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ORIGINAL PAPER

Fluid intelligence and empathy in association with personality disorder trait-scores: exploring the link

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Abstract There is some evidence that fluid intelligence as well as empathy may be significantly related to personality disorders (PDs). To our knowledge, no study has addressed those issues simultaneously in all 10 DSM PDs in a sample of the general population. We analysed data from 196 participants aged 20–41 from the Epidemiology Survey of the Zurich Programme for Sustainable Development of Mental Health Services (ZInEP), a comprehensive psychiatric survey in the general population of Zurich, Switzerland. We assessed the digit symbol-coding test (DSCT), the "reading the mind in the eyes" test (RMET) and the interpersonal reactivity index (IRI). Both measures of cognitive empathy (i.e. RMET and IRI perspective taking) were not related to any PD trait-score. The total PD trait-score was significantly associated with low scores on DSCT and IRI empathic concern and high scores on IRI personal distress, which indicates a dose–response relationship in those measures. DSCT was particularly related to borderline PD, IRI empathic concern to schizoid and narcissistic PDs, and IRI personal distress to avoidant PD. The proportion of variance explained in the total PD trait-score accounted for by DSCT, IRI empathic concern and IRI personal distress was 2.6, 2.3 and 13.3 %, respectively. Symptomatology and severity of PDs are related to low fluid intelligence and reduced emotional empathy as characterized by low empathic concern and high personal distress towards emotional expressions of others. Further research is needed that examines the association between cognitive empathy and personality pathology as well as potential clinical applications.

Keywords Personality disorder · Processing speed · Fluid intelligence · Empathy · Theory of mind · Cognitive reserve · Social brain hypothesis

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Introduction

Studies focusing on associations between personality disorders (PDs) and intelligence in the general population are rare. Furthermore, there is still an ongoing debate as to how such relationships might be interpreted [1]. Several recent longitudinal studies reported an association between premorbid reduced intelligence and increased risk of hospital admission for any PD [1–3]. Findings from a large cross-sectional male adolescent community study provides strong evidence that low general intelligence is not solely restricted to psychiatric hospitalization, but also to increased PD prevalence [4]. Coid [5] found that paranoid, antisocial, borderline, avoidant and dependant PDs were associated with low general intelligence, whereas narcissistic PD was related to above-average intelligence. Finally, testing a sample of university students and using dimensional PD scores, Unsworth et al. [6] found modest negative correlations for schizotypal and antisocial PDs with fluid intelligence, whereas associations for all other PDs failed to reach statistical significance.

While for most PD categories comprehensive data are still lacking, there has been a long tradition of studies on cognitive abilities in borderline patients. More recently,

research on borderline PD has also focused on empathy. Empathy is a multi-facet construct with substantial overlap with interrelated cognitive and emotional concepts [7]. Altogether, those concepts form a cluster of affective socio-cognitive abilities that encompass empathy, emotional intelligence and theory of mind (ToM). Here, we focus specifically on the concepts of cognitive empathy and emotional empathy [8]. Cognitive empathy is based on ToM, that is, a subject's ability to understand the mental states that underlie other people's manifest behaviours and facial expressions [9]. Emotional empathy describes one's emotional reaction towards other people's affective states.

Because all those concepts are highly entwined, we subsequently also refer to studies that report on emotional intelligence or ToM. With respect to borderline PD, findings are inconsistent. While some studies have reported associations between borderline symptomatology and reduced empathy/emotional intelligence/ToM [10–12], others have failed to find a relationship [13–15]. Two recent studies found reduced cognitive and emotional empathy scores in psychopathic antisocial subjects [16, 17] and another study suggests that also narcissistic PD may be associated with reduced emotional empathy, but not with cognitive empathy [18]. In addition, Arntz et al. [13] found that cluster-C PD patients achieved higher ToM-scores than borderline PD patients. There are no data available with respect to other PD categories, and studies in community samples are lacking. For instance, according to the DSM-IV-TR, lack of empathy is an important criterion of schizoid PD [19], although we did not find one single contemporary study addressing this association.

To our knowledge, no study has ever examined fluid intelligence and empathy in association with all 10 DSM-IV PDs in a general population-based sample. Evidence based on community samples is crucial because most persons with mental disorders are not treated in psychiatric settings. In addition, patient samples are considerably biased with respect to various socio-demographic factors (e.g. social support, education or socio-economic status). Thus, the objective of the present study was to overcome those shortcomings and to examine indicators of fluid intelligence and empathy in association with dimensional trait-scores of all 10 DSM-IV PDs in a population-based community sample.

Methods

Study design and sampling

This study was conducted within the scope of the Epidemiology Survey of the Zurich Programme for Sustainable Development of Mental Health Services (ZInEP; in German: "*Z*ürcher *I*mpulsprogramm zur *n*achhaltigen *E*ntwicklung der *P*sychiatrie"), a research and health care programme involving several psychiatric research divisions and mental health services of the canton of Zurich, Switzerland. The Epidemiology Survey is one of the six ZInEP subprojects and consists of four components: (1) a short telephone screening, (2) a comprehensive semi-structured face-to-face interview followed by self-report questionnaires, (3) tests in the sociophysiological laboratory and (4) a longitudinal survey (see Fig. 1). Telephone screening and semi-structured interviews started in August 2010, the tests at the sociophysiological laboratory in February 2011 and the longitudinal survey in April 2011. The screening ended in May 2012 and all other components in September 2012.

First, 9829 Swiss males and females aged 20–41 years at the onset of the survey and representative of the canton of Zurich, Switzerland, were screened by computer-assisted telephone interview (CATI) using the Symptom Checklist-27 (SCL-27) [20]. All participants were randomly chosen through the residents' registration offices of all municipalities of the canton of Zurich. Residents without Swiss nationality were excluded from the study. The CATI was conducted by GfK (Growth for Knowledge), a major market and field research institute, in accordance with instructions from the ZInEP research team. The overall response rate was 53.6 %. Reasons for non-response were no response, only telephone responder, incorrect telephone number, communication impossible, unavailability during the study period or refusal by a third person or the target person. In cases where

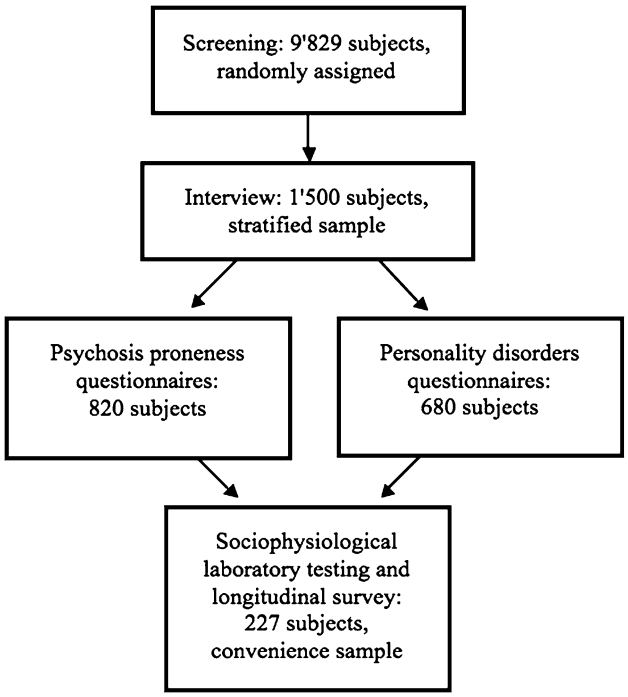

Fig. 1 The sampling procedure of the ZInEP Epidemiology Survey

potential subjects were available by telephone, the response rate was 73.9 %.

Second, 1,500 subjects were randomly selected from the initial screening sample for subsequent face-to-face interviews (response rate: 65.2 %). We applied a stratifying sampling procedure including 60 % high scorers (scoring above the 75th percentile of the global severity index of the SCL-27) and 40 % low scorers (scoring below the 75th percentile of the global severity index). The basic sampling design was adapted from the prospective Zurich cohort study [21] and was chosen to enrich the sample with subjects at high risk of mental disorders. Such a two-phase procedure with initial screening and subsequent comprehensive interview with a stratified subsample is fairly common in epidemiological research [22].

Face-to-face interviews were carried out by experienced and extensively trained clinical psychologists. The interviews took place either at the participants' homes or at the Zurich University Hospital of Psychiatry in Zurich. All participants who completed the semi-structured interview were additionally assigned to complete various questionnaires. For this purpose, the sample was divided into subsamples focusing either on psychosis ($N = 820$) or on personality disorders ($N = 680$).

Third, for the longitudinal survey, 227 subjects from the two subsamples were selected. Participants initially assigned to the psychosis subsample additionally completed the PD questionnaires (and vice versa). All subjects first performed a set of neuropsychological tests and were subsequently interviewed at 2-month time intervals over a maximum period of 6 months with a brief telephone screening. The neuropsychological tests were conducted in the laboratory of the University Hospital of Psychiatry Zurich. Subjects who participated in the laboratory testing and the longitudinal survey additionally received a 100 CHF payout in cash to recompense their time and effort. A total of 31 subjects did not complete all tests at the laboratory. Thus, for the present study, we included 196 participants who completed the questionnaires related to personality disorders and who provided all required data from the neuropsychological testing. Out of these 196 subjects, altogether 146 participants (74.5 %) were initially assigned to the stratum of high scorers.

The ZInEP Epidemiology Survey was approved by the Zurich State Ethical Committee (KEK) as fulfilling all legal and data privacy protection requirements and is in strict accordance with the declaration of Helsinki of the World Medical Association. All participants gave their written informed consent.

Instruments and measures

To measure dimensional PD trait-scores in each participant, we applied the Assessment of DSM-IV Personality Disorders Questionnaire (ADP-IV) [23]. The ADP-IV design allows a dimensional trait-score and a categorical PD diagnosis for each of the DSM-IV PDs and higher-order PD clusters A, B or C. The ADP-IV is a paper–pencil self-report instrument consisting of 94 items representing the 80 criteria of the 10 DSM-IV PDs and the 14 research criteria of the depressive and the passive-aggressive PDs. Each trait-question is rated on a 7-point Likert scale, ranging from "totally disagree" to "totally agree". For the ZInEP Epidemiology Survey, the German translation by Doering et al. [24] was used. Internal consistency and test–retest reliability of the dimensional trait-scores are good, and concurrent validity is also satisfactory [24, 25]. Most importantly, the ADP-IV shows good concordance with the SCID-II interview [26] and may be considered as an economic alternative to semi-structured interviews. In the present study, the internal consistency (Cronbach's α) for each PD dimension was as follows: $\alpha = 0.81$ for paranoid PD, $\alpha = 0.64$ for schizoid PD, $\alpha = 0.85$ for schizotypal PD, $\alpha = 0.77$ for antisocial PD, $\alpha = 0.86$ for borderline PD, $\alpha = 0.80$ for histrionic PD, $\alpha = 0.80$ for narcissistic PD, $\alpha = 0.86$ for avoidant PD, $\alpha = 0.76$ for dependent PD and $\alpha = 0.75$ for obsessive–compulsive PD. We applied dimensional PD trait-scores because clinical diagnoses of PDs are conceived as arbitrary distinctions along continuous personality dimensions [27]. Furthermore, dimensional PD measures are more reliable and valid than dichotomous clinical diagnoses [28].

The digit symbol-coding test (DSCT) is a subtest of the well-established Wechsler Adult Intelligence Scale, third Edition (WAIS-III) [29]. It serves as a screening instrument for neuropsychological dysfunction and is predominantly associated with information processing speed [30], whereas processing speed is substantially associated with fluid intelligence [31, 32]. The task of the test is to write down the right numbers allocated to various symbols. The test ends after 120 s, and the test score is calculated by adding all symbols that have been correctly coded within the 120 s. Reliability and validity of the DSCT are good [30, 33].

The "reading the mind in the eyes" test (RMET) measures a subject's ability to deduce emotions and intentions by looking at a pair of eyes [34]. This ability is regarded as a major component of ToM and is referred to as social cognition or mentalizing and is consistent with the concept of cognitive empathy. Thus, in the following, we refer to the RMET as an indicator of cognitive empathy. The revised version of the RMET consists of 36 pictures of eye-pairs. Every picture is presented with 4 response items that may describe the mental state of the person on the picture. The participants have to indicate which term best describes what the person in the picture is thinking or feeling. For every right answer, the participant receives a point. There

is no time limitation. The reliability and validity of the test are good [34, 35].

The interpersonal reactivity index (IRI) [36] is a self-rating questionnaire that consists of four subscales with 7 items each that assess different aspects of empathy. Each item is evaluated on a 5-point Likert scale ranging from "does not describe me well" to "describes me very well". The "perspective-taking" subscale (IRI-PT) measures a person's subjective ability to comprehend other people's perspective. IRI-PT is accordingly a measure of cognitive empathy. The second subscale—"fantasy" (IRI-FS)—assesses the tendency to put oneself into a fictitious character. IRI-FS was not included in the analysis because we considered its face validity to be insufficient and the concept of the subscale to be irrelevant for the aims of this study. The "empathic concern" subscale (IRI-EC) detects the willingness to feel compassion and concern for other people, and the fourth subscale—"personal distress" (IRI-PD)—covers a person's self-oriented negative feelings in reaction to others' emotional expressions. Both IRI-EC and IRI-PD assess emotional empathy. The IRI has shown good reliability and validity [37, 38]. Note that in contrast to the RMET, the IRI is not an objective test that captures abilities because it relies on self-report and subjective appraisal.

Statistical analysis

First, we analysed the associations between every predictor variable and each dimensional PD trait-score as well as the total PD trait-score by applying a series of generalized linear regression models (GLMs). All dependent variables (i.e. PD dimensions) were right skewed; therefore, we fitted models with a gamma distribution and log-link function. A robust estimator was used to reduce the effects of outliers and influential observations. The z-transformed RMET, DSCT and IRI subscales were entered separately as predictor variables. Results were reported with unstandardized regression coefficients (b) and their standard errors (SE). All associations were adjusted for sex and age. Second, we estimated the proportion of variance explained in each PD dimension and the total PD trait-score by applying partial correlation analysis, again adjusting for sex and age. All analyses were performed with SPSS version 20 for Macintosh.

Results

The final sample consisted of 111 females (56.6 %) and 85 males. The mean age was 29.3 years (SD = 6.5). Altogether, 49 subjects were married (25.0 %) and 145 were unmarried; for 2 subjects, information on civil status was missing. A high education level (college or higher) was achieved by totally 73 subjects (37.2 %), whereas 122 subjects reported a low education level; information from 1 participant was missing. Finally, 44 subjects (22.4 %) had children and 152 subjects did not. According to the ADP-IV, a dichotomous clinical diagnosis of any PD was fulfilled by 7 subjects (3.6 %), whereof 4 subjects fulfilled 1 diagnosis, 2 subjects fulfilled 3 diagnoses and 1 subject fulfilled 6 diagnoses, resulting in totally 16 PD diagnoses. In detail, 1 person met the criteria of schizotypal PD, 1 person of antisocial PD, 6 persons of borderline PD, 2 persons of histrionic PD, 1 person of narcissistic PD, 1 person of avoidant PD and 4 persons of obsessive–compulsive PD. The descriptive statistics (unstandardized raw scores) of the continuous measures are provided in Table 1.

The results of the GLMs are reported in Table 2. No significant associations were found for RMET and IRI-PT. DSCT was significantly and negatively associated with the total PD trait-score ($b = -0.053$) and with the schizoid ($b = -0.066$), schizotypal ($b = -0.073$) and borderline PDs ($b = -0.118$). IRI-EC was significantly negatively related to the total PD trait-score ($b = -0.047$) and to the paranoid ($b = -0.068$), schizoid ($b = -0.094$), antisocial ($b = -0.074$), narcissistic ($b = -0.093$) and avoidant PDs ($b = -0.069$). Finally, IRI-PD was significantly positively related to the total PD trait-score ($b = 0.113$) and to the paranoid ($b = 0.117$), schizoid ($b = 0.066$), schizotypal ($b = 0.111$), borderline ($b = 0.147$), histrionic

Table 1 Descriptive statistics of PD trait-scores and measures of fluid intelligence (DSCT), cognitive empathy (RMET and IRI-PT) and emotional empathy (IRI-EC and IRI-PD)

	Min	Max	Mean (SD)	Skewness	Kurtosis
Paranoid PD	1.00	5.71	2.49 (0.98)	0.84	0.52
Schizoid PD	1.00	5.14	2.21 (0.80)	0.92	0.90
Schizotypal PD	1.00	5.67	2.33 (0.98)	0.89	0.34
Antisocial PD	1.00	6.13	1.81 (0.78)	1.95	5.70
Borderline PD	1.00	6.70	2.53 (1.09)	1.01	0.98
Histrionic PD	1.00	5.63	2.49 (0.94)	0.74	0.66
Narcissistic PD	1.00	6.00	2.43 (0.89)	1.43	3.20
Avoidant PD	1.00	5.86	2.61 (1.15)	0.78	−0.17
Dependent PD	1.00	5.13	2.35 (0.85)	0.70	0.19
Obsessive–compulsive PD	1.00	5.63	2.99 (0.94)	0.30	0.11
Total PD trait-score	10.65	54.24	24.25 (7.53)	0.80	0.93
DSCT	35	110	80.93 (14.14)	−0.43	0.21
RMET	13	33	25.00 (3.71)	−0.35	−0.25
IRI-EC	8	28	19.63 (4.04)	−0.34	−0.02
IRI-PD	4	24	13.78 (4.16)	0.12	−0.44
IRI-PT	3	27	17.00 (3.78)	−0.41	0.73

DSCT digit symbol-coding test, *RMET* reading the mind in the eye test, *IRI* interpersonal reactivity index, *IRI-EC* empathic concern, *IRI-PD* personal distress, *IRI-PT* perspective-taking

Table 2 Results of a series of generalized linear models: associations between PD trait-scores and measures of fluid intelligence (DSCT), cognitive empathy (RMET and IRI-PT) and emotional empathy (IRI-EC and IRI-PD); adjusted for sex and age

	DSCT *b* (SE)	RMET *b* (SE)	IRI-EC *b* (SE)	IRI-PD *b* (SE)	IRI-PT *b* (SE)
Paranoid	−0.053 (0.030)	0.011 (0.029)	**−0.068 (0.029)***	**0.117 (0.028)****	−0.030 (0.027)
Schizoid	**−0.066 (0.027)***	−0.031 (0.029)	**−0.094 (0.024)****	**0.066 (0.028)***	−0.022 (0.022)
Schizotypal	**−0.073 (0.031)***	−0.003 (0.028)	−0.048 (0.031)	**0.111 (0.031)****	0.008 (0.027)
Antisocial	−0.033 (0.029)	−0.029 (0.029)	**−0.074 (0.028)****	0.012 (0.041)	−0.035 (0.027)
Borderline	**−0.118 (0.032)****	−0.012 (0.028)	0.004 (0.031)	**0.147 (0.032)****	−0.033 (0.028)
Histrionic	−0.033 (0.029)	0.019 (0.027)	−0.018 (0.028)	**0.083 (0.029)****	−0.024 (0.025)
Narcissistic	−0.036 (0.028)	0.001 (0.027)	**−0.093 (0.027)****	0.054 (0.028)	−0.041 (0.026)
Avoidant	−0.046 (0.032)	0.048 (0.032)	**−0.069 (0.032)***	**0.215 (0.027)****	−0.034 (0.029)
Dependent	−0.050 (0.029)	0.014 (0.027)	0.005 (0.025)	**0.169 (0.025)****	−0.024 (0.025)
Obsessive–compulsive	−0.038 (0.026)	0.034 (0.025)	−0.024 (0.023)	**0.120 (0.022)****	−0.037 (0.023)
Total score	**−0.053 (0.024)***	0.010 (0.024)	**−0.047 (0.021)***	**0.113 (0.023)****	−0.028 (0.020)

Statistically significant associations are indicated in bold

DSCT digit symbol-coding test, *RMET* reading the mind in the eye test, *IRI* interpersonal reactivity index, *IRI-EC* empathic concern, *IRI-PD* personal distress, *IRI-PT*, perspective-taking

* $p < 0.05$; ** $p < 0.01$

Table 3 Results of a series of partial correlation analyses: proportion of variance explained (R^2) in PD trait-scores by measures of fluid intelligence (DSCT) and emotional empathy (IRI-EC and IRI-PD)

	DSCT R^2	IRI-EC R^2	IRI-PD R^2
Paranoid	0.018	**0.029***	**0.089****
Schizoid	**0.029***	**0.066****	**0.033***
Schizotypal	**0.025***	0.015	**0.074****
Antisocial	0.004	**0.033***	0.001
Borderline	**0.059****	0.000	**0.128****
Histrionic	0.005	0.003	**0.049****
Narcissistic	0.009	**0.066****	**0.023***
Avoidant	0.009	**0.024***	**0.216****
Dependent	0.016	0.001	**0.215****
Obsessive–compulsive	0.013	0.006	**0.147****
Total score	**0.026***	**0.023***	**0.133****

Statistically significant associations are indicated in bold

DSCT digit symbol-coding test, *IRI* interpersonal reactivity index, *IRI-EC* empathic concern, *IRI-PD* personal distress

* $p < 0.05$; ** $p < 0.01$

($b = 0.083$), avoidant ($b = 0.215$), dependent ($b = 0.169$) and obsessive–compulsive PDs ($b = 0.120$).

The proportion of variance explained in the PD trait-scores is indicated in Table 3. The RMET and IRI-PT were not included because they yielded no significant associations (see Table 2). $R^2 = 0.01$ corresponds to a small effect size, $R^2 = 0.09$ corresponds to a medium effect size and $R^2 = 0.25$ to a large effect size. The proportion of variance explained in the total PD trait-score accounted for by DSCT, IRI-EC and IRI-PD was 2.6, 2.3 and 13.3 %, respectively, corresponding to small-to-medium effect sizes for DSCT and IRI-EC and a medium-to-large effect size for IRI-PD. Specifically, the DSCT accounted for the largest proportion of variance explained in borderline PD (5.9 %; small-to-medium effect size), the IRI-EC in schizoid and narcissistic PDs (both 6.6 %; small-to-medium effect sizes), and the IRI-PD in avoidant PD (21.6 %; medium-to-large effect size).

Discussion

This is the first study to examine all ten DSM-IV PD trait-scores in association with indicators of fluid intelligence and empathy in a population-based community sample. Generalized linear regression models revealed that all PDs were negatively associated with processing speed, although the regression coefficients were statistically significant only for schizoid, schizotypal and borderline PDs. However—and most importantly—the analysis showed a significant association with the total PD trait-score, which indicates a dose–response relationship. That is, the higher the severity of personality pathology the lower the processing speed. Processing speed is an important indicator of fluid intelligence [31, 32]. An association between any PD and reduced general intelligence has been reported consistently in the literature [1, 3, 4]. Reduced general cognitive function and fluid intelligence specifically in borderline PD [5] and schizotypal PD [6, 39] have also been reported previously. However, in contrast to Coid [5]

in our data, narcissistic PD was not associated with higher intelligence scores, but rather with lower fluid intelligence (although statistically not significant at $\alpha = 0.05$).

Both measures of cognitive empathy, that is, the RMET and IRI-PT, were not significantly related to any PD dimension or total trait-score. Research in socio-cognitive abilities has almost exclusively focused on borderline PD. In this respect, our results are consistent with several studies that did not find a significant association between cognitive empathy/emotional intelligence/ToM and borderline PD [13–15]. However, we were not able to detect a salient methodological feature that discriminates between these studies and the others that did report a significant association [10–12]. This inconsistency must definitively be addressed in future research. In line with Ritter et al. [18], we found that narcissistic PD was unrelated to cognitive empathy, but significantly negatively related to emotional empathy.

In our analyses, all PD dimensions were significantly associated with either low empathic concern (paranoid, schizoid, antisocial, narcissistic and avoidant PDs) or high empathic personal distress (paranoid, schizoid, schizotypal, borderline, histrionic, avoidant, dependent and obsessive–compulsive PDs). In addition, the total PD trait-score was significantly related to both measures of emotional empathy. We are not aware of other studies that included such a comprehensive assessment of empathy in all DSM-IV PDs. The associations reported here are nevertheless well captured and explained through specific criteria of those respective PDs in DSM-IV-TR [19]. For instance, schizoid PD is characterized by high indifference towards and detachment from emotional relations, which is well displayed by the substantial negative association with empathic concern. Avoidant PD symptoms comprise fear of criticism and rejection; thus, as expected, this PD dimension was positively and strongly related to empathic personal distress. The latter was in addition strongly associated with all PD dimensions except for antisocial and narcissistic PD, which was expected because of the callous nature of antisocial (and to a lesser extent also narcissistic) subjects [17]. Empathic concern was significantly negatively related to paranoid, schizoid, antisocial, narcissistic and avoidant PDs, which captures well the symptoms of aloofness, mistrust and interpersonal detachment in those disorders [19].

In conclusion, our analysis showed that general PD symptomatology and severity of personality pathology are consistently related to low fluid intelligence and reduced emotional empathy as characterized by low empathic concern in conjunction with personal distress towards the emotional expressions of others. Surprisingly, we found no significant association with cognitive empathy as measured by the "reading the mind in the eyes" test. Reduced empathy—cognitive and emotional—relates similarly to other mental disorders than PDs [7, 8]. We also acknowledge that low intelligence is not specifically related to PDs. Several authors have concluded that psychiatric disorders in general are associated with at least mild cognitive impairment and that the IQ score has no specificity among different diagnoses [1, 3, 4, 40]. Those findings are consistent with the cognitive reserve hypothesis [41], which posits that low cognitive resources represent a general vulnerability for various psychopathological syndromes. In this respect, it would be interesting to examine whether empathic abilities contribute to cognitive reserve. Such an approach could be helpful for cognitive interventions in the treatment for PDs [42].

Evolutionary theorists contend that the hominid neocortex and its functions principally evolved because of increasingly complex and challenging social demands, which is also known as the social brain hypothesis [43, 44]. Fluid intelligence and empathy are thus evolutionary evolved adaptive traits [45, 46] that are highly relevant for the social functioning and adaptation of modern humans [47–49]. In contrast, general personality pathology represents a maladaptive trait that is related to social functioning deficits [50, 51]. In line with this theory, our data showed that the severity of dysfunctional personality (i.e. the total PD trait-score) was negatively correlated with fluid intelligence and emotional empathy (although inconsistently not with cognitive empathy). From a developmental perspective, two main explanations have been put forward: the first posits that reduced cognitive abilities constitute a marker of general neurobiological impairment, and the second states that reduced cognitive abilities are direct causally related to mental disorders [1]. However, there is still an ongoing debate whether empathy may as well be conceived as a cognitive ability [46]. Finally, further research is particularly needed to examine the association between cognitive empathy and PDs. If cognitive empathy and personality pathology are truly unrelated (in contrast to fluid intelligence and emotional empathy), theorists should coherently incorporate this finding into an evolutionary and neurodevelopmental framework.

This study is subject to the following limitations: first, because of the cross-sectional design, we cannot draw causal conclusions from our data. Second, we assessed only one single indicator of fluid intelligence. A more extensive test battery may have yielded further or more differentiated associations. Third, the IRI is a self-report questionnaire and captures only subjective appraisals. It is not a test of objective abilities. In addition, the RMET is possibly too narrowly reduced to eye expression to capture general interindividual differences in cognitive empathy in subjects with pathological personality traits. Here, a test that measures cognitive empathy in more complex social interactions would presumably have provided more valid data (and possibly significant associations). Fourth, because our

participants were included through a convenience sample, the representativeness and external validity of our results may be restricted. Fifth, we did not adjust for the interrelation of PD dimensions. Although a multivariate analysis that takes into account the covariance between PD dimensions could easily be carried out using structural equation modelling, we decided against such a statistical approach because of the rather modest sample size (to ascertain the reliability and validity of complex structural equation modelling, large samples are required).

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Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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