 1988). Findings from longitudinal studies using measures based on concepts allied to CD have been consistent with early effects. For example, disrupted caregiver-infant communication (e.g. caregiver's contradictory affective cues or withdrawal, Lyons- Ruth, Bronfman, 1999) at the age of 18 months has been shown to significantly predict symptoms of dissociation 20 years later (Dutra, Bureau, Holmes, Lyubchik, & Lyons-Ruth, 2009).

Drawing from data collected in a high-risk longitudinal study (University of Rochester Child and Family Study, Wynne, Cole, & Perkins, 1987), researchers

reported associations between parental communication that is vague, contradictory and disconfirming and both anxiety (Wichstrøm, Holte, & Wynne, 1993) and poorer social competence in 7 and 10 year old offspring (Wichstrøm, Holte, Husbey, & Wynne, 1994; Wichstrøm, Holte, Husby, & Wynne, 1993). Interestingly, in the same high-risk cohort, but at longer follow-up (≥ 18 years of age), disqualifying communication in parents significantly predicted psychological distress, well-being and global mental health in their children (Wichstrøm, Anderson, Holte, & Wynne, 1996). Disconfirmatory communication was also a significant predictor of poor interpersonal functioning and mental health hospitalization in the offspring (Wichstrøm, Anderson, Holte, Husby, & Wynne, 1996).

Wynne's original proposal was that child socio-cognitive development occurred along different dimensions of family *relatedness* such as caregiving, problem solving, mutuality and intimacy and that these dimensions represented different and evolving levels of dyadic and familial interaction (Wynne, 1984, 1988). Specific atypicalities at the level of communication in the caregiver were hypothesized to disrupt early development through its expression at the more basic level of *relatedness* with the infant i.e. during early pre-verbal dialogues (Wynne, 1968). In other words, caregiving was assumed to have a crucial communicative component and CD was conceptualized as a risk marker for parental mental processes that might give rise to disruptions to the caregiving system (Singer & Wynne, 1966). For example, CD may reflect a general limitation in a parent's capacity to generate a reciprocal intersubjective space with the child, basis for shared meaning, which should be evident in observed early caregiver-infant interactions prior to language. However, this hypothesis has not been examined previously.

1.2 Maternal sensitivity

Maternal sensitivity, refers to the extent to which parental responses to infant cues are contingent, appropriate, interested and warm (Bornstein & Tamis-LeMonda, 1997). The importance of maternal sensitivity during infancy is supported by diverse findings, including that low maternal sensitivity during infancy predicts harsh parental discipline during toddlerhood (Joosen, Mesman, Bakermans-Kranenburg, & van Ijzendoorn, 2012), and that maternal sensitivity interacts with MAOA polymorphisms to predict temperamental anger proneness (Pickles et al., 2013), and with DRD4 polymorphisms to predict child externalizing behaviors (Bakermans-Kranenburg & Van Ijzendoorn, 2006).

Associations between maternal sensitivity during infancy and academic and social functioning in adolescence and up to age 32 years have been reported, suggesting an enduring effect. Using data from the NICHD Study of Early Child Care and Youth Development, Fraley and colleagues took advantage of repeated measurements of maternal sensitivity and of social and academic competence over childhood, together with measures of potential confounders to examine whether there was an enduring independent contribution of maternal sensitivity to adolescent functioning (Fraley, Roisman, Booth-LaForce, Owen, & Holland, 2013). They found that the strength of association between maternal sensitivity and later social and cognitive functioning did not attenuate over time, and that it could not be accounted for by potential confounding variables such as maternal education, nor by maternal sensitivity over the intervening period between infancy and adolescence, nor by transactional processes. Using data from the Minnesota Longitudinal Study of Risk and Adaptation, the same group showed similar effects up to age 32 for academic functioning although, in the case of social functioning, associations with maternal

sensitivity were accounted for by confounders such as early socio-economic factors and child's sex (Raby et al., 2014). Although these studies did not consider potential genetic confounds, van der Voort and colleagues (2014) addressed this possibility in a longitudinal study of children adopted in infancy (parent-child dyads had no biological relation) and found that maternal sensitivity during infancy predicted internalizing symptomatology during adolescence. A causal role for maternal sensitivity in development is further supported by clinical trials of attachment-based intervention programmes that show that rates of insecure or disorganized attachment can be reduced by increasing maternal sensitivity (Juffer, Bakermans-Kranenburg, & van IJzendoorn, 2005; Van IJzendoorn, Juffer, & Duyvesteyn, 1995).

1.2.1 Sensitivity to distress and to non-distress

Methods to assess maternal sensitivity vary considerably in the extent to which they use home or lab-based observations, whether the conditions are standardised, the duration of the observations, and their coding. It may be that these broad characterizations ignore possible issues of domain specificity whereby aspects of sensitivity that entail different processes may have different developmental consequences (Grusec & Davidov, 2010). In particular, maternal sensitivity to infant bids for reciprocity in playful interactions are likely to promote joint exploration and joint attention (Hobson, Patrick, Crandell, Perez, & Lee, 2004) and hence cognitive development (Bornstein & Tamis-LeMonda, 1997) but they do not appear to contribute to attachment security (Murray et al., 2008). In contrast, sensitive comforting responses to infant distress are associated with attachment security (Leerkes, 2011) but not cognitive development (McElwain & Booth-Laforce, 2006). Moreover, it has been suggested that sensitivity to distress and sensitivity to non-

distress may have different antecedents, with maternal sensitivity to non-distress being associated with socio-demographic risk (e.g. age, education, income, uninvolved partner) and sensitivity to distress being associated with the caregiver's emotional and cognitive competencies and responses to the infant's negative emotions (Leerkes, Crockenberg, & Burrous, 2004; Leerkes, Weaver, & O'Brien, 2012; Leerkes, 2010).

1.3 Current study

Most previous studies of CD are open to the criticism that associations with child behaviours may arise from evocative effects of children on parental speech and communications (Miklowitz & Stackman, 1992). In this study, we assessed maternal CD during pregnancy, before the birth of a first child, and so are able to ask whether there is a temporal association between CD and observed interactions between mother and child as the child develops.

We investigated whether CD measured during pregnancy in primiparous mothers was a significant predictor of caregiver's insensitivity during caregiver-infant interaction at 29 weeks. Given Wynne's (Wynne et al., 1977) hypothesis that CD indexes a more fundamental disruption of mother-child relatedness, we predicted that increased CD at 32 weeks gestation would be associated with decreased maternal sensitivity during early caregiver-infant dyadic communication and that plausible confounders would not explain these effects. As maternal sensitivity in the context of infant distress and non-distress may each have distinct antecedents, and different consequences for the infant's socio-cognitive development, we examined the contribution of CD to each.

2. Methods

2.1 Design

The current study draws on data from the Wirral Child Health and Development Study (WCHADS; Sharp et al., 2012), a prospective longitudinal study that aims to identify early social, emotional and biological risks involved in the development of childhood conduct problems.

First-time mothers were recruited to establish a general population (extensive) sample, from which an intensive subsample stratified by psychosocial risk (partner psychological abuse) was drawn, and both were then followed in tandem. This two stage stratified design enables intensive measurement in the subsample, including assessment of CD and maternal sensitivity, while collection of other measures across the extensive sample allows weighting back of the findings from the intensive subsample to give general population estimates. A detailed flowchart of the sampling and recruitment procedure can be found elsewhere (Sharp et al., 2012). The extensive sample comprised primiparous mothers (≥ 18 years of age and English speaking) who sought antenatal care at 12 weeks gestation between February 2007 and October 2008 at the Wirral University Teaching Hospital.

At 32 weeks, mothers in the intensive sample completed a five-minute speech sample (FMSS; Leeb et al., 1991), which were later coded for CD. The task was part of a more comprehensive set of interviews and assessments. The speech samples were audio-recorded and later transcribed by members of the WCHADS team. At 29 weeks into the post-natal period, mothers completed a 15-min play protocol with their babies in the research base (NICHD Early Child Care Research Network, 1999). Maternal sensitivity was coded from these interactions. CD was coded blind to maternal sensitivity codings and vice-versa.

Approval for the procedures was obtained from the local Research Ethics Committee.

2.2 Recruitment and sample

Described in detail in Sharp et al. (2012) the full cohort of 1233 WCHADS mothers with live singleton births have participated in several waves of assessment but a stratified random sub-sample of 316 was drawn for additional more intensive assessment. FMSS at 32 weeks gestation were available for 287 women in the intensive sub-sample and 272 mother-infant dyads were later observed in interaction at 29 weeks. Completed speech samples and postnatal interaction data was available for 237 dyads for sensitivity in a non-distressed context, and for the 180 dyads whose interaction included naturally occurring infant distress, sensitivity in the context of infant distress. Appropriately analysed the design allows estimates of means and coefficients for the whole general population cohort to be derived for all measures including those available only in the intensive sample

2.3 Measures and procedure

2.3.1 CD

The CD coding system was originally developed for family interaction (Velligan, 1985) and it captures eight different types of communicational atypicalities that are based on previous work on CD (Doane & Singer, 1977; Singer & Wynne, 1965a, 1965b, 1966; Wynne et al., 1977; Wynne & Singer, 1963a, 1963b), namely: (1) abandoned, abruptly ceased, uncorrected remarks; (2) unintelligible remarks; (3) contradictions, denials and retractions; (4) ambiguous referents; (5) extraneous questions and remarks, (6) tangential, inappropriate responses to questions or

remarks; (7) odd word usage/odd sentence construction; and (8) reiteration. Table 1 shows definitions and examples for the different codes.

CD scores were calculated as the number of instances of CD divided by the number of words spoken to account for verbosity (as suggested in the literature, Hirsch & Leff, 1971; Miklowitz & Stackman, 1992). This coding protocol has been shown to have good reliability and construct validity (Velligan, Goldstein, Nuechterlein, Miklowitz, & Ranlett, 1990) and has been previously used with clinical (Velligan et al., 1996; Velligan, Funderburg, Giesecke, & Alexander, 1995) and high-risk populations (Velligan et al., 1988). The system has also been previously applied to natural speech samples (Docherty, 1993) and to FMSS (Kymalainen, 2005; Kymalainen, Weisman, Rosales, & Armesto, 2006).

A total of 287 FMSS (Leeb et al., 1991) were coded from the mothers in the intensive sample. In this task the mother was invited to talk for five minutes about her future child using the following prompt:

“I would like to hear your thoughts and feelings about your baby at the moment, in your own words without me interrupting. When I ask you to begin I would like you to speak for 5 minutes, tell me what your impressions have been of your baby whilst you’ve been pregnant. Have you got any questions before we start?”

<i>CD code</i>	<i>Definition</i>	<i>Example</i>
Abandoned, abruptly ceased, uncorrected remarks	Speaker abruptly abandons an idea without returning to it leaving a sense of no closure.	<i>“M: You know, what does it...I wanna look like that you know. So it wasn’t...That’s, I think that’s what was sort of so err, hard.”</i>
Unintelligible remarks	Speaker makes remarks that are not understandable in the context of conversation.	<i>“M: At the moment I feel like... ‘cause even, we had a doctors appointment yesterday morning and we still can’t categorically say we know a lot about genetically what happens, what the baby’s made of so I don’t think many people know that you see.”</i>
Contradictions, denials and retractions	Speaker contradicts, openly retracts or denies what he has previously said.	<i>“M: That’s all really, I’m just happy about it (...) M: I <u>don’t</u> know how I feel.”</i>
Ambiguous referents	Speaker uses linguistic referents that are unclear or ambiguous and that could be referring to more than one person or object.	<i>“M: I maybe don’t allow myself as much of <u>that</u> as what maybe I should do because I’m always focussed on making sure everything’s okay, you know.”</i>
Extraneous questions and remarks	Speaker makes comments or asks questions that are extraneous to the task.	<i>“M: What do people normally say? M: It’s very strange being asked to ramble”</i>

Tangential, inappropriate responses to questions or remarks	Speaker makes non-sequitur replies to questions or remarks.	<i>"(...) Err, chest of drawers and we just need to get a little wardrobe and I've got like this lamp, a Winnie the pooh lamp, that plays music and stuff and you can get like a Winnie the Pooh thing to put over the cot and stuff, make it all dead nice. It doesn't have to be Winnie the Pooh but I thought Winnie the Pooh would be nice, plus [partner's name]'s mum gave us some Winnie the Pooh pictures for the walls so that's made us decide Winnie the Pooh."</i>
Odd word usage/odd sentence construction	Speaker uses of words or sentences in a way that is odd, incorrect or out of context.	<i>"M: I feel like quite protective over her even though she's not here <u>already</u>."</i>
Reiteration	Speaker repeats the same thought, idea or word several times without adding new information.	<i>"M: I think I <u>probably</u> worry <u>probably</u> as a tendency more than <u>probably</u> most people would but then that's <u>probably</u> because I <u>probably</u> am aware of every eventuality."</i>

Table 1 - Definitions and examples of the CD codes (Velligan, 1985).

Two raters, who were blind to all other study variables, carried out the coding. For purposes of training, first (P.S.) and third author (K.F.) coded 31% (90) of the speech samples. The training period was preceded by the careful reading of relevant papers in the field of CD (Singer & Wynne, 1966) and the coding manual that was kindly provided by its author (Velligan, 1985). Both coders were only provided with anonymised transcripts and audio-recordings (the only information available was the participants id number) hence remaining blind to any background information about the mothers. Following a period of training, both coders independently scored a subset of 30 speech samples (~10%). Some of the CD codes were very infrequent (e.g. reiteration) but the estimated reliability was good (intraclass correlations for the different items ranged from .77 to .97).

2.3.2 Maternal sensitivity at 29 weeks

Maternal sensitivity was assessed with a 15-min standardized laboratory-based protocol (NICHD Early Child Care Research Network, 1999). Mothers were asked to play with their infants seated in a reclining chair or on the floor mat as they would at home. The protocol started with the following prompt:

“Play as you might usually do with your baby”

During the initial 7 minutes, mothers were instructed to play with their babies using a toy of their choice. After the initial 7 minutes, a researcher knocked on the door and instructed the mother to play for an extra 8 minutes with a set of standardised toys provided by the WCHADS team resulting in a total of 15 minutes of video recorded play. The camera was placed so that full-face view of the infant and

the mother could be captured to enable team to code eye-to-eye contact between mother and infant.

An investigator from NICHD Early Child Care Research Network trained raters who were blind to other measures of the study. Subsequently, raters coded sensitivity from the video recordings. Each rater (K.A. and L.F.) achieved good inter-rater reliability for maternal sensitivity on a subset of 30 assessments (intraclass correlations ranged from .85 to .91).

Maternal sensitivity to distress and maternal sensitivity to non-distress were rated using a 5-point scale, ranging from 1 (not at all characteristic) to 5 (highly characteristic) reflecting mothers' appropriate, supportive, warm responding to infant communications, playful bids or distress.

2.3.3 Confounders

Maternal age and socio-economic deprivation have been found to be important predictors of maternal sensitivity to non-distress (Leerkes et al., 2012) and therefore were included in the analysis as potential confounders. Moreover, although CD has been found to be unrelated to IQ (e.g. Doane, West, Goldstein, Rodnick, & Jones, 1981), we decided to include ratings of verbal IQ in our analysis because CD is coded from speech and verbal communication.

2.3.3.1 Index of Multiple Deprivation (IMD)

Socioeconomic status was determined using the revised IMD (Noble et al., 2004). According to this system, postcode areas in England are ranked from the most deprived (IMD of 1) to the least deprived (IMD of 32,482) based on seven domains of inequality: (1) income deprivation; (2) employment deprivation; (3) health

deprivation and disability; (4) education, skill and training deprivation; (5) barriers to housing and services; (6) living environment deprivation; and, (7) crime. All mothers were ranked according to their area postal code and assigned to a quintile based on the UK distribution of deprivation.

2.3.3.2 Verbal IQ

Verbal IQ in mothers was measured with Wechsler Test of Adult Reading (WTAR). The WTAR is a neuropsychological test that takes approximately 10 minutes to complete and that assesses pre-morbid intelligence through the use of 50 irregularly spelled words. During the test, the examiner presents a series of cards with the words prompting the participant for a single pronunciation of the word. The test is stopped when the participant gives 12 consecutive incorrect pronunciations. Each correct pronunciation is given a score of 1 with the maximum raw score of 50. The raw score is then standardized by age and education using published guidelines (Holdnack, 2001). WTAR scores are strongly correlated with measures of verbal IQ, verbal comprehension and full scale IQ (Strauss, Sherman, & Spreen, 2006).

2.4 Statistical analysis

In order to make inference about the general population from our sample, we applied inverse probability weights that accounted for both the stratified sample and sample attrition associated with maternal age, education, depression score at booking and in pregnancy, smoking and marital status (Dunn, Pickles, Tansella & Vázquez-Barquero, 1999). We then ran three separate linear regressions with the CD as the predicting variable of the three different maternal sensitivity scores (overall sensitivity and sensitivity in and out of the context of infant distress, with different weights to

account for the fact that a substantial proportion of the infants did not become distressed during the observation). These analyses were carried out in a stepwise fashion with estimation of an initial unadjusted model and then with adjustment for confounders (i.e. maternal age, verbal IQ and IMD quintile). Lastly, we checked for non-linearity in the association of CD and overall maternal sensitivity using a lowess regression smooth (Cleveland, 1979) and a “bent-stick” regression that hypothesized that the association was limited to only part of the range of CD scores (Bacon & Watts, 1971). All analyses were carried out in Stata 13 by the fifth author (AP).

3. Results

3.1. Characteristics of the sample

Table 2 shows the mean and standard deviation for the key variables of the study. The mean age of the mothers was 26.96 years (s.d. = 5.96) and the mean IQ score was 105.68 (s.d. = 6.43). Regarding the IMD, mothers in the sample ranked on average in the second lowest quintile (2.29, s.d. = 1.3) consistent with the high levels of deprivation in some parts of the Wirral. In Table 2, we also present the means and standard deviations for the maternal sensitivity scores, the different CD codes, duration of speech samples and word count.

Variable	N	Mean (s.d.)
20 weeks gestation		
Maternal age	237	26.96 (5.96)
Verbal IQ	237	105.68 (6.43)
IMD (quintiles)	237	2.29 (1.3)
32 weeks gestation		
Abandoned and abruptly ceased remarks	237	1.67 (1.9)
Unintelligible remarks	237	.29 (.71)
Contradictions, denials and retractions	237	.31 (.62)
Ambiguous referents	237	.44 (.88)
Extraneous questions and remarks	237	.29 (.69)
Tangential, inappropriate responses to questions or remarks	237	.33 (.69)
Odd word usage/odd sentence construction	237	1.23 (1.5)
Reiterations	237	.1 (.31)
CD	237	4.62 (3.77)
Duration (minutes)	237	04:27 (01:09)
Verbosity (words spoken)	237	579.84 (267.5)
CD ratio (CD/words spoken)	237	.96 (.84)
29 weeks postnatal		
Overall sensitivity	237	3.63 (1)
Sensitivity to non-distress	237	3.69 (.99)
Sensitivity to distress ¹	180	3.42 (1.14)

Note: ¹not all infants became distressed so sensitivity to distress is available for only a subset of mothers.

Table 2 – Means and standard deviation for the key variables (unweighted).

3.2. CD and maternal sensitivity scores

Table 3 shows the summary of the regression analysis testing the associations between CD at 20 weeks gestation and the different maternal sensitivity scores at 29 weeks before and after adjustment for confounders.

An initial regression with CD predicting overall maternal sensitivity score showed a highly significant association ($p < 0.001$) suggesting that a 1 SD increase in CD was associated with a 0.385 SD decrease in maternal sensitivity (95% CI [-0.567; -0.203]; $F [1,236] = 17.38$; $p < 0.001$; $R^2 = 0.078$). The effect of CD on overall maternal sensitivity score remained significant ($p < 0.005$) after adjustment for confounders (maternal age, verbal IQ and IMD quintile) despite the smaller estimated coefficient of -0.216 (95% CI [-0.365; -.067]). Of note are the significant association of the confounders with overall sensitivity score (p values ranging from $p < 0.001$ to $p = 0.015$) especially maternal age. The inclusion of these confounders led to an overall improvement of the model ($F [4,233] = 19.30$; $p < 0.001$; $R^2 = 0.266$).

In our second set of analyses, we repeated the same procedure but this time with the maternal sensitivity to non-distress as the outcome variable. The initial model, without confounders, revealed that CD was significant predictor of maternal sensitivity to non-distress (-0.311; 95% CI [-0.547; -0.076]; $p = 0.01$). After the adjustment for confounders CD remained as a significant predictor of sensitivity to non-distress (-0.185; 95% CI [-0.346; -0.024], $p = 0.024$). Again, the confounders were significantly associated with the outcome variable (p values ranging from $p < 0.001$ to $p = 0.036$) especially maternal age and verbal IQ. The overall model with all the variables proved to be highly significant explaining 24.7% of the observed variance ($F [4,233] = 17.65$; $p < 0.001$; $R^2 = 0.247$).

In order to draw the comparison with sensitivity to non-distress, we then tested the association between CD and maternal sensitivity in the context of infant distress. In this analysis, the effect estimate without adjustment for confounders was not just significant but also substantially larger (-0.514; 95% CI [-0.767; -0.262]; $p < 0.01$) than the one reported for the association between CD and maternal sensitivity to non-distress. After adjustment for confounders, CD remained as a highly significant predictor ($p < 0.001$) despite the smaller estimate coefficient of -0.293 (95% CI [-0.421; -0.164]). Interestingly, in this model maternal age and verbal IQ were not significantly associated with maternal sensitivity in the context of infant distress ($p = 0.257$ and $p = 0.243$, respectively) only IMD quintile was ($p = 0.006$). Again, the overall model was highly significant ($F [4,176] = 11.36$; $p < 0.001$; $R^2 = 0.216$).

	Coeff(SE)	p-value
Overall sensitivity		
Unadjusted		
CD	-0.385 (.092)	0.000
Adjusted		
CD	-0.216 (.076)	0.005
Maternal age	0.041 (.010)	0.000
Verbal IQ	0.027 (.011)	0.012
IMD quintiles	0.123 (.050)	0.015
Sensitivity to non-distress		
Unadjusted		
CD	-0.311	0.010
Adjusted		
CD	-0.185 (.082)	0.024
Maternal age	0.040 (.010)	0.000
Verbal IQ	0.030 (.011)	0.006
IMD quintile	0.106 (.050)	0.036
Sensitivity to distress		
Unadjusted		
CD	-0.514	<0.001
Adjusted		
CD	-0.293 (.065)	0.000
Maternal age	0.016 (.014)	0.257
Verbal IQ	0.014 (.012)	0.243
IMD quintile	0.164 (.059)	0.006

Table 3 - Weighted linear regression with CD as a predictor of overall maternal sensitivity, sensitivity to non-distress and distress before and after adjustment for age, IQ and IM

3.3. Testing non-linearity in the association between CD and maternal sensitivity

Figure 1 shows the fitted regression model together with a non-linear regression (locally weighted scatterplot smoothing, LOWESS). The LOWESS suggested that the association might be restricted to the upper-end of the distribution of CD scores. A “bent-stick” regression that allowed for the lower end of the distribution of CD scores to have no effect was estimated and is also shown in Figure 1. This suggested that the point of inflection in the regression, though appearing quite close to the lower end of the range of raw scores, fell at the 48th percentile, close to the middle of the distribution, because of the skew of the distribution. The 95% confidence interval for this break point or threshold spanned from the 37th to the 60th percentile. A formal test of the superiority of this model in our stratified sample was not straightforward.

Figure 1 – Regression model with LOWESS smooth, linear and “bent-stick” fit.

4. Discussion

CD in first time pregnant women, assessed as the use of confusing verbal constructions when describing their anticipated infants, predicted lower sensitivity to infant cues approximately 9 months later. This association was stronger for lower sensitivity in the context of their infant's distress rather than in a non-distress context, and it was greater over the upper range of the CD distribution. This is the first time this association has been described. It both offers clues to a better understanding of inter-generational processes indexed by CD and leads to questions regarding the interpretation of the link.

Previous research has suggested that maternal sensitivity in the context of infant's non-distress cues is significantly predicted by socio-demographic risk factors (Leerkes et al., 2012). Our analyses supported this assertion by revealing significant associations between maternal sensitivity to non-distress cues in the infant and maternal age, verbal IQ and deprived living conditions. In contrast, maternal sensitivity in the context of infant distress may be more related to both the emotional and cognitive skills and competencies of the mother (e.g. fewer negative emotions in response to infant crying or better skills at detecting infant distress, Leerkes, 2010). The results of the present study suggest that CD and, generally speaking, communicational difficulties, may contribute to more basic early relational difficulties between mothers and their infants and particularly in emotionally stressful contexts, such as when there is a need to respond to the infant's distress.

The findings should be interpreted in the larger context of studies that have reported associations between caregivers disrupted communication, during face-to-face interaction with their infants, and difficulties sensitively attuning to their 4-months-old distress cues (Crockett, Holmes, Granger, & Lyons-Ruth, 2013) as well as

initiating and sustaining joint attention bids from the infant (Annie Yoon, Kelso, Lock, & Lyons-Ruth, 2014; Schechter et al., 2010). Moreover, the findings are relevant in the context of the robust association observed in previous studies between caregiver's disrupted communication (12 to 18 months) and disorganized attachment styles in children (Madigan et al., 2006). In these studies, disrupted communication is conceptualized as the caregiver's failure to grasp and respond to the intentions conveyed in the infant's communication, and it is therefore possible that the communicational problems identified in mothers in our study may reflect broader difficulties with cognitive and emotional processes (e.g. accurate identification of negative emotions and emotional responses to distress, Leerkes & Crockenberg, 2006) which are important in attuning and responding to infant's distress.

One interpretation of our results is to consider that both maternal CD and maternal sensitivity may reflect underlying difficulties with mentalization in the mother. A useful concept that might build a conceptual bridge between CD and sensitivity is 'maternal mind-mindedness' which has been found to be a significant and important predictor of children's socio-cognitive development (Meins et al., 2002; Meins et al., 2003). Mind-mindedness refers to the caregiver's ability to "read" their infant's thoughts and feelings accurately during play and comment on their internal states in an attuned way. It is conceivable that both maternal sensitivity to infant's distress and mother's communication may rely on the same mentalizing processes and mechanisms. For example, it has been argued that mentalizing is an important factor for repairing misunderstandings during conversation (e.g. clarifying deictic references that the listener finds ambiguous or vague and that lead to misalignment and communication breakdown) and that mentalizing and alignment,

although dissociable processes, both contribute to successful communication (Brennan, Galati, & Kuhlen, 2010).

Importantly, in the context of the substantial literature on CD in schizophrenia, the observed association between CD and lower maternal sensitivity to distress may help to explain previously observed associations between CD and poor social and emotional outcomes in children (Wichstrøm et al., 1996; Wichstrøm, Holte, Husby, et al., 1993; Wichstrøm, Holte, & Wynne, 1993; Wichstrøm et al., 1994) and psychopathology in adult offspring (de Sousa et al., 2013; Roisko et al., 2014; Wahlberg et al., 1997, 2000). Moreover, such disruptions could partly explain the cognitive and affective atypicalities often observed in young children who are later diagnosed with schizophrenia (Welham, Isohanni, Jones, & McGrath, 2009) in birth cohort studies (Cannon et al., 2002; Jones, Rodgers, Murray, & Marmot, 1994).

Our findings suggest as well that the impact of CD on child's socio-cognitive development may not be solely mediated by verbal communication and that CD may have a cross-modal expression, as has been suggested by previous investigators (Lewis, Rodnick, & Goldstein, 1981). Hence, the detrimental effect of CD may be observable in early development (Velligan et al., 1988) and at a more basic level of maternal relatedness with the preverbal infant (Wynne, 1988).

An important strength of the present study was that CD was measured before the birth of the child, eliminating the possibility of evocative effects of infant-related variables on the parent, a weakness previously identified in the CD literature (Miklowitz & Stackman, 1992). However, the study also has several important limitations. First, because of its aim (to eliminate the possibility of evocative effects of the infant on the parent) communication was not measured when both mother and infant were interacting. Also, our five-minute speech samples are not an everyday

conversation; they reflect soliloquies rather than dialogues and it could be argue that CD scores were confounded by the constraints of the experimental condition (e.g. anxiety and self-consciousness). Moreover, it would be an advantage to have measured CD at multiple time points during the infant's development and test, not just its stability across time, but also across settings (e.g. when mother-infant are interacting) and include other developmental constructs (e.g. joint attention) as well as infant-related variables (e.g. theory of mind, attachment, etc.) to explore more complex models and effects.

Thus far, research on CD has been largely carried out by researchers interested in environmental and developmental influences on later psychopathology, especially schizophrenia (Bentall, 2003; Bentall & Fernyhough, 2008; Bentall et al., 2014; de Sousa, et al., 2013). The present findings suggest that CD may be a useful concept in understanding the impact of maternal characteristics on early child development. Future studies should examine maternal characteristics associated with CD and its associations with other a wider range of developmental processes in children.

5. Bibliographic references

Annie Yoon, S., Kelso, G. A., Lock, A., & Lyons-Ruth, K. (2014). Mother–Infant Joint Attention and Sharing: Relations to Disorganized Attachment and Maternal Disrupted Communication. *The Journal of Genetic Psychology: Research and Theory on Human Development*, 1–14. doi:10.1080/00221325.2014.964170

Bacon, D. W., & Watts, D. G. (1971). Estimating the transition between two intersecting straight lines. *Biometrika*, 58, 525–534. doi:10.1093/biomet/58.3.525

Bakermans-Kranenburg, M. J., & Van Ijzendoorn, M. H. (2006). Gene-environment interaction of the dopamine D4 receptor (DRD4) and observed maternal insensitivity predicting externalizing behavior in preschoolers. *Developmental Psychobiology*, 48, 406–409. doi:10.1002/dev.20152

Bentall, R. P. (2003). *Madness Explained: Psychosis and Human Nature*. London, UK: Allen Lane.

Bentall, R. P., & Fernyhough, C. (2008). Social predictors of psychotic experiences: Specicity and psychological mechanisms. *Schizophrenia Bulletin*, 34, 1012–1020.

Bentall, R. P., de Sousa, P., Varese, F., Wickham, S., Sitko, K., Haarmans, M., &

- Read, J. (2014). From adversity to psychosis: Pathways and mechanisms from specific adversities to specific symptoms. *Social Psychiatry and Psychiatric Epidemiology*, 1-12. doi:10.1007/s00127-014-0914-0.
- Bornstein, M. H., & Tamis-LeMonda, C. S. (1997). Maternal responsiveness and infant mental abilities: Specific predictive relations. *Infant Behavior and Development*. doi:10.1016/S0163-6383(97)90001-1
- Brennan, S. E., Galati, A., & Kuhlen, A. K. (2010). Two minds, one dialog: Coordinating speaking and understanding. *The Psychology of Learning and Motivation: Advances in Research and Theory*, 53, 301-344. doi:10.1016/S0079-7421(10)53008-1.
- Cannon, M., Caspi, A., Moffitt, T. E., Harrington, H., Taylor, A., Murray, R. M., & Poulton, R. (2002). Evidence for early-childhood, pan-developmental impairment specific to schizophreniform disorder: results from a longitudinal birth cohort. *Arch Gen Psychiatry*, 59(5), 449–456. doi:DOI 10.1001/archpsyc.59.5.449
- Cleveland, W. S. (1979). Robust Locally Weighted Regression and Smoothing Scatterplots. *Journal of the American Statistical Association*, 74, 829–836. doi:10.2307/2286407
- Crockett, E. E., Holmes, B. M., Granger, D. A., & Lyons-Ruth, K. (2013). Maternal disrupted communication during face-to-face interaction at 4 months: Relation

to maternal and infant cortisol among at-risk families. *Infancy*, 18, 1111–1134.
doi:10.1111/infa.12015

De Sousa, P., Varese, F., Sellwood, W., & Bentall, R. P. (2013). Parental Communication and Psychosis: A Meta-analysis. *Schizophrenia Bulletin*, DOI:10.1093/schbul/sbt088. doi:10.1093/schbul/sbt088

Doane, J. A., Jones, J., Fisher, L., Ritzler, B., Singer, M., & Wynne, L. (1982). Parental communication deviance as a predictor of competence in children at risk for adult psychiatric disorder. *Family Process*, 21(2), 211–223. Retrieved from <Go to ISI>://A1982NS75400007

Doane, J. A., & Singer, M. (1977). *Communication deviance scoring manual for use with Consensus Rorschach*. University of Rochester: Rochester, NY, USA: Unpublished manuscript.

Doane, J. A., West, K. L., Goldstein, M. J., Rodnick, E. H., & Jones, J. (1981). Parental communication deviance and affective style: Predictors of subsequent schizophrenia spectrum disorders in vulnerable adolescents. *Arch Gen Psychiatry*, 38(6), 679–685. Retrieved from <Go to ISI>://A1981LU68200008

Docherty, N. (1993). Communication deviance, attention and schizotypy in parents of schizophrenic patients. *Journal of Nervous and Mental Disease*, 181(12), 750–756. doi:Doi 10.1097/00005053-199312000-00007

- Dunn, G., Pickles, A., Tansella, M., & Vázquez-Barquero, J. L. (1999). Two-phase epidemiological surveys in psychiatric research. *British Journal of Psychiatry*, *174*, 95-100.
- Dutra, L., Bureau, J.-F., Holmes, B., Lyubchik, A., & Lyons-Ruth, K. (2009). Quality of early care and childhood trauma: a prospective study of developmental pathways to dissociation. *The Journal of Nervous and Mental Disease*, *197*, 383–390. doi:10.1097/NMD.0b013e3181a653b7
- Fraley, R. C., Roisman, G. I., Booth-LaForce, C., Owen, M. T., & Holland, A. S. (2013). Interpersonal and genetic origins of adult attachment styles: a longitudinal study from infancy to early adulthood. *Journal of Personality and Social Psychology*, *104*, 817–38. doi:10.1037/a0031435
- Fraley, R. C., Roisman, G. I., & Haltigan, J. D. (2012). The Legacy of Early Experiences in Development: Formalizing Alternative Models of How Early Experiences Are Carried Forward Over Time. *Developmental Psychology*. doi:10.1037/a0027852
- Grusec, J. E., & Davidov, M. (2010). Integrating different perspectives on socialization theory and research: A domain-specific approach. *Child Development*, *81*, 687–709. doi:10.1111/j.1467-8624.2010.01426.x

- Hirsch, S. R., & Leff, J. P. (1971). Parental abnormalities of verbal communication in the transmission of schizophrenia. *Psychol Med*, 1(2), 118–127. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/5148763>
- Hobson, R. P., Patrick, M. P. H., Crandell, L. E., Perez, R. M. G., & Lee, A. (2004). Maternal sensitivity and infant triadic communication. *Journal of Child Psychology and Psychiatry*, 45(3), 470–480. Retrieved from <Go to ISI>://000221788500006
- Holdnack, H. A. (2001). *Wechsler Test of Adult Reading: WTAR*. San Antonio: The Psychological Corporation.
- Jones, P., Rodgers, B., Murray, R., & Marmot, M. (1994). Child developmental risk factors for adult schizophrenia in the British 1946 birth cohort. *Lancet*, 344, 1398–1402. doi:10.1016/S0140-6736(94)90569-X
- Joosen, K. J., Mesman, J., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2012). Maternal sensitivity to infants in various settings predicts harsh discipline in toddlerhood. *Attachment & Human Development*. doi:10.1080/14616734.2012.661217
- Juffer, F., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2005). The importance of parenting in the development of disorganized attachment: Evidence from a preventive intervention study in adoptive families. *Journal of*

Child Psychology and Psychiatry and Allied Disciplines, 46, 263–274.

doi:10.1111/j.1469-7610.2004.00353.x

Kymalainen, J. A. (2005). *Expressed emotion and communication deviance in anglo-american, latino-american and african-american families with schizophrenia*. University of Massachusetts, Boston.

Kymalainen, J. A., Weisman, A. G., Rosales, G. A., & Armesto, J. C. (2006). Ethnicity, expressed emotion, and communication deviance in family members of patients with schizophrenia. *The Journal of Nervous and Mental Disease*, 194, 391–396. doi:10.1097/01.nmd.0000221171.42027.5a

Leeb, B., Hahlweg, K., Goldstein, M. J., Feinstein, E., Mueller, U., Dose, M., & Magana-Amato, A. (1991). Cross-national reliability, concurrent validity, and stability of a brief method for assessing expressed emotion. *Psychiatry Research*, 39, 25–31. doi:10.1016/0165-1781(91)90005-A

Leerkes, E. M. (2010). Predictors of Maternal Sensitivity to Infant Distress. *Parenting*. doi:10.1080/15295190903290840

Leerkes, E. M. (2011). Maternal sensitivity during distressing tasks: A unique predictor of attachment security. *Infant Behavior and Development*, 34, 443–446. doi:10.1016/j.infbeh.2011.04.006

- Leerkes, E. M., & Crockenberg, S. C. (2006). Antecedents of mothers' emotional and cognitive responses to infant distress: The role of family, mother, and infant characteristics. *Infant Mental Health Journal*, 27(4), 405–428.
- Leerkes, E. M., Crockenberg, S. C., & Burrous, E. (2004). Identifying Components of Maternal Sensitivity to Infant Distress: The Role of Maternal Emotional Competencies. *Parenting: Science and Practice*, 4(1), 1–23.
- Leerkes, E. M., Weaver, J. M., & O'Brien, M. (2012). Differentiating Maternal Sensitivity to Infant Distress and Non-Distress. *Parenting*. doi:10.1080/15295192.2012.683353
- Lewis, J. M., Rodnick, E. H., & Goldstein, M. J. (1981). Intrafamilial interactive behavior, parental communication deviance, and risk for schizophrenia. *J Abnorm Psychol*, 90(5), 448–457. Retrieved from <Go to ISI>://A1981ML34000003
- Lyons- Ruth, K., Bronfman, E., & P. (1999). Maternal frightened, frightening or atypical behaviour and disorganized infant attachment patterns. In *Atypical attachment in infancy and early childhood. Monographs of the Society for Research in Child Development*.
- Madigan, S., Bakermans-Kranenburg, M. J., Van Ijzendoorn, M. H., Moran, G., Pederson, D. R., & Benoit, D. (2006). Unresolved states of mind, anomalous parental behavior, and disorganized attachment: a review and meta-analysis of a

transmission gap. *Attachment & Human Development*, 8, 89–111.
doi:10.1080/14616730600774458

McElwain, N. L., & Booth-Laforce, C. (2006). Maternal sensitivity to infant distress and nondistress as predictors of infant-mother attachment security. *Journal of Family Psychology : JFP : Journal of the Division of Family Psychology of the American Psychological Association (Division 43)*, 20, 247–255.
doi:10.1037/0893-3200.20.2.247

Meins, E., Fernyhough, C., Wainwright, R., Clark-Carter, D., Gupta, M. Das, Fradley, E., & Tuckey, M. (2003). Pathways to Understanding Mind: Construct Validity and Predictive Validity of Maternal Mind-Mindedness. *Child Development*, 74(4), 1194–1211.

Meins, E., Fernyhough, C., Wainwright, R., Das Gupta, M., Fradley, E., & Tuckey, M. (2002). Maternal mind-mindedness and attachment security as predictors of theory of mind understanding. *Child Development*, 73(6), 1715–1726.

Miklowitz, D. J., & Stackman, D. (1992). Communication deviance in families of schizophrenic and other psychiatric patients: Current state of the construct. *Prog Exp Pers Psychopathol Res*, 15, 1–46. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/1343105>

Murray, L., Hentges, F., Hill, J., Karpf, J., Mistry, B., Kreutz, M., ... Green, R. (2008). The effect of cleft lip and palate, and the timing of lip repair on mother-

infant interactions and infant development. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 49, 115–123. doi:10.1111/j.1469-7610.2007.01833.x

Noble, M., Wright, G., Dibben, C., Smith, G., McLennan, D., Anttila, C., ... Lloyd, M. (2004). *The English Indices of Deprivation 2004 (revised). Report to the Office of the Deputy Prime Minister*. London: Neighbourhood Renewal Unit.

Nuechterlein, K. H., Goldstein, M. J., Ventura, J., Dawson, M. E., & Doane, J. A. (1989). Patient-environment relationships in schizophrenia. Information processing, communication deviance, autonomic arousal, and stressful life events. *Br J Psychiatry Suppl*, (5), 84–89. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/2605027>

Pickering, M. J., & Garrod, S. (2004). Toward a mechanistic psychology of dialogue. *The Behavioral and Brain Sciences*, 27, 169–190; discussion 190–226. doi:10.1017/S0140525X04000056

Pickering, M. J., & Garrod, S. (2006). Alignment as the basis for successful communication. In *Research on Language and Computation* (Vol. 4, pp. 203–228). doi:10.1007/s11168-006-9004-0

Pickles, A., Hill, J., Breen, G., Quinn, J., Abbott, K., Jones, H., & Sharp, H. (2013). Evidence for interplay between genes and parenting on infant temperament in the first year of life: monoamine oxidase A polymorphism moderates effects of

- maternal sensitivity on infant anger proneness. *Journal of Child Psychology and Psychiatry*, 54(12), 1308–1317. doi:10.1111/jcpp.12081
- Raby, K. L., Roisman, G. I., Fraley, R. C., & Simpson, J. A. (2014). The Enduring Predictive Significance of Early Maternal Sensitivity: Social and Academic Competence Through Age 32 Years. *Child Development*. doi:10.1111/cdev.12325
- Roisko, R., Wahlberg, K.-E., Hakko, H., & Tienari, P. (2014). Association of adoptive child's thought disorders and schizophrenia spectrum disorders with their genetic liability for schizophrenia spectrum disorders, season of birth and parental communication Deviance. *Psychiatry Research*. doi:10.1016/j.psychres.2014.12.036
- Schechter, D. S., Willheim, E., Hinojosa, C., Scholfield-Kleinman, K., Turner, J. B., McCaw, J., ... Myers, M. M. (2010). Subjective and objective measures of parent-child relationship dysfunction, child separation distress, and joint attention. *Psychiatry*, 73, 130–144. doi:10.1521/psyc.2010.73.2.130
- Sharp, H., Pickles, A., Meaney, M., Marshall, K., Tibu, F., & Hill, J. (2012). Frequency of Infant Stroking Reported by Mothers Moderates the Effect of Prenatal Depression on Infant Behavioural and Physiological Outcomes. *PLoS ONE*, 7. doi:10.1371/journal.pone.0045446

- Singer, M., & Wynne, L. (1965a). Thought disorder and family relations of schizophrenics: III. Methodology using projective techniques. *Arch Gen Psychiatry*, 12, 187–200. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/14237629>
- Singer, M., & Wynne, L. (1965b). Thought disorder and family relations of schizophrenics: IV. Results and Implications. *Arch Gen Psychiatry*, 12, 201–212. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/14237630>
- Singer, M., & Wynne, L. (1966). Principles for scoring communication defects and deviances in parents of schizophrenics: Rorschach and TAT scoring manuals. *Psychiatry*, 29(3), 260–288. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/5969538>
- Strauss, E., Sherman, E. M., & Spreen, O. (2006). *A compendium of neuropsychological tests: Administration, norms, and commentary*. New York: Oxford University Press.
- The NICHD Early Child Care Research Network. (1999). Child care and mother-child interaction in the first 3 years of life. NICHD Early Child Care Research Network. *Developmental Psychology*, 35, 1399–413. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10563730>
- Van der Voort, A., Linting, M., Juffer, F., Bakermans-Kranenburg, M. J., Schoenmaker, C., & van Ijzendoorn, M. H. (2014). The development of

- adolescents' internalizing behavior: longitudinal effects of maternal sensitivity and child inhibition. *Journal of Youth and Adolescence*, 43, 528–40. doi:10.1007/s10964-013-9976-7
- Van Ijzendoorn, M. H., Juffer, F., & Duyvesteyn, M. G. C. (1995). Breaking the intergenerational cycle of insecure attachment: A review of the effects of attachment-based interventions on maternal sensitivity and infant security. *Journal of Child Psychology and Psychiatry and Allied Disciplines*. doi:10.1111/j.1469-7610.1995.tb01822.x
- Velligan, D. I. (1985). *Communication deviance coding manual for coding family confrontations*. unpublished manuscript: Los Angeles: University of California.
- Velligan, D. I., Christensen, A., Goldstein, M. J., & Margolin, G. (1988). Parental communication deviance: It's relationship to parent, child and family system variables. *Psychiatry Res*, 26(3), 313–325. Retrieved from <Go to ISI>://A1988R915000009
- Velligan, D. I., Funderburg, L. G., Giesecke, S. L., & Alexander, A. L. (1995). Longitudinal analysis of communication deviance in the families of schizophrenic patients. *Psychiatry-Interpersonal and Biological Processes*, 58(1), 6–19. Retrieved from <Go to ISI>://A1995QN79500002
- Velligan, D. I., Goldstein, M. J., Nuechterlein, K. H., Miklowitz, D. J., & Ranlett, G. (1990). Can communication deviance be measured in a family problem solving

interaction? *Family Process*, 29(2), 213–226. Retrieved from <Go to ISI>://A1990DK81000011

Velligan, D. I., Miller, A. L., Eckert, S. L., Funderburg, L. G., True, J. E., Mahurin, R. K., ... Hazelton, B. C. (1996). The relationship between parental communication deviance and relapse in schizophrenic patients in the 1-year period after hospital discharge: A pilot study. *Journal of Nervous and Mental Disease*, 184(8), 490–496. Retrieved from <Go to ISI>://A1996VD33100006

Wahlberg, K. E., Wynne, L., Hakko, H., Läksy, K., Moring, J., Miettunen, J., & Tienari, P. (2004). Interaction of genetic risk and adoptive parent communication deviance: longitudinal prediction of adoptee psychiatric disorders. *Psychol Med*, 34(8), 1531–1541. doi:Doi 10.1017/S003291704002661

Wahlberg, K. E., Wynne, L., Oja, H., Keskitalo, P., Anais-Tanner, H., Koistinen, P., ... Tienari, P. (2000). Thought disorder index of Finnish adoptees and communication deviance of their adoptive parents. *Psychol Med*, 30(1), 127–136. Retrieved from <Go to ISI>://000085919100013

Wahlberg, K. E., Wynne, L., Oja, H., Keskitalo, P., Pykalainen, L., Lahti, I., ... Tienari, P. (1997). Gene-environment interaction in vulnerability to schizophrenia: Findings from the Finnish adoptive family study of schizophrenia. *Am J Psychiatry*, 154(3), 355–362. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9054783>

- Welham, J., Isohanni, M., Jones, P., & McGrath, J. (2009). The antecedents of schizophrenia: a review of birth cohort studies. *Schizophrenia Bulletin*, 35, 603–623. doi:sbn084 [pii]r10.1093/schbul/sbn084
- Wichstrøm, L., Anderson, A. M., Holte, A., Husby, R., & Wynne, L. C. (1996). Confirmatory and disconfirmatory family communication as predictor of offspring socio-emotional functioning. A 10 to 14 year follow-up of children at risk. *Acta Psychiatrica Scandinavica*, 93, 49–56. doi:10.1111/j.1600-0447.1996.tb10618.x
- Wichstrøm, L., Anderson, A. M., Holte, A., & Wynne, L. C. (1996). Disqualifying family communication and childhood social competence as predictors of offspring's mental health and hospitalization. A 10- to 14-year longitudinal study of children at risk of psychopathology. *The Journal of Nervous and Mental Disease*, 184, 581–588. doi:10.1097/00005053-199610000-00001
- Wichstrøm, L., Holte, A., Husbey, R., & Wynne, L. C. (1994). Disqualifying family communication as a predictor of changes in offspring competence: A 3-year longitudinal study of sons of psychiatric patients. *Journal of Family Psychology*. doi:10.1037/0893-3200.8.1.104
- Wichstrøm, L., Holte, A., Husby, R., & Wynne, L. C. (1993). Competence in children at risk for psychopathology predicted from confirmatory and disconfirmatory family communication. *Family Process*, 32, 203–220.

- Wichstrøm, L., Holte, A., & Wynne, L. C. (1993). Disqualifying family communication and anxiety in offspring at risk for psychopathology. *Acta Psychiatrica Scandinavica*, 88, 74–79.
- Wynne, L. (1968). Methodologic and conceptual issues in the study of schizophrenics and their families. *Journal of Psychiatric Research*, 6(suppl. 1), 185–199.
- Wynne, L. (1981). Current concepts about schizophrenics and family relationships. *Journal of Nervous and Mental Disease*, 169(2), 82–89. doi:10.1097/00005053-198102000-00003
- Wynne, L. (1984). The epigenesis of relational systems: a model for understanding family development. *Family Process*, 23(3), 297–318. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/6479297>
- Wynne, L. (1988). An epigenetic model of family processes. In C. J. Falicov (Ed.), *Family transitions: Continuity and change over the life cycle* (pp. 81–106). New York: Guilford Press.
- Wynne, L., Cole, R. E., & Perkins, P. (1987). University of Rochester child and family study: Risk research in progress. *Schizophr Bull*, 13(3), 463–476. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/3477019>

Wynne, L., & Singer, M. (1963a). Thought disorder and family relations of schizophrenics: I. A research strategy. *Arch Gen Psychiatry*, 9, 191–198.
Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/14002138>

Wynne, L., & Singer, M. (1963b). Thought disorder and family relations of schizophrenics: II. A classification of forms thinking. *Arch Gen Psychiatry*, 9, 199–206. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/14002139>

Wynne, L., Singer, M., Bartko, J., & Toohey, M. (1977). Schizophrenics and their families: Research on parental communication. In J. M. Tanner (Ed.), *Developments in psychiatric research* (pp. 254–286). London: Hodder & Stoughton.