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Association between processing speed and subclinical psychotic symptoms in the general population: Focusing on sex differences

Wulf Rössler [a,b,c,*], Vladeta Ajdacic-Gross [a,c], Mario Müller [a,c], Stephanie Rodgers [a,c], Wolfram Kawohl [a], Helene Haker [d], Michael P. Hengartner [a,c,e]

[a] Department of Psychiatry, Psychotherapy and Psychosomatics, Psychiatric Hospital, University of Zurich, Switzerland
[b] Institute of Psychiatry, Laboratory of Neuroscience (LIM 27), University of Sao Paulo, Brazil
[c] Zurich Program for Sustainable Development of Mental Health Services, Zurich, Switzerland
[d] Translational Neuromodeling Unit, Institute for Biomedical Engineering, University of Zurich & ETH Zurich, Switzerland
[e] Department of Applied Psychology, Zurich University of Applied Sciences (ZHAW), Zurich, Switzerland

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ABSTRACT

Evidence is growing that persons along the schizophrenia spectrum, i.e., those who also display subclinical psychotic symptoms, exhibit deficits across a broad range of neuropsychological domains. Because sex differences in the association between cognitive deficits and psychosis have thus far been mostly neglected, we believe that ours is the first study specifically focused upon those differences when examining the relationship between subclinical psychosis and processing speed. Using a sample of 213 persons from the general population from Zurich, Switzerland, psychotic symptoms were assessed with three different questionnaires including the Schizotypal Personality Questionnaire, an adaptation of the Structured Interview for Assessing Perceptual Anomalies, and the Paranoia Checklist. Processing speed was assessed with the WAIS digit-symbol coding test. Two higher-order psychosis domains were factor-analytically derived from the various psychosis subscales and then subjected to a series of linear regression analyses. The results demonstrate that in both men and women associations between subclinical psychosis domains and processing speed were weak to moderate (β ranging from -0.18 to -0.27; all $p < 0.05$). However, we found no sex-differences in the interrelation of subclinical psychosis and processing speed ($\Delta R^2 < 0.005$; $p > 0.30$). In conclusion, it appears that sex differences in psychosis manifest themselves only at the high end of the continuum (full-blown schizophrenia) and not across the sub-threshold range. The small magnitude of the effects reported herein conforms to the etiopathology of the disorder. Since schizophrenia and related disorders from the spectrum are assumed to be multifactorial diseases, it follows that many etiological components of small effect are involved.

1. Introduction

Since the writings of Kraepelin (1896), there has been a widespread notion that schizophrenia is associated with cognitive decline. Indeed, individuals with schizophrenia exhibit deficits across a broad range of neuropsychological domains, e.g., working memory, attention and vigilance, executive functioning, and processing speed. Cognitive deficits already can be found in patients with a first episode of schizophrenia (Galderisi et al., 2009; Heydebrand et al., 2004). Today, those deficits are regarded as relatively stable over the course of the illness and independent of the clinical states (Green, 2006).

In their seminal work, Jones et al. (1994) reported developmental disruptions and cognitive impairments in children with later onset of schizophrenia. Various ensuing studies replicated those cognitive deficits prior to the onset of full-blown psychosis (e.g., MacCabe et al., 2008; MacCabe et al., 2013; Metzler et al., 2014; Müller et al., 2013; Reichenberg et al., 2010; Zammit et al., 2004). Broad scientific consensus now exists among experts that poor premorbid cognitive functioning is a risk factor for schizophrenia and other psychotic disorders (Khandaker et al., 2011; MacCabe, 2008).

Interest is growing in understanding these deficits in persons from the whole schizophrenia spectrum, since the notion of an inherent continuum of psychotic disorders provides interesting new insights in the etiopathology of the various categorical disorders from this spectrum (Barrantes-Vidal et al., 2015). As such, impairments in working memory, attention, processing speed, and verbal learning have been found in subjects with schizotypal personality disorder (see review by Siever et al., 2002). Along with the increasing body of evidence for a continuum that encompasses schizotypal personality disorder (Raine, 2006), subclinical psychosis (Rössler et al., 2007; Rössler et al., 2013a) or psychotic experiences (Linscott and van Os, 2013) in the general population, research is needed concerning cognitive capacities at the low

* Corresponding author at: Psychiatric University Hospital, University of Zurich, Militärstrasse 8, CH-8004 Zurich. Tel.: +41 44 296 7401; fax: +41 44 296 7409.
E-mail address: wulf.roessler@uzh.ch (W. Rössler).

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end of the schizophrenia spectrum, i.e., sub-threshold psychotic states in non-clinical community samples. Measures that encompass this extended psychosis phenotype – schizotypal personality and subclinical psychosis – have been shown to be negatively related to executive functions (Gooding et al., 1999; Lenzenweger and Korfine, 1994), sustained attention (Chen et al., 1998; Gooding et al., 2006), verbal intelligence (Noguchi et al., 2008), working memory (Gooding and Tallent, 2003; Kelleher et al., 2012), or processing speed (Hengartner et al., 2014; Kelleher et al., 2012).

To date, sex differences have been mostly disregarded within the field despite some evidence of variations between males and females. For example, Welham et al. (2010) found that premorbid fluid and verbal intelligence in childhood and adolescence related to adult non-affective psychosis were slightly lower in males, but not in females. We are unaware of further reports about cognitive deficits that are separated by sex in those phenotypes. Many conclusions about premorbid cognitive functioning in psychosis have been drawn exclusively from male samples (e.g., MacCabe et al., 2013; Müller et al., 2013; Zammit et al., 2004). None of the studies focusing on the extended psychosis phenotype have examined potential sex differences. Therefore, the aim of the research presented here was to fill those gaps by analyzing several established measures of subclinical psychosis in association with processing speed, separating by sex for participants drawn from a representative community sample.

2. Methods

2.1. Study design and sampling

This study was conducted as part of the Zurich Program for Sustainable Development of Mental Health Services (ZInEP), a research and mental health care program involving several such services in the canton of Zurich, Switzerland. The Epidemiology Survey, one of nine ZInEP subprojects, comprised four components: 1) telephone screening; 2) comprehensive semi-structured, face-to-face interviews followed by self-report questionnaires; 3) tests in a socio/neuro-physiological laboratory; and 4) a longitudinal survey (Fig. 1). Start dates were August 2010 for screening and interviews, February 2011 for laboratory tests, and April 2011 for the survey. The screening ended in May 2012 while all other components were completed in September 2012.

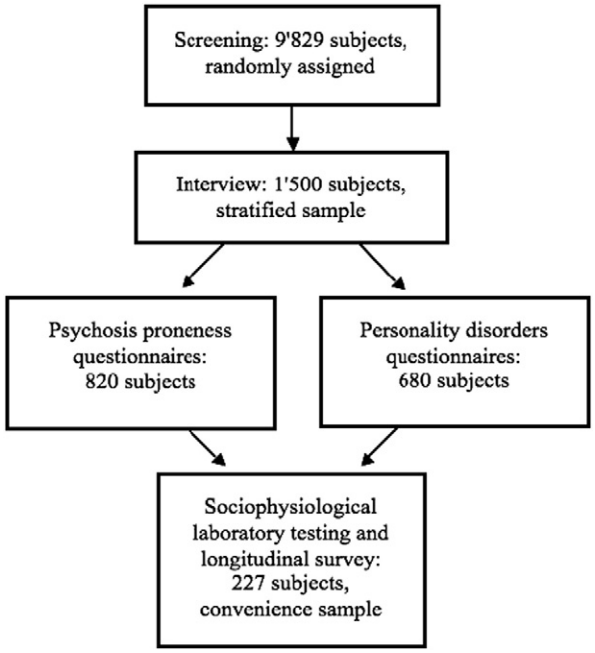

Fig. 1. Sampling procedure for the ZInEP Epidemiology Survey.

As a first step, we used a computer-assisted telephone interview (CATI) to screen 9829 Swiss male and female participants who were 20 to 41 years old at the onset of the survey. This pool was considered representative of the general population in the canton of Zurich. The Symptom Checklist-27 (SCL-27) (Hardt et al., 2004) served as our screening instrument. Participants were randomly chosen through the residents' registration offices of all municipalities within the canton. The inclusion criteria were Swiss nationality and being aged between 20 and 41. Residents without Swiss nationality were excluded. The SCL-27 (Hardt et al., 2004) is a German short-form of the well-known SCL-90-R (Derogatis, 1977) that covers a wide variety of psychopathological symptoms from the most recent four-week period. Subjects responded according to a five-point Likert scale. The SCL-27 contains the six subscales *depressive*, *dysthymic*, *vegetative*, *agoraphobic*, *sociophobic symptoms*, and *symptoms of mistrust*. A total distress score similar to the global severity index (GSI) of the SCL-90-R is also available. In accordance with detailed instructions from the research team, a renowned marketing and field research institute, GfK ("Growth for Knowledge"), conducted the CATI. The overall response rate was 53.6%. Reasons for non-response included no telephone connection, reaching only a telephone answering machine, incorrect telephone number, communication impossible, unavailability during the study period, or refusal by the target person or a third party. In the cases where potential subjects were available by telephone the response rate was 73.9%.

In our second step, we randomly selected 1500 subjects from the initial screening sample for face-to-face interviews (response rate: 65.2%). Our stratified-sampling procedure included 60% high-scorers (scoring above the 75th percentile of the global severity index for the SCL-27) and 40% low-scorers (below the 75th percentile). This design was chosen to enrich the sample pool with high scoring subjects at higher risk for mental disorders. Such a two-phase procedure – initial screening and comprehensive interviews with a stratified subsample – is fairly common in epidemiological research (Dunn et al., 1999; Eich et al., 2003). Experienced and trained clinical psychologists conducted the interviews either in the participants' homes or at the Psychiatric University Hospital in Zurich. All subjects who completed the interviews were subsequently asked to complete various questionnaires. For this purpose, the sample pool was randomly divided into subsamples focusing on either psychosis ($N = 820$) or personality disorders (PD; $N = 680$). This approach was chosen because completing all instruments, i.e., psychosis and PD questionnaires, would have increased the risk that participants prematurely terminate the interview. This risk is inherent to all epidemiological field work with the need to carefully balance our informational needs and willingness of participants to complete lengthy interviews. Thus participants were randomly assigned to either subgroup, which is why they did not differ in any characteristics besides the different questionnaires that they had to complete. A detailed rationale and description of the sampling procedure has been provided by Ajdacic-Gross et al. (2014).

In the final step, 227 subjects from the two subsamples were randomly selected for laboratory testing and longitudinal surveys based on their prior consent to undergo additional testing (see Ajdacic-Gross et al., 2014). Those initially assigned to the psychosis subsample additionally completed the PD questionnaires and vice versa. All subjects first underwent a set of endocrinological, neurophysiological and psychometric tests and were then interviewed at two-month intervals (maximum of six months) via a brief telephone screening. All tests were conducted in the laboratory of the Psychiatric University Hospital. Participants in the testing and survey received an additional 100 CHF payout in cash to compensate their time and effort.

The Ethics Committee of the canton of Zurich (KEK) approved the ZInEP Epidemiology Survey as fulfilling all legal and data privacy protection requirements. It was designed to be in strict accordance with the Declaration of Helsinki of the World Medical Association as revised in 2008. All participants gave written informed consent.

2.2. Instruments and measures

As a global measure of cognitive capacity the test battery included a test of processing speed. The latter was assessed with the digit symbol-coding test (DSCT), which is a subtest of the well-established Wechsler Adult Intelligence Scale, Third edition (WAIS-III) (Wechsler, 1997). It serves as a screening instrument for neuropsychological dysfunction and primarily pertains to the speed with which information is processed (Joy et al., 2004). The task of the test is to write the correct symbols allocated to the digits 1 through 9 for a pre-printed, pseudo-random series of 140 digits. A score is determined based on how many symbols have been properly coded within the 120-s time limit. Reliability and validity of the DSCT are good (Gonzalez-Blanch et al., 2011; Joy et al., 2004). As measured there, processing speed is thought to be particularly good in assessing generalized dysfunction that might be causing cognitive failures in schizophrenia spectrum disorders (Gonzalez-Blanch et al., 2011). The MATRICS Consensus Cognitive Battery (Nuechterlein et al., 2008) chose a different processing speed test (i.e., the BACS symbol coding test), but their analysis also showed that the DSCT performs equally well except from a marginally small practice effect. Since the ZInEP Epidemiology Survey incorporates a broad and comprehensive framework that includes various mental disorders other than psychosis (see for instance Hengartner et al., 2014), we chose the more widely applied DSCT over the BACS symbol coding test.

The brief form of the Schizotypal Personality Questionnaire (SPQ-B) (Raine and Benishay, 1995) contains 22 items and measures three factors of schizotypal personality: "cognitive–perceptual" (SPQ-cog: paranoid ideation, illusionary perception), "interpersonal" (SPQ-int: lack of close friends, social withdrawal, anhedonia), and "disorganized" (SPQ-dis: eccentric behavior, odd mannerisms). Each dichotomous item answered by "yes" scores one point on the corresponding factor. Internal consistency and test–retest reliability of the subscales are high (Raine and Benishay, 1995), and the three-factor structure has been replicated (Reynolds et al., 2000). Here, we used the German-language version of the SPQ-B translated by Klein et al. (1997). Because the questionnaire items were designed to measure stable personality traits, subjects were not restricted to a specific time frame.

The Paranoia Checklist (PARA) (Freeman et al., 2005) is a self-report instrument with 18 items, each rated on a five-point Likert scale. The PARA measures the most recent one-week prevalence of paranoid ideation. Each item assessing a feature of paranoid and suspicious thoughts is rated separately for frequency (PARA-fre), degree of conviction (PARA-con), and distress (PARA-dis). We used the German translation by Lincoln et al. (2009). Internal consistency of the PARA is very good and convergent validity has also been provided (Freeman et al., 2005; Lincoln et al., 2009).

The Structured Interview for Assessing Perceptual Anomalies (SIAPA) (Bunney et al., 1999) captures the most recent (i.e., "past few days") deficits in sensory gating. There, perceptual and attentional anomalies such as hyper-alertness and poor selective attention to external stimuli are evaluated. The SIAPA focuses on auditory, visual, tactile, olfactory, and gustatory modalities. Combined, they provide a total mean score (SIAPA-total). Each modality includes three items – hypersensitivity, inundation or flooding, and selective attention – that are rated on a five-point Likert scale ranging from "not at all" to "extremely". For the ZInEP Epidemiology Survey the SIAPA was adapted as a self-rating questionnaire by the authors of the current manuscript. Reliability and validity of the original interview form are good (Bunney et al., 1999). Here, the internal consistency of the various modalities for the adapted self-rating scales ranged from Cronbach's $\alpha = 0.70$ (visual) to $\alpha = 0.74$ (olfactorial), with a mean $\alpha = 0.72$. The coefficient for the total score was $\alpha = 0.87$.

2.3. Statistical analysis

To assure comparability across measures and ease the interpretation of the regression coefficients, we standardized the DSCT and all measures of sub-clinical psychosis using a z-transformation. Following previous work (see Rössler et al., 2015) we then conducted a principal component analysis (PCA) on an 11×11 item correlation matrix comprising the 11 subscales of the SPQ, PARA and SIAPA. The best-fitting factor solution was determined by inspecting the scree test (Cattell, 1966) and Horn's parallel analysis (PA) (Horn, 1965). The latter was performed with a syntax program provided by O'Connor (2000). Component scores were derived according to the Bartlett method included in SPSS. To analyze the associations between the extended psychosis phenotypes as predictor variables and the DSCT as the dependent variable, we ran a series of hierarchical linear regression models for each sex separately. Age was negatively related to the DSCT ($r = -0.21$). Therefore, to adjust for age and to estimate the proportion of variance explained by factors of the extended psychosis phenotype independently, we entered the former in the first block and the latter in the second block. We also computed a model in both men and women together that included the interaction effect between sex and psychosis in the third block. So, in this final model age was entered in the first block, the main effects of subclinical psychosis in the second block, and the sex-interaction in the third block. All results were reported with standardized regression coefficients (β), their standard errors (SE), and changes in the proportion of variance explained beyond the effect of age (ΔR^2). Because of the firm assumptions of linear regression analysis, multicollinearity was tested using the tolerance index and the variance inflation factor. Autocorrelation of the residuals was examined with the Durbin–Watson coefficient while homoscedasticity was inspected with scatterplots and normality of the residuals with histograms. All analyses were conducted with SPSS version 20 for Macintosh.

3. Results

A total of 14 subjects (6.2%) did not complete all questionnaires or tests in the laboratory. Thus, for the present study we included 213 participants (118 females and 95 males) who finished the questionnaires related to the extended psychosis phenotype and provided complete data from the DSCT. Their ages ranged from 20 to 41 years (mean of 29; standard deviation: 6.6 years). In all, 50 subjects (23%) were married, another 136 (64%) lived in a committed relationship, and 45 subjects (21%) had children. A high education level (college or higher) was achieved by a total of 77 subjects (36.2%). The global psychopathological impairment according to the GSI of the SCL-27 ranged from 1.0 to 3.9 ($M = 2.0$; $SD = 0.6$). The descriptive statistics of all measures (unstandardized raw scores) included in the analysis are shown in Table 1.

The common structure of the 11 sub-clinical psychosis measures was examined via PCA. Eigenvalues for the first four components were

Table 1
Descriptive statistics.

	N	Range	Mean	SD
DSCT	213	35–110	81.05	14.08
SPQ-cog	213	0.00–8.00	2.38	1.70
SPQ-int	213	0.00–8.00	3.05	2.10
SPQ-dis	213	0.00–6.00	2.03	1.79
PARA-fre	213	1.00–3.22	1.42	0.41
PARA-con	213	1.00–5.00	2.17	1.06
PARA-dis	213	1.00–4.94	1.75	0.67
SIAPA-aud	213	0.00–3.00	0.69	0.66
SIAPA-vis	213	0.00–3.00	0.72	0.66
SIAPA-tac	213	0.00–4.00	0.49	0.72
SIAPA-olf	213	0.00–2.67	0.36	0.54
SIAPA-gus	213	0.00–3.00	0.33	0.54

DSCT: Digit Symbol Coding Test.
SPQ: Schizotypal Personality Questionnaire; cog: cognitive–perceptual; dis: disorganized and int: interpersonal.
PARA: Paranoia Checklist; fre: frequency; con: conviction and dis: distress.
SIAPA: Structured Interview for Assessing Perceptual Anomalies; aud: auditory; vis: visual; tac: tactile; olf: olfactory and gus: gustatory.

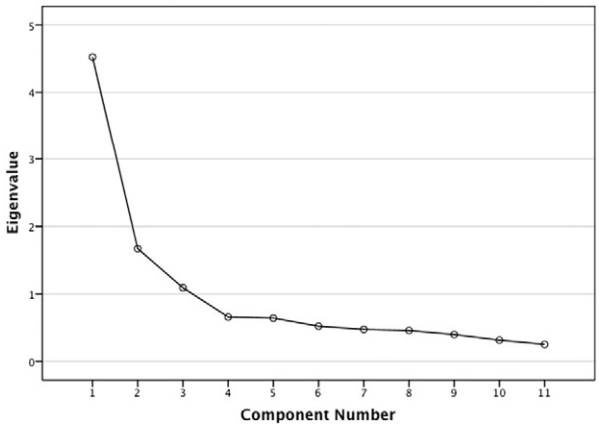

Fig. 2. Scree plot of principal component analysis with 7 items.

4.53, 1.67, 1.09, and 0.66. The scree plot (Fig. 2) demonstrated that, after the third component, there was a bend at which the curve flattened. Thus, according to the scree test a three-component model should have been favored. However, this finding was challenged by Horn's PA, which pointed toward a two-component model. A close inspection of the three-component solution revealed that this structure was intricate and not interpretable; various items showed substantial cross-loadings. By contrast, the two-component solution was neat and consistent and, therefore, we chose it as being more parsimonious and appropriate. This component-solution was also in line with a previous PCA of those scales performed with a larger sample (Rössler et al., 2015). The pattern matrix is presented in Table 2. All SIAPA subscales exhibited strong loadings on the first component and both SPQ and PARA had strong loadings on the second component. The component scores derived from this model were used to compute two higher-order dimensions of the extended psychosis phenotype for each participant, the first labeled as "anomalous perception" and the second as "odd behavior and beliefs". Because those measures were standardized they were approximately normally distributed with a mean of 0.0 and a standard deviation of 1.0.

Table 3 shows the associations of the "anomalous perception" and "odd behavior and beliefs" components with the DSCT according to the hierarchical linear regression analyses. Normality and autocorrelation of the residuals, homoscedasticity, and multicollinearity were acceptable in all models (data not shown). Age was negatively associated with the DSCT, which indicates that younger participants performed better on the processing speed test (Pearson $r = -0.21$, $p < 0.01$). Age was thus included in all models as a covariate. For males, anomalous perception accounted for 7.2% of the variance explained in processing speed, whereas odd behavior and beliefs explained 3.8% of the variance. The corresponding standardized regression coefficients (both $p < 0.05$) were $\beta = -0.268$ (perception) and $\beta = -0.197$ (behavior/belief), indicating that higher values on the extended psychosis phenotype were related to lower processing speed. For females, anomalous perception ($\beta = -0.241$) and odd behavior and beliefs ($\beta = -0.177$) explained 5.8% and 3.1% of total variance in processing speed. Their regression coefficients were comparable to those found for males. In the total sample, i.e., males and females together, the unadjusted association was $\beta = -0.176$ ($SE = 0.068$) for anomalous perceptions and $\beta = -0.162$ ($SE = 0.068$) for odd behavior and beliefs. Adjusted for sex and age the associations in the total sample were $\beta = -0.242$ ($SE = 0.064$) and $\beta = -0.178$ ($SE = 0.064$) for anomalous perceptions and odd behavior and beliefs, respectively. Fitting the models with a third block that consisted of an additional interaction term (sex * anomalous perception and sex * odd behavior and beliefs) consequently yielded no significant effects ($\Delta R^2 = 0.004$; $p = 0.33$ for anomalous perceptions and $\Delta R^2 < 0.001$; $p = 0.75$ for odd beliefs), which indicates that sex did not significantly contribute to the association between psychosis and processing speed.

Table 2
Result of a two-component solution.

	Component		Communality
	1	2	
SPQ-cog	0.048	**0.780**	0.644
SPQ-int	−0.110	**0.763**	0.518
SPQ-dis	−0.096	**0.813**	0.599
PARA-fre	0.108	**0.701**	0.573
PARA-con	−0.062	**0.496**	0.221
PARA-dis	0.135	**0.581**	0.429
SIAPA-aud	**0.565**	0.258	0.520
SIAPA-vis	**0.824**	−0.077	0.626
SIAPA-tac	**0.807**	0.054	0.695
SIAPA-olf	**0.852**	−0.113	0.651
SIAPA-gus	**0.861**	−0.028	0.720
Variance explained	41.1%	15.2%	Total: 56.3%

SPQ: Schizotypal Personality Questionnaire; cog: cognitive–perceptual; dis: disorganized and int: interpersonal.
PARA: Paranoia Checklist; fre: frequency; con: conviction and dis: distress.
SIAPA: Structured Interview for Assessing Perceptual Anomalies; aud: auditory; vis: visual; tac: tactile; olf: olfactory and gus: gustatory.
Component loadings higher than 0.320 are indicated in bold.

Table 3
Processing speed in association with two components of the extended psychosis phenotype in males and females, adjusted for age.

	Males			Females		
	β (SE)	ΔR^2	Sig.	β (SE)	ΔR^2	Sig.
Anomalous perception	−0.268 (0.098)	0.072	0.007	−0.241 (0.089)	0.058	0.008
Odd beliefs	−0.197 (0.100)	0.038	0.052	−0.177 (0.090)	0.031	0.051

4. Discussion

Cognitive deficits are considered a predominant core symptom underlying the psychopathology of schizophrenia (Elvevag and Goldberg, 2000; Reichenberg and Harvey, 2007). With the present study we provide evidence that some of those deficits are also prevalent in subclinical psychosis, which represents the rather low sub-threshold region along the continuum of an extended psychosis phenotype. Our findings are in accord with a growing body of literature showing significant associations among cognitive deficits and various phenotypes across the schizophrenia spectrum that encompass transient psychotic experiences, paranoia, schizotypal personality traits, and full-blown schizophrenia (Cohen et al., 2012; Gooding et al., 2006; Hengartner et al., 2014; Kelleher et al., 2012; MacCabe, 2008; Siever et al., 2002). In contrast to previous research demonstrating that premorbid cognitive deficits are only prevalent in men (Welham et al., 2010), we found that psychotic symptoms were moderately related to reduced processing speed in both men and women. Since processing speed is a powerful predictor of cognitive impairment (Gonzalez-Blanch et al., 2011), those results have far-reaching implications. Applying the DSCT in our study had two major advantages. First, it has been shown that processing speed, as assessed with the DSCT, is the most severely impaired cognitive function in schizophrenia (Dickinson et al., 2007). Second, processing speed is a substantial predictor of fluid and general intelligence (Deary et al., 2010; Jung and Haier, 2007).

Our measures of sub-clinical psychosis were two factors condensed from a variety of symptoms commonly characterized as being positive for psychosis, i.e., hallucinations and delusions, that we named "anomalous perception" and "odd behavior and beliefs" (Rössler et al., 2015). We were not surprised to find only a weak to moderate association between our sub-clinical psychosis measures and processing speed. This is because schizophrenia and all related disorders are assumed to be multifactorial diseases that entail many etiological components of

small effect (Jonas and Markon, 2013). It is also important to note that a greater psychotic symptom load was negatively associated with processing speed, which corresponds to an increase in cognitive deficits. Because ours is a cross-sectional study, we cannot make assumptions about the nature of this relationship, i.e., whether an increase in the occurrence of psychotic symptoms leads to a deterioration in cognitive abilities, or vice versa. In principle, cognitive functions can interact with psychopathology in three ways: 1) those functions affect the risk for developing such a disorder (in our case a disorder from the schizophrenia spectrum), 2) symptoms of the disorder precede a cognitive deterioration, or 3) cognitive deficits and/or symptoms are expressed in an affected person's functional outcome (Barnett et al., 2006). With respect to schizophrenia, it has been argued that a general neurodevelopmental impairment model is the most promising explanation (MacCabe, 2008; Rapoport et al., 2005). Concerning the functional outcome, it seems that an increase in sub-clinical psychosis symptoms leads to a rise in functional impairment (Jonas and Markon, 2013).

Sex differences in the association between cognitive deficits and psychosis were mostly neglected in past research. To the best of our knowledge, this is the first study that specifically focuses on those differences when examining the relationship between psychotic psychopathology and processing speed. Overall, we found that increased psychopathology was moderately related to reduced speed in males and females, although the effect sizes were somewhat larger with respect to the psychosis component “anomalous perception” than to “odd behavior and beliefs”. Historically, sex differences in schizophrenia have been associated with almost all aspects of this disease (Abel et al., 2010; Leung and Chue, 2000). In an earlier community study (Rössler et al., 2012), we investigated those differences in the symptom load of sub-clinical psychosis over time as well as cross-sectionally. If factors related to full-blown psychosis were equally meaningful along the entire continuum, we would have expected to identify sex differences but, instead, found none there. Thus it appears that sex differences in psychosis only manifest themselves at the high end of the continuum (full-blown schizophrenia) and not within the sub-threshold range.

The results of this study need to be interpreted in the light of the following major limitations. First, as stated above, this study was cross-sectional and we thus may not draw causal conclusions. For future research it would thus be worthwhile to follow subclinical psychosis symptoms prospectively across sexes. Possibly there are time- and age-dependent etiopathological pathways that differ between men and women, since gender differences are highly prevalent already in childhood and adolescence (Zahn-Waxler et al., 2008). Second, the assessment of subclinical psychosis relied exclusively on self-report, which may be biased trough method effects such as reduced awareness, concealment or social desirability. Here a major target of future research would be to additionally incorporate reliable and objective measures of subclinical psychosis that do not rely on self-report, possibly through the inclusion of endophenotypes or specific psychometric tests. Third, the present study focused exclusively on processing speed. It could thus be that sex-differences arise in other cognitive domains such as verbal fluency, which future studies should take into account by incorporating a comprehensive test battery such as the MATRICS Consensus Cognitive Battery (Nuechterlein et al., 2008). In conclusion, subclinical psychosis is not trivial in the lives of the affected persons. It influences not only their behavior and feelings but also their cognitive abilities. Reduced cognitive abilities are also phenotypically represented as “thought disorder” in persons with sub-clinical psychosis (Rössler et al., 2013c). Although most psychosis symptoms are transient and episodic in nature, the variability in their expression is predominantly caused by stable traits (Rössler et al., 2013b). In this respect we might define cognitive impairment as a core component of such a stable underlying liability trait (i.e., schizotypy or schizotypal personality; see Raine, 2006). Furthermore, subclinical psychosis generally represents a risk factor for the development of common mental disorders and a liability for co-occurring disorders (Barrantes-Vidal et al., 2015; Rössler et al., 2011). This has important implications for the whole spectrum of mental disorders, since according to recent research a person's score on the psychosis liability factor may account for a large proportion of variance in global psychopathological impairment (Caspi et al., 2014; Stochl et al., 2014). Thus, even if subclinical psychosis does not constitute a diagnostic category of its own, but rather a distinction along a continuous liability spectrum instead, it deserves careful clinical considerations (see also Barrantes-Vidal et al., 2015).

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Contributors

Wulf Rössler wrote and revised the manuscript and is responsible for ZInEP. Vladeta Ajdacic-Gross and Wulf Rössler designed the ZInEP Epidemiology Survey. Mario Müller, Stephanie Rogers, and Vladeta Ajdacic-Gross contributed significantly to data management and critically revised the manuscript. Wolfram Kawohl and Helene Haker were responsible for the laboratory testing and also critically revised the manuscript. Michael P. Hengartner contributed significantly to data management; conducted the statistical analyses; and conceived, wrote, and revised the manuscript.

Conflict of interest

All authors declare no conflicts of interest.

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