Parental Communication and Psychosis: A Meta-analysis

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Background: Parental communication deviance (CD) has long been suggested as a potential risk factor for the development of psychosis and thought disorder in genetically sensitive offspring. However, the findings of the studies on the prevalence of CD in parents of psychotic patients have never been submitted to quantitative synthesis. Method: PsycINFO was searched from January 1959 to January 2012 for studies on the prevalence of CD in parents of psychotic patients. This search was supplemented with the results from a much larger systematic search (PsycINFO, PubMed, EMBASE, and Web of Science) on childhood trauma and psychosis. *Results:* A total of 20 retrieved studies (n = 1753 parents) yielded a pooled g of large magnitude (0.97; 95% CI [0.76;1.18) with a significant amount of heterogeneity (Q = 33.63; P = .014; P = 46.47). Subgroup and sensitivity analysis of methodological features (study's design, comparison group, diagnostic criteria, CD rating method, inter-rater reliability not reported, year of publication, and verbosity) and demographic characteristics (level of education or offspring's age) revealed that pooled effect size was stable and unlikely to have been affected by these features. Conclusion: CD is highly prevalent in parents of psychotic offspring. This is discussed in the broader context of adoption and longitudinal studies that have reported a $G \times E$ interaction in the development of psychosis and thought disorder. A potential developmental mechanism is suggested to explain how CD may affect the developing offspring. The importance of further studies on CD and its potential value as a clinical concept are discussed.

Key words: communication deviance/thought disorder/ family/psychosis

Daughter: What did *you* mean by a conversation having an outline? Has this conversation had an outline?

Father: Oh, surely, yes. But we cannot see it yet because the conversation isn't finished. You cannot ever see it while you're in the middle of it.

Bateson^{1(p42)}.

Introduction

Over the last decade, there has been a renewed interest in the role of the environment in the development of psychotic experiences.²⁻⁵ It is becoming increasingly evident that a coherent scientific account of these experiences cannot be accomplished without the integration of environmental variables.^{6,7} Among these, quality of the family environment has long interested researchers.⁸⁻¹⁰ Family research in psychosis had its peak during the 1970s and 1980s with the publication of studies looking at different aspects of family interaction.¹¹ Since then, interest in this field has somehow declined. This sociohistorical shift can be explained in part by 2 factors. The first factor is related to the emergence of neurobiological framework as a dominant paradigm of research in the field of psychosis.7 The second factor is related to sensitivities surrounding this line of research, and worries that this may lead to the stigmatization of families.¹² It is our view that the family environment cannot be excluded as an important focus for both research and clinical intervention.¹³ Indeed, there is strong evidence that variables such as expressed emotion,^{14,15} family rearing environment,^{16,17} or family communication^{18,19} affect the course and development of psychosis.

One of the most researched family variables in the field of psychosis is parental communication deviance (CD).²⁰ CD refers to a form of intrafamilial communication that is vague, fragmented, and contradictory and that compromises the development and sharing of meaning between the parent and the offspring, leading to the consequent breakdown in communication.²¹ The concept has a multidimensional structure^{22,23} and its frequency and severity are continuously distributed with no clear cutoff point.^{21,24} Examples can range from linguistic characteristics such as the use of *contorted and peculiar language*, eg, "This man is *in the process in thinking of the process of being a doctor*"^{25(p166)} and *ambiguous linguistic referents*, eg, "Kid stuff that's one thing, but *something else*

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is different too" (D. I. Velligan, unpublished data, p. 18) to problems at the level of pragmatics such as *nonverbal disruptive behavior*.²⁶ Other areas of research have examined variables that can be assumed to be related to CD such as *double-bind* statements¹⁰ or thinking problems in the parents of psychotic offspring.²⁷ However, some of these concepts have not been rigorously researched and, in some cases, the underlying concept does not necessarily reflect CD (eg, thought disorder).^{28,29}

CD was initially developed and operationalized by Wynne and Singer,^{9,30-34} who devised a scoring system for the Rorschach and the Thematic Apperception Test.²⁶ Since then, the field has evolved with the development of new methodologies,^{35,36} prospective cohort designs,^{18,37} and adoption studies that have helped elucidate the role of gene-environment interactions in determining the crossgenerational transmission of psychotic communication disorders.^{19,38-42} The most important and replicated finding in the field is that CD is highly prevalent in the parents of psychotic offspring across diagnoses.^{24,25} Some authors have, therefore, suggested that exposure to this kind of communication during childhood may play a causal role in the development and ontogeny of psychotic experiences.^{21,43,44} However, there is still no known mechanism by which CD may affect the offspring. Some researchers have shown that CD can be successfully measured during problem solving where parent and psychotic offspring are asked to discuss a salient family problem.^{35,45,46} In other studies, it has been shown that parents with high scores on CD show less topic and affective focus during family discussions.^{47,48} Therefore, it is conceivable that the continuous exposure to communication that is vague, fragmented, and contradictory may lead the developing offspring to internalize it, resulting in psychotic experiences and thought disorder in particular.^{21,49} However, other mechanisms of transmission are clearly possible.

Since Wynne and Singer's early work,^{30–34} the prevalence of CD among parents of psychotic offspring has been independently replicated by other groups using a variety of designs,^{18,19,28,36,50–55} with some studies documenting an exposure-response relationship between parental CD and severity of psychosis in the offspring.^{43,51,56,57} Other studies have shown more specific associations between CD and thought disorder,⁵⁸ distractibility,^{59,60} and relapse.^{46,61} Moreover, CD does not seem to be a culture-bound phenomenon^{62–64} and has been found to be relatively uninfluenced by parents' level of education^{65,66} or amount of speech produced (verbosity).^{28,43,67}

Despite previous reviews,^{24,68–71} the literature in the field has never before been subjected to a quantitative analysis. Such analysis will allow us to establish the overall effect size for CD among parents of psychotic patients and determine its magnitude and consistency across studies. This analysis will also allow us to examine the impact of different study features that might affect our confidence in the findings. Finally, in conducting this analysis, we were also interested in comparing effect sizes between mothers and fathers. According to Wynne and Singer, the presence of at least 1 parent with low CD should be a protective factor and hence that CD is required in both parents for psychosis to develop. If this is the case, we would expect the magnitude of the effect to be the same for both parents. If, on the other hand, there is a difference in the magnitude of the effects for mothers and fathers, this might point to moderating factors that affect the mechanism by which CD confers risk of psychosis.

Methods

Literature Search Strategy and Eligibility Criteria

Two of the authors (F.V. and R.P.B.) undertook an initial search of all the published and unpublished materials on CD as part of a more extensive meta-analysis on childhood experiences and psychosis. Specific details of the search strategy can be found elsewhere.⁴ This initial search yielded 47 studies that were screened for coding at the phase 4 of the present search. To check this first search, which focused on a wide range of potential environmental risk factors, a second complementary search was undertaken specifically focusing on CD and psychosis. This was limited to the time period between January 1959 and January 2012. The starting year was chosen because this was the date of the first empirical study published on thought disturbance in parents of patients diagnosed with schizophrenia.²⁷ PsycINFO was searched using the following search terms: "communication deviance," "communication disturbance*," and "thought dis*" combined with the terms famil*, parent*, mother, father combined with schiz*, and psycho* using Boolean operator "and" and "or." To minimize publication bias, we included unpublished material in our search and tracked the citations of the most cited articles in the field.^{30,32–34} Concurrently, secondary searches were conducted using the names of the main publishing authors in the field, main methodologies, and research projects. Finally, we manually searched the bibliographic references of previous reviews in the field for material that had not been identified in our primary search^{24,68} and contacted available authors in the field for further information about their published and unpublished work.

One exclusion criterion was the use of "artificial family" designs.^{72–74} These designs involve experimental procedures in which family members of psychotic offspring interact with healthy offspring and parents of healthy offspring interact with psychotic offspring. These studies raised important issues about ecological validity and have used highly modified versions of Wynne and Singer's methodology.

Also excluded were studies that operationalized *concept formation* using methodologies such as the object sorting test.^{27,75–80} In these studies, communication is not tested through means of a speech sample. Furthermore,

they have already been subject to a meta-analysis and review.⁸¹ Studies that used analog measures of CD such as consensus tasks^{82–85} were also excluded. The dependent variable in these studies is the product of an interaction and so does not allow for a quantification of CD in parents individually. Another set of excluded studies were those where the dependent variable was *disconfirmatory feedback* or *disqualifying communication*.^{86–94} These constructs, despite measuring the quality of the family communication, only partly cover Wynne and Singer's original construct. The final exclusion criterion involved studies that have measured subclinical thought disorder in parents of psychotic offspring^{28,95,96} because CD and thought disorder are not necessarily correlated in such samples.²⁸

We initially retrieved a total of 22044 titles. Figure 1 shows the 4 phases of the systematic search. Only 20 studies were found to be eligible for analysis. In part, this was due to the fact that many of the studies retrieved were based on the same data set^{51,65,97,98} or were part of the same research project such as the *UCLA High-Risk Project*.^{18,47,48,99,100} In cases where studies had been based on the same data set, we selected the articles with the most complete statistical information for effect size computation.

Coding Protocol and Effect Sizes (g) Computation

The primary goal of the protocol was to allow a detailed subgroup analysis based on the methodological features that were likely to influence effect sizes. The following study characteristics were coded (see table 1): age of the offspring, diagnostic criteria, control group, type of methodology, and education or verbosity accounted for.

The computation of effect sizes and consequent statistical analysis were performed using Comprehensive Meta-analysis.¹⁰⁶ This software allows the user to easily compute effect sizes using a wide variety of data formats.

The computation of effect sizes was performed using *hedges*' g^{107} given that CD is a continuous construct with no real threshold values. In some studies, the means, SDs, samples sizes, and *P* values for both the experimental and control groups were available^{43,51} and therefore *g* was calculated using the original equation.

$$g = \frac{\text{Me} - \text{Mc}}{\text{SD pooled}} \times \left(\frac{N-3}{N-2.25}\right) \times \sqrt{\frac{N-2}{N}}$$

Here, Me stands for mean of the experimental group, Mc for mean of the control group, and *N* for number of participants. In 2 cases,^{22,58} SDs were not available and *g* was calculated using the means, sample sizes, and *P* values for both groups of parents. In 1 case,⁶⁷ g was computed from *t* test, *P* value, and effect direction given that no other statistical data were available.

In studies where the dependent variable was dichotomous,^{18,23,31,50,52,62,101,104} standard means difference (SMD) was calculated from OR using agreed statistical conventions.^{108,109}

$$\mathrm{SMD} = \frac{\sqrt{3}}{\pi} \ln \mathrm{OR}$$

Finally, in one study, g was calculated from the chi-square (χ^2) , P value, and sample size¹⁰⁵ given that no other statistical information was available. In studies where the research design included more than 2 groups, the effect size was calculated from the comparison between parents of offspring diagnosed with schizophrenia and parents of healthy offspring.^{28,43,66} For studies that had used more than 1 concept of CD, only the data that reflected Wynne and Singer's original conceptualization were extracted.

Finally, computation of effect sizes was carried out under random effects model given that our assumption was that the studies retrieved were likely to be heterogeneous and the analysis was likely to carry across-study variation.¹¹⁰

Results

Pooled Effect Sizes and Heterogeneity Analysis

The final analysis included 19 case-control studies and data from 1 prospective study.¹⁸ The studies included an overall pooled sample of 1753 parents. The computation carried out under a random effects model for the entire sample revealed a very large pooled effect size of 1.45 (SE = 0.27; 95% CI [0.92; 1.97]; z = 5.41; P < .001), with a significant amount of heterogeneity (Q[19] = 238.8; $P < .001; I^2 = 92.04$). After visual inspection of the funnel plot, we decided to exclude Wynne et al⁴³ because this effect size was of an unusually large magnitude (g = 12.4; SE = 0.8; 95% CI [10.84; 13.97]; z = 15.54; P < .001). The exclusion of this outlier reduced the overall effect size to 0.97 (SE = 0.11; 95% CI [0.76; 1.18]; z = 9.2; P < .001),with a more acceptable, but still significant, level of heterogeneity (Q[18] = 33.63; P = .014; $I^2 = 46.47$; $\tau^2 = 0.1$; $\tau = 0.3$). According to benchmark thresholds,¹¹¹ we can interpret that our pooled g is of large magnitude. Onestudy removed analysis revealed that the results were stable and unlikely to be affected by the exclusion of any one study (figure 2).

In order to test how the different features affected our result, we recomputed the pooled effect size extracting studies using our coding protocol. The exclusion of 1 cohort study did not change our overall effect size (k = 18; g = 0.96; SE = 0.11; 95% CI [0.75; 1.16]; z = 8.95; P < .001; Q[17] = 32.42; P = .013; $I^2 = 47.56$; $\tau^2 = 0.09$; $\tau = 0.3$). The computation of the effect size using studies that had compared parents of psychotic offspring with healthy controls (as opposed to other kinds of controls, eg, parents of children with depression or learning

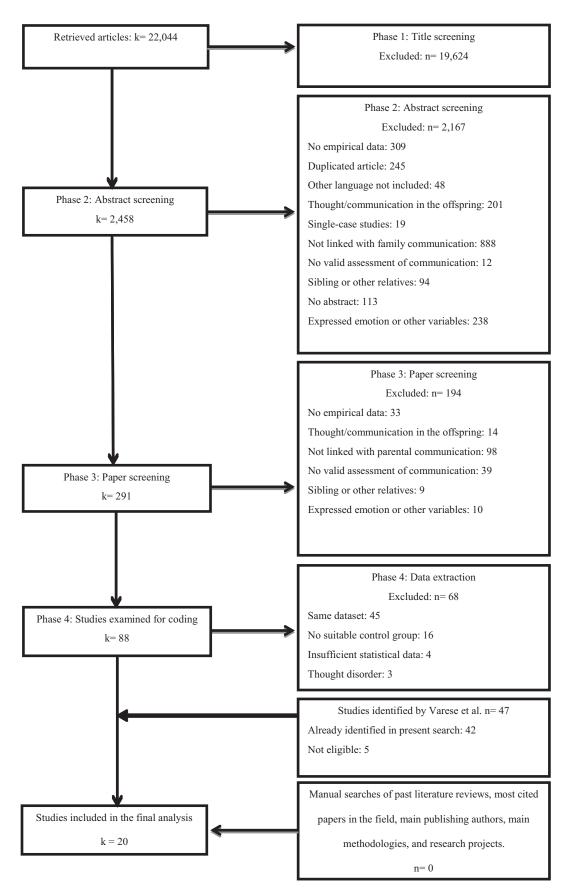


Fig. 1. Flowchart of studies included in meta-analysis.

Source	Study Type	Parents (n)	Comparisons (<i>n</i>)	Control Groups	Education (Y/N)	Diagnostic Criteria (≥DSM-III)	Age of the Offspring (>15)	Methodology	Scoring	Parent	IRR (Y/N)	Verbosity (Y/N)
Asarnow et al ¹⁰¹	CCS	28	72	Mixed	X	×	z	Proiective	CD	Mother	X	
Behrens et al ⁶²	CCS	56	22	Healthy	Y	Z	Y	Projective	CD	Both	Y	Z
Docherty and Gordinier ⁶⁵	CCS	59	24	Healthy	Y	Y	Υ	Other	CDI	Both	Y	Y
Docherty ⁵⁵	CCS	18	10	Healthy	Y	Y	Y	Other	ICD	Both	Y	Y
Glaser ¹⁰²	CCS	20	20	Mixed	Y	N	Y	Projective	CD	Both	Y	Y
Goldstein ¹⁸	PCS	128		N/a	Y	Υ	Y	Projective	CD	Both	Y	Y
Hirsch and Leff ¹⁰³	CCS	40	40	Other	Y	Z	Υ	Projective	CD	Both	Y	Y
Holte and Wichstrøm ⁹³	CCS	14	28	Mixed	Y	Y	Υ	Projective	EU	Both	Y	Y
Johnston and Holzman ²⁸	CCS	24	34	Mixed	Y	Z	Υ	Projective	CD	Both	Y	Y
Jones ²³	CCS	15	12	Mixed	Y	Z	Y	Projective	CD	Both	Y	Y
Rund ⁶⁶	CCS	42	58	Mixed	Y	Υ	Y	Projective	CD	Both	Y	Y
Sass et al ⁵⁸	CCS	42	8	Other	Y	Υ	Υ	Projective	CD	Both	Y	Υ
Singer and Wvnne ³¹	CCS	40	80	Other	Z	Z	Z	Projective	CD	Both	Z	Z
Solana ⁶⁷	CCS	40	40	Other	Y	Υ	Υ	Projective	CD	Both	Y	Y
Wender et al ¹⁰⁴	CCS	56	28	Other	Z	Z	Υ	Projective	CD	Both	Y	Y
Wild et al ⁵²	CCS	44	49	Healthy	Υ	N	Υ	Other	CD	Both	Z	Z
Wild et al ⁵⁰	CCS	72	102	Mixed	Y	N	Υ	Other	CD	Both	Y	Υ
Wynne ¹⁰⁵	CCS	38	80	Mixed	Z	N	Υ	Projective	CD	Both	Z	Z
Wynne et al ⁴³	CCS	88	140	Mixed	Y	N	Y	Projective	CD	Both	Y	Y
Singer et al ²²	CCS	26	16	Other	N/K	N	Υ	Projective	CD	Both	Z	Υ
<i>Note</i> : CCS, case-control study; CD, communication devianc EU, egocentric utterances; healthy, parents of healthy offsp groups; N, no; N/a, not applicable; N/K, not known; other, or Phillipson; Y, yes.	control study; tterances; heal /a, not applica yes.	, CD, com lthy, paren able; N/K,	munication devi uts of healthy off not known; oth		, Cognitive D D, interactio of patients w	<i>Note:</i> CCS, case-control study; CD, communication deviance; CDI, Cognitive Disturbances Index; DSM-III, Diagnostic and Statistical Manual of Mental Disorders-III; EU, egocentric utterances; healthy, parents of healthy offspring; ICD, interactional communication deviance; IRR, inter-rater reliability reported; mixed, multiple contrast groups; N, no; N/a, not applicable; N/K, not known; other, parents of patients with other mental health diagnoses; PCS, prospective cohort study; projective, Rorschach, TAT, or Phillipson; Y, yes.	SM-III, Diagnostic viance; IRR, inter th diagnoses; PCS,	c and Statistical -rater reliability , prospective coh	Manual of reported; 1 10rt study;	Mental D nixed, mu projective	bisorders Itiple con , Rorschá	-III; ntrast ıch, TAT,

Table 1. Characteristics of the Studies Included in the Meta-analysis

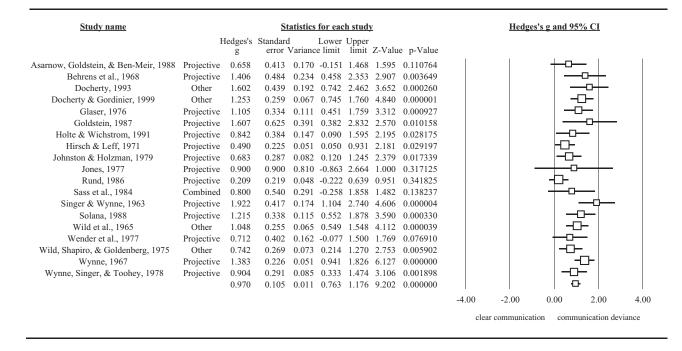


Fig. 2. Forest plot.

difficulties), again, did not change the pooled effect size significantly (k = 5; g = 0.91; SE = 0.24; 95% CI [0.44;1.38]; z = 3.79; P < .001; Q[4] = 14.76; P = .005; $I^2 = 72.91$; $\tau^2 = 0.2$; $\tau = 0.45$). However, heterogeneity increased significantly and the CI broadened. The exclusion of studies that had not controlled for the parents' educational level brought the effect size to a still significant and large $0.89 \ (k = 15; \text{SE} = 0.11; 95\% \text{ CI} [0.67; 1.1]; z = 7.97; P <$.001; Q[14] = 22.29; P = .073; $I^2 = 37.18$; $\tau^2 = 0.06$; $\tau = 0.25$). The exclusion of studies that had tested parents of children below the age of 15 again did not change the overall pooled effect size (k = 17; g = 0.94; SE = 0.1; 95% CI [0.73; 1.14]; z = 8.99; P < .001; Q[16] = 27.39; P = .037; $I^2 = 41.59$; $\tau^2 = 0.07$; $\tau = 0.27$). Unfortunately, we could not carry out a subgroup analysis by offspring's gender because there were too few data. Finally, we recomputed the effect size for studies that had accounted for verbosity. This reanalysis brought the pooled g down to a still large and significant 0.83 (k = 15; SE = 0.11; 95% CI [0.63; 1.04]; z = 7.93; P < .001; Q[14] = 20.09; P = .127; $I^2 = 30.32; \tau^2 = 0.05; \tau = 0.22$), whereas the effect size for studies that did not account for verbosity was 1.35 (k = 4; SE = 0.16; 95% CI [1.03; 1.66]; z = 8.42; P < .001; $Q[3] = 3.31; P = .346; I^2 = 9.45; \tau^2 = 0.01; \tau = 0.1)$ and difference between the 2 types of study was significant (Q[1] = 7.22; P = .007).

Because diagnostic criteria have changed considerably since Wynne and Singer's early studies, we decided to run a subgroup analysis of the studies carried out before and after the publication of Diagnostic and Statistical Manual of Mental Disorders-III (DSM-III). The estimated effect size for the latter studies was 0.96 (k = 8; SE = 0.2; 95% CI [0.57; 1.36]; z = 4.78; P < .001), however, with a significant level of heterogeneity (Q[7] = 16.75; P = .019; $I^2 = 58.22; \tau^2 = 0.18, \tau = 0.42$). The pooled effect size for the studies undertaken before the publication of the DSM-III was 0.98 (k = 11; SE = 0.12; 95% CI [0.74; 1.22]; z = 8.02; P < .001), but with a nonsignificant level of heterogeneity (Q[10] = 16.37; P = .09; $I^2 = 38.9$). To complement the above analysis, we carried out a metaregression using year of publication as a moderator variable. The regression was carried out using mixed effects to allow for between-study heterogeneity. Overall, year of publication was not found to be a significant predictor of effect size $(\beta = -0.01; SE = 0.01; 95\% CI [-0.03; 0.02]; z = -0.51;$ $P = .61; \alpha = 11.68; SE = 20.99; 95\% CI [-29.47; 52.82];$ $z = 0.56; P = .58; \tau^2 = 0.1; Q_R = 0.26; P = .61; Q_E = 14.82;$ $P = .61; Q_{\rm T} = 15.08; P = .66).$

Another potential source of heterogeneity between studies was the diverse methodologies used to elicit speech samples. A subgroup analysis of the studies that have used projective techniques revealed a g = 0.93 (k = 16; SE = 0.13; 95% CI [0.68; 1.18]; z = 7.17; P < .001) with a significant amount of heterogeneity (Q[15] = 28.49; P = .012; $I^2 = 50.87$; $\tau^2 = 0.12$; $\tau = 0.34$), whereas studies that have used other methodologies yielded a g of 1.09 (k = 4; SE = 0.15; 95% CI [0.79; 1.39]; z = 7.05; P < .001) with a nonsignificant level heterogeneity (Q[3] = 3.45; P = .327; $I^2 = 13.04$).

We were also interested in the effect sizes per parental sex. The effect size for mothers of psychotic offspring was g = 0.89 (k = 7; SE = 0.18; 95% CI [0.54; 1.24]; z = 4.99; P < .001; Q[6] = 7.92; P = .244; P = 24.21). Analysis of the effect sizes for the fathers of psychotic offspring revealed

a much smaller g = 0.39 (k = 6; SE = 0.16; 95% CI [0.07; 0.7]; z = 2.42; P < .05; Q[5] = 5.06; P = .41; P = 1.2). Using a mixed effect analysis, the comparison revealed that the difference between the 2 mean effect sizes was statistically significant (Q[1] = 4.38; P < .05).

Finally, we ran subgroup analysis between studies that have reported inter-rater reliability (IRR) (k = 14; g = 0.87; SE = 0.12; 95% CI [0.64; 1.11]; z = 7.25; P <.001; Q[13] = 21.49; P = .064; $I^2 = 39.5$; $\tau^2 = 0.07$; $\tau = 0.27$) and studies that either had not reported IRR or in which reliability was poor¹⁰⁴ (k = 5; g = 1.18; SE = 0.17; 95% CI [0.84; 1.52]; z = 6.83; P < .001; Q[4] = 6.5; P = .165; $I^2 = 38.45$; $\tau^2 = 0.06$; $\tau = 0.24$). Using a mixed effect analysis, the comparison revealed that the difference between the 2 mean effect sizes was not statistically significant (Q[1] = 2.1; P = .147).

Publication Bias

The visual inspection of the funnel plot revealed potential publication bias. The following statistical tools were used to explore this: (1) Begg and Mazumdar's rank order correlation, (2) Egger's regression intercept, and (3) Duval and Tweedie's "trim and fill" procedure. Begg and Mazumdar's test¹¹² revealed a nonsignificant Kendall's τ of 0.22 (z = 1.33; P = .09). Although this nonsignificant value suggests nonexistence of publication bias, the test has relatively low power for meta-analyses with a small number of studies.

In Egger's test,¹¹³ funnel plot asymmetry was calculated from a linear regression where the more the intercept deviates from 0, the more pronounced the asymmetry. Given the small number of pooled studies, evidence for asymmetry was taken at P < .1. In our case, the intercept was 1.49 (95% CI [-0.54; 3.52]; t[17] = 1.55; P = .07) supporting the existence of bias. Finally, Duval and Tweedie's¹¹⁴ "trim and fill" procedure identified 2 potential missing studies. The recomputed point estimate was 0.91 (95% CI [0.7; 1.13]) revealing that the presence of these "missing studies" was not likely to affect the overall magnitude of our effect size.

Discussion

The overall pooled effect size of the studies we considered was large in magnitude supporting Wynne and Singer's clinical intuitions and early findings. This effect was observed to be larger for mothers than for fathers.

It can be argued that these results should be treated cautiously given that there was considerable heterogeneity between studies. However, we have tried to circumvent this problem by combining individual effect sizes using a random effects model by excluding an outlier and finally through subgroup and sensitivity analyses, which brought down the heterogeneity to more acceptable levels. The most striking consequence was that all of these analyses continued to reveal large and significant effect sizes suggesting that variation between studies should not undermine our overall confidence in the association between CD in parents and psychosis in offspring. It is important to note, however, that the result of Egger's test suggested the existence of publication bias. When we recomputed a point estimate using the "trim and fill" procedure, we found that potential missing studies were not likely to undermine the presence of a significant effect. However, the existence of publication bias is an important issue that cannot be disregarded completely.

Some between-study variability should be unsurprising given the many limitations that these studies have in terms of their methodological quality. For example, many of the studies that were undertaken before the publication of DSM-III used diagnostic approaches that were quite different from today's standardized methods. On this issue, it was reassuring to see that a subgroup analysis, based on this specific methodological variable, yielded stable effect sizes across groups. Also, metaregression analysis showed that year of publication of the study had no impact on overall effect size.

A second problem affecting some of the old studies is the multiplicity of different methodologies used to gather speech samples. This plurality has the advantage of showing that effect sizes are not an artifact of any specific methodology. However, it makes the task of quantitative synthesis difficult and is likely to be a source of significant amount of heterogeneity. This is especially relevant when one looks at the differences in the methods of standardization of the CD measures. For example, in some studies, this ratio was calculated from word counts,¹⁰³ whereas in others studies, it was calculated using the number of lines of speech.⁵⁵ On this specific limitation, it was reassuring to note that the magnitude of the effect size did not change when we subanalyzed the results using methodology as a criterion. It is also interesting that some studies have replicated Wynne and Singer's early findings using sophisticated and standardized linguistic methodologies⁵¹ showing that findings on CD can be replicated using more natural conversational samples.

Another issue that limited the power of the present meta-analysis is the lack of standardized threshold values. In the studies in which results were reported as dichotomous outcomes, we have opted to reconstruct a continuous variable using agreed statistical conventions. However, we are aware that this approach has some limitations. In this respect, we felt reassured by the fact that nearly all the studies identified and retrieved reported positive findings and by the fact that our analysis comparing dichotomous and continuous outcomes revealed a stable effect size.

Another limitation is related to issues of reliability and validity. If it is true that in the majority of studies IRR has been ascertained and reported, it is no less true that in a few studies this issue, if not completely ignored, at least was not discussed and reported. Our subgroup analysis revealed that differences in mean effect sizes between studies that reported IRR and studies that did not were not significant.

Finally, our analysis tells us very little about the explanation for the prevalence of CD in parents of psychotic offspring. Given the robustness of the association between psychosis in offspring and parental CD, it is pertinent to consider the possible processes that might account for it.

Speculating about reverse causality, some authors have suggested that the higher prevalence of CD in parents of psychotic offspring could reflect a reaction of the parent to the disordered communication of the offspring.^{69,72–74,115,116} However, rigorous studies have shown that parents' CD measured during individual protocols correlates positively with CD during problem-solving situations with their offspring,³⁵ suggesting that variance in CD is not explained by the offspring's immediate behavior.^{40,102}

In an attempt to settle the issue, prospective and adoption studies have demonstrated that CD in the parent precedes the development of psychosis in the offspring by many years,^{18,19} and more importantly, that healthy communication in an adopting couple seems to exert a protective effect in the case of high-risk adoptees.⁴¹ Also relevant to the question of reverse causality is the observation that CD has the quality of an enduring trait-like characteristic in parents^{45,61,117} that becomes stable in the transition from adolescence to adulthood¹¹⁸ and that does not worsen with arousal or stress in the parent.^{56,98} These studies as a whole support the view that CD, rather than a reactive and transient phenomenon,⁸⁰ seems to be an enduring characteristic of some parents.^{61,117} Despite these observations, it remains possible that CD may become involved in a complex dynamic process of circular causality where cause and effect are intertwined^{12,94} as appears to be the case with other family variables such as expressed emotion.^{119–121}

Another hypothesis that has been suggested to explain the prevalence of CD among parents of psychotic offspring is that this form of communication could be an epiphenomenon of shared genetic vulnerability to psychosis, ie, *endophenotype*.^{104,122,123} According to this account, CD among parents of psychotic offspring should be interpreted against a broader context of cognitive deficits that are believed to be an expression of genetic liability for schizophrenia among unaffected first-degree relatives.¹²⁴

Some researchers have suggested that the *FOXP2* gene (*CNTNAP2* pathway) could be responsible for a shared vulnerability to CD and thought disorder^{125,126} although a recent meta-analysis of 2 genome-wide association studies found a significant association between thought disorder and 4 other genetic loci (*PKNOX2*, *MYH13*, *PHF2*, and *GPC6*).¹²⁷ However, an exclusively genetic account seems unlikely given that methodologically rigorous studies have shown that CD is a transdiagnostic risk factor for psychiatric disorders other than schizophrenia.^{128,129} Furthermore,

in our meta-analysis, a larger effect was found for maternal CD than for paternal CD. Although sex-linked genetic effects are not impossible, an obvious explanation for this finding is that actual exposure to CD is required for there to be an increased risk in the offspring. This gender effect appears to suggest that low CD in one of the parents (fathers) by itself may not have the protective impact on the development of psychosis that Wynne and Singer initially hypothesized. However, we were not able to extract data comparing families in which both parents had CD vs families in which only 1 parent had CD, and we therefore could not test the protection hypothesis directly.

Interestingly, evidence of a gene-environment interaction was reported by Tienari and colleagues in a relatively small study,^{19,41,42} in which it was found that at-risk children only developed a psychosis and thought disorder if they were raised by adoptive parents who exhibited CD. This finding has never been replicated and, if found to be secure in further studies, would provide one of the few examples of gene-environment interactions known to be important in psychosis. Hence, an important avenue for future research might be to measure parental CD alongside genetic data obtained from offspring in studies comparing patients and controls.

Prospective cohort studies could help us clarify the mechanism by which exposure to CD may affect the development of psychosis¹⁹ and thought disorder^{41,42} in offspring, which might ultimately have important implications for the prevention of psychosis and thought disorder. Miklowitz and Stackman²⁴ have suggested that exposure to CD might act as a psychosocial stressor that particularly affects genetically sensitive children. If this is the case, it might be expected that CD will affect the likelihood of a wide range of psychotic and affective symptoms. An alternative possibility is that CD affects some symptoms more than others. Indeed, some studies have focused specifically on the relationship between parental CD and thought disorder in offspring⁵⁸ although, to our knowledge, none have carried out adequate statistical controls for the co-occurrence of symptoms. Since Wynne and Singer first began their work on CD, more has been discovered about the structure of psychosis and its course across time. Although more complex models have also been proposed,¹³⁰ a widely supported model proposes that all psychotic disorders can be described along 5 symptom dimensions: positive symptoms, negative symptoms, cognitive disorganization, depression, and mania.¹³¹ Future research should consider whether CD is specifically related to any of these dimensions.

Consistent with the idea that actual exposure to CD is required to increase the risk of psychosis, some authors have argued that the impact of maternal CD is likely to occur during early development through the progressive internalization of language during social interaction with the parent,^{21,29,49,132} a hypothesis that is consistent with Vygotsky's sociocultural analysis of

cognitive development.¹³³ Another hypothesis is that the inability to establish and maintain shared foci of attention in the parent has a specific effect on very early nonverbal reciprocal dialogues between mother and baby, leading to the disruption of early cognitive development and communication in the child, resulting in a high risk of psychosis.¹³⁴ Interestingly, and despite remaining completely unexplored, this hypothesis is consistent with work by researchers in the field of developmental psychology, whose studies have demonstrated the crucial role of the mother in scaffolding the child's cognitive development during early episodes of joint attention.^{135–143} Along with other ante- and perinatal risk factors that have been suggested within the framework of the neurodevelopmental hypothesis of schizophrenia, such a developmental pathway could in part explain the results of birth cohort studies that have documented early developmental delays in children who were later diagnosed with schizophrenia.¹⁴⁴⁻¹⁴⁶ This hypothesis is also consistent with studies that show an association between maternal CD and poor cognition in offspring diagnosed with schizophrenia^{49,59,60} and with our present finding of a lower prevalence of CD in fathers of psychotic offspring. This hypothesis should be considered in future cohort studies.

At a clinical level, the revival of research on CD may have important implications for the development of family interventions. Results from a systematic review¹⁴⁷ and meta-analyses^{148,149} have clearly shown that these interventions are effective in reducing psychotic relapse and hospital admissions. Parental CD has also been found to be associated with psychotic relapse in the offspring in 2 independent studies.^{46,61} Hence, a fruitful avenue for enhancing these interventions might be to target the quality of the family communication from a CD standpoint.

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