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Emotional Intelligence and cognitive abilities – associations and sex differences

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Abstract

In order to expand on previous research, this cross-sectional study investigated the relationship between Emotional Intelligence (EI) and cognitive abilities in healthy adults with a special focus on potential sex differences. EI was assessed by means of the Mayer-Salovey-Caruso-Emotional-Intelligence Test (MSCEIT), whereas cognitive abilities were investigated using the Brief Assessment of Cognition in Schizophrenia (BACS), which measures key aspects of cognitive functioning, i.e. verbal memory, working memory, motor speed, verbal fluency, attention and processing speed, and reasoning and problem solving. 137 subjects (65% female) with a mean age of 38.7 ± 11.8 years were included into the study. While males and females were comparable with regard to EI, men achieved significantly higher BACS composite scores and outperformed women in the BACS subscales motor speed, attention and processing speed, and reasoning and problem solving. Verbal fluency significantly predicted EI, whereas the MSCEIT subscale understanding emotions significantly predicted the BACS composite score. Our findings support previous research and emphasize the relevance of considering cognitive abilities when assessing ability EI in healthy individuals.

Keywords

Emotional Intelligence; cognitive abilities; sex differences

Introduction

Emotional Intelligence (EI) is a concept first introduced by Leuner (1966) and focuses on personality traits and abilities enabling people to cope with both their own feelings as well as those of others. It has been related to a range of social, health, and occupational outcomes (Agnoli et al., 2012; Perera & DiGiacomo, 2013; Sánchez-Álvarez, Extremera, & Fernández-Berrocal, 2016; Schutte, Malouff, Thorsteinsson, Bhullar, & Rooke, 2007; Song

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et al., 2010). The so-called ability model defines EI as an emotion-related cognitive ability to perceive, use, understand, and regulate emotions (ability EI) (Mayer, Salovey, & Caruso, 2004), while the trait model defines it as ‘a constellation of behavioral dispositions and self-perceptions concerning one’s ability to recognize, process, and utilize emotion-laden information’ (trait EI) (Petrides, Frederickson, & Furnham, 2004, p. 278). These different definitions are also reflected in the operationalization of EI. Ability EI is measured with performance tests referring to an underlying ability model (e.g. Mayer-Salovey-Caruso-Emotional-Intelligence Test (MSCEIT), Mayer, Salovey, Caruso, & Sitarenios, 2003) that is similar to standard intelligence (Farrelly & Austin, 2007), while trait EI is determined by means of self-reports (Austin & Saklofske, 2014). The model underlying this approach is usually described as a mixed model, because self-report EI scales typically consist of self-reports of emotional abilities and other personality traits (Farrelly & Austin, 2007). Using an integrative theoretical model, Joseph and Newman (2010) suggest that both ability and mixed models of EI can be measured with self-report and performance-based measures and accordingly, they distinguish between performance-based ability EI, self-report ability EI, and self-report mixed EI. Notably, the two paradigms (ability model vs. mixed model) are only moderately related (Joseph & Newman, 2010) and show different associations to cognitive abilities and personality (Joseph & Newman, 2010; Mayer, Roberts, & Barsade, 2008): while self-report measures of mixed EI and ability EI show a weak association with cognitive abilities and a more powerful relationship with personality, performance-based measures of ability EI show a stronger relationship with cognitive abilities and marginal correlations with personality (Joseph & Newman, 2010). Accordingly, the ability model and the trait model of EI are different and do not measure the same construct (Austin, 2010; Joseph & Newman, 2010). This is also reflected in a meta-analysis reporting on smaller sex differences when mixed-based EI measures were used in contrast to ability-based approaches (Joseph & Newman, 2010).

Previous studies using the MSCEIT have reported on higher EI scores in women as compared to men (Brackett, Mayer, & Warner, 2004; Day & Carroll, 2004; Extremera, Fernández-Berrocal, & Salovey, 2006; Joseph & Newman, 2010; MacCann, Joseph, Newman, & Roberts, 2014). Of note, differences in MSCEIT scores decrease when age is controlled for (Fernández-Berrocal, Cabello, Castillo, & Extremera, 2012). Notably, sex differences have consistently been shown with regard to overall ability EI, whereas sex differences in ability-based EI dimensions have rarely been investigated, so far (Joseph & Newman, 2010). Accordingly, the current study focused on ability EI as a facet of intelligence (McCann et al., 2014), which has previously been shown to positively correlate with cognitive abilities (Joseph & Newman, 2010; Mayer, Caruso, & Salovey, 2000). In a number of previous studies, the association between ability EI and crystallized intelligence has been shown to be more consistent than that with fluid intelligence, especially with verbal abilities (Farrelly & Austin, 2007; MacCann, Roberts, Matthews, & Zeidner, 2004). Accordingly, there is a strong relationship between intelligence and the understanding branch of measures of ability EI (Joseph & Newman, 2010; Roberts, Schulze, & MacCann, 2008).

Cognitive abilities are important for coping with everyday life, and deficits in one or more functions can lead to a restriction or loss of functional independence (Diener & Olbrich,

2010; Green, 1996). Sex differences in cognitive functioning have been found in some studies over the past decades (Halpern & LaMay, 2000; Kimura, 2000), but findings are inconsistent. This can be attributed to the complexity of biological, psychological, and social variables influencing these differences (Halpern & LaMay, 2000). On average, women show better performance in linguistic tasks (Halpern & LaMay, 2000; Hyde & Linn, 1988) and in processing speed (Burns & Nettelbeck, 2005; Camarata & Woodcock, 2006), whereas men tend to outperform women in visuospatial abilities (de Frias, Nilsson, & Herlitz, 2006; Masters & Sanders, 1993; Voyer, Voyer, & Bryden, 1995).

Current study

In order to expand on previous research the current study investigated the associations between ability EI and cognitive functioning in healthy adults with a special focus on sex differences. We hypothesized that females would achieve higher overall ability EI levels compared to males and that in both sexes ability EI dimensions would be positively associated with cognitive functioning, especially with verbal abilities.

Methods

The present study is part of a project on EI in schizophrenia and bipolar I disorder and was approved by the Ethics Committee of the Medical University Innsbruck. It was conducted according to GCP standards on human experimentation and the Helsinki Declaration of 1975, as revised in 2008. All participants signed informed consent forms. Study procedures were performed by a trained research team.

Participants

137 healthy individuals (89 female) from the community between the ages of 18 and 60 years were included into the study. Following the collection of sociodemographic data a brief medical screening interview was used to exclude subjects with any physical or neurological illness or any condition or medication affecting neural or cerebrovascular function. Psychiatric disorders were excluded by using the Mini Mental Neuropsychiatric Interview (MINI, Sheehan et al., 1998) and the Structured Clinical Interview for Axis-II-Disorders according to DSM-IV (SCID II, Wittchen, Wunderlich, Gruschwitz, & Zaudig, 1996).

Emotional Intelligence

EI was assessed by means of the German version (Steinmayr, Schütz, Hertel, & Schröder-Abe, 2011) of the MSCEIT. The MSCEIT is a self-administered test based on 141 items and consists of 8 tasks with two tasks forming a single branch. The MSCEIT provides an overall EI score, two area scores (experiential EI, strategic EI), and four subscale (branch) scores (Mayer, Salovey, & Caruso, 2002): (1) perceiving emotions (tasks: faces, pictures), (2) using emotions (tasks: facilitation, sensations), (3) understanding emotions (tasks: changes, blends), and (4) managing emotions (tasks: emotional management, emotional relations).

The MSCEIT full-test split-half reliability ranges from .73 to .93 and reliabilities for each of the four branches range from .80 to .92. It is both content and structurally valid besides

showing discriminate validity from measures of analytic intelligence and many personality constructs (Brackett & Salovey, 2006). The scores are reported as EI quotients (EIQs; Mayer et al., 2002) with a mean of 100 and a standard deviation of 15, similar to common intelligence tests. The evaluation is performed automatically via evaluation software based on the Hogrefe Test System. The results are presented as a report. In the present study the consensus-based scoring method was used.

Cognitive abilities

Cognitive abilities were assessed with the the German version (Sachs, Winklbaur, Jagsch, & Keefe, 2011) of the Brief Assessment of Cognition in Schizophrenia (BACS, Keefe et al., 2008), which assesses verbal memory (list learning), working memory (digit sequencing), motor speed (token motor task), verbal fluency (category and letter fluency), attention and processing speed (symbol coding), and reasoning and problem solving (Tower of London). This instrument was chosen, because it covers a broad range of cognitive functions and can be carried out shortly. Furthermore, standard values for healthy subjects are available. In the German validation (Sachs et al., 2011), test–retest reliability was very high, with intraclass correlations (ICC) of .95 in the schizophrenia patient group and .91 in the healthy control group. BACS raw values are converted into *T* values with a mean of 50 and a standard deviation of 10.

Statistical methods and data analysis

The distribution of continuous variables was checked for deviations from normality by means of the Shapiro–Wilk test. Comparison of male and female participants with regard to age and education was performed by independent sample *t*-test and Mann–Whitney *U*-test, depending on the variable type (normally distributed, non-normally distributed).

We applied a square root transformation to those MSCEIT subscales and BACS subscales showing deviations from normality to obtain normal distribution. For analyses of sex differences regarding MSCEIT scores (total score, experiential EI, strategic EI, and the four branches of EI) and BACS scores (composite score and the six subtests) we used independent sample *t*-tests.

Associations between MSCEIT and BACS were investigated by correlation analysis (Pearson's correlation coefficient). In addition, two multiple linear regression models were used to investigate the association of MSCEIT and BACS. In one model, we used the BACS composite score as dependent variable and the MSCEIT subscales as predictor variables. In another model, we included the MSCEIT total score as dependent variable and the BACS subtests as predictors. Significant predictors were determined using the backward stepwise variable elimination method. In order to account for a possible effect of sex differences on the results of the regression analyses, the variable sex was also included as a predictor. The latter variable was always retained in the regression model (even if statistically insignificant) to ensure that significance testing within the regression model was always performed with adjustment for sex. All statistical tests were performed at a .05 level of significance.

Results

Sample characteristics

Study participants had a mean age of 38.7 (SD = 11.8) years (males: 39.1 [SD = 12.4], females: [SD = 11.6]) and a mean education of 14.6 (SD = 12.4) years (males: 14.6 [SD = 3.0], females: 14.5 [SD = 3.0]). The two sexes did not differ with respect to age ($t(134) = .33, p = .741$) or education ($U(-.262) = 137, p = .794$). BACS scores were available for all 137 study participants and MSCEIT scores for 136 participants. All MSCEIT branches were positively intercorrelated ranging from $r = .18 (p < .05)$ to $r = .47 (p < .001)$.

Sex differences

The means and standard deviations in MSCEIT (sub-)scores and BACS (sub-)scores are shown in Table 1. Comparison of the mean values of MSCEIT (sub-)scores revealed no significant sex differences in EI. In contrast, men scored significantly higher than women in the BACS composite score ($t(134) = 3.10, p < .01$) and in the BACS subtests Tower of London ($t(134) = 3.23, p < .01$), symbol coding ($t(134) = 2.27, p < .05$), and token motor task ($t(134) = 2.11, p < .05$). There were no significant sex differences in verbal fluency, digit sequencing, and verbal memory (BACS).

Relationship between Emotional Intelligence and cognitive abilities

As shown in Table 2, correlation analysis revealed a positive correlation between the MSCEIT subscale understanding emotions and the BACS composite ($r = .35, p < .01$) score as well as verbal memory ($r = .31, p < .01$), verbal fluency ($r = .36, p < .01$), and symbol coding ($r = .22, p < .01$). We also found a positive association between both the MSCEIT total score ($r = .23, p < .01$) and the MSCEIT subscale using emotions ($r = .17, p < .05$) and verbal fluency.

In a multiple linear regression model verbal fluency was the only BACS subscale significantly predicting total EI ($\beta = .232, R^2 = .072$, adjusted $R^2 = .058, p = .006$) (Table 3). In another model, the MSCEIT subscale understanding emotions was the only significant predictor of the BACS composite score ($\beta = .374, R^2 = .207$, adjusted $R^2 = .195, p < .001$) (Table 4).

Discussion

This study investigated sex differences in ability EI and cognitive abilities and the relationship between these two constructs in a sample of 137 healthy volunteers. Contrary to previous research which reported on higher ability EI in women as compared to men (Brackett et al., 2004; Day & Carroll, 2004; Extremera et al., 2006; Joseph & Newman, 2010; MacCann et al., 2014) we found no significant sex differences in this regard. One possible explanation for this discrepancy could be the fact that previous studies had mainly investigated students and their results may therefore be limited to this population. Our sample shows a greater diversity, particularly in educational level and age. Moreover, a recent study has shown that women in the high compared with the low progesterone phase of

their menstrual cycle perform better on the MSCEIT (Milivojevic, Sinha, Morgan, Sofuoglu, & Fox, 2014) and we did not control for this potential confounder.

Studying sex differences in cognitive abilities is generally a complex and controversial topic and the relevance of biological and environmental factors is not clear yet (Hausmann, 2007; Miller & Halpern, 2014). In our sample, the mean BACS values were in the upper average range. Males achieved a significantly higher mean BACS composite score and scored significantly higher in the BACS subtests token motor task, symbol coding, and Tower of London. No significant sex differences were found with regard to verbal memory, verbal fluency, and working memory. These results are contradictory to previous studies (Burns & Nettelbeck, 2005; de Frias et al., 2006; Weiss, Kemmler, Deisenhammer, Fleischhacker, & Delazer, 2003) and we suggest that the missing sex differences in verbal fluency are responsible for missing sex differences in the MSCEIT total score since these scales correlate with each other. However, when interpreting these data, one has to consider the low effect sizes, especially in symbol coding and the token motor task. Accordingly, the differences within groups were by far larger than the differences between men and women.

We found inter-correlations between the MSCEIT subscale understanding emotions, i.e. the knowledge about emotions, and a number of BACS (sub)scores. Furthermore, verbal fluency significantly predicted the MSCEIT total score, and the MSCEIT subscale understanding emotions was a significant predictor of the BACS composite score. These results corroborate those of previous studies which had shown associations between ability EI and crystallized intelligence (especially verbal abilities) (Farrelly & Austin, 2007; MacCann et al., 2004) as well as an interrelation between cognitive abilities and the understanding emotions branch of the MSCEIT (Joseph & Newman, 2010; Roberts et al., 2008). However, in view of the missing positive correlations with other cognitive abilities our findings provide evidence, that ability EI as measured by the MSCEIT is not a distinct form of intelligence (Mayer et al., 2000). Accordingly and following MacCann et al. (2014), multiple aspects of intelligence need to be controlled for when assessing EI for the prediction of several outcomes such as academic success, workplace success, and health outcomes.

Limitations and recommendations for future research

A major limitation of the current study was the small sample of convenience, which could have led to some degree of selection bias. This clearly limits the generalizability of our data.

Although the MSCEIT is the most widely used instrument, this ability test of EI has been criticized by several authors and shows major limitations (Fiori & Antonakis, 2011, 2012; Maul, 2012; Zeidner, Matthews, & Roberts, 2001). Subsequent to the conduction of this study it has been shown by Fiori et al. (2014) that the MSCEIT does not seem to have strong measurement precision for distinguishing average from high EI individuals. Accordingly, the authors suggested to use the MSCEIT for testing clinical subsamples that are expected to be below average on EI (Fiori et al., 2014). Our data therefore need to be replicated by using other instruments, e.g. the Situational Test of Emotional Understanding (STEU; MacCann & Roberts, 2008).

Another limitation is the potential artificial relation between the performance on EI measures like the MSCEIT and reading comprehension because of the text-based instructions (Wilhelm, 2005). Therefore, McCann et al. (2014) suggested to use multimedia tests with stimuli presented as images and video footage. Notably, a recent study has shown validity evidence for assessing EI (managing emotions) with multimedia tests which was equivalent to text-based MSCEIT test scores (MacCann, Lievens, Libbrecht, & Roberts, 2016). However, further research is needed to prove these findings for other MSCEIT branches.

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Table 1

Sex differences in Emotional Intelligence and cognitive abilities.

Measure	All	Male	Female	Statistics		
	Mean (SD)	Mean (SD)	Mean (SD)	<i>t</i>	<i>d</i> ^a	<i>p</i> -Value ^a
<i>MSCEIT (sub-)scale</i>						
Perceiving emotions	104.2 (14.6)	102.5 (16.8)	105.1 (13.2)	-.999	.179	.321
Using emotions	107.9 (12.2)	105.8 (13.8)	109.1 (11.2)	-1.551	.271	.123
Understanding emotions	101.5 (14.1)	100.0 (14.6)	102.4 (13.9)	-.923	.170	.358
Managing emotions	106.2 (13.6)	105.0 (15.1)	106.9 (12.7)	-.849	.140	.397
Experiential EI	106.7 (14.0)	104.5 (16.5)	107.9 (12.4)	-1.334	.243	.186
Strategic EI	105.1 (14.3)	103.2 (15.7)	106.1 (13.5)	-1.131	.203	.260
Total score	107.4 (14.2)	105.0 (17.2)	108.7 (12.2)	-1.427	.042	.158
<i>BACS (sub-)scale</i>						
Verbal memory	57.9 (11.1)	60.2 (11.4)	56.7 (10.7)	1.809	.320	.073
Digit sequencing	56.1 (8.1)	57.9 (7.0)	55.1 (8.6)	1.971	.347	.051
Token motor task	55.4 (9.0)	57.6 (9.4)	54.2 (8.5)	2.110	.385	.037 *
Verbal fluency	55.6 (11.0)	55.4 (10.5)	55.7 (11.4)	-.161	.027	.872
Symbol coding	50.6 (8.3)	52.8 (7.7)	49.5 (8.4)	2.267	.404	.025 *
Tower of london	52.7 (6.9)	55.2 (6.6)	51.3 (6.8)	3.231	.579	.002 **
Composite score	57.7 (8.7)	60.8 (8.7)	56.0 (8.3)	3.101	.561	.002 **

Notes: MSCEIT: *N* = 136 (male: 48, female: 88) BACS: *N* = 137 (male: 48, female: 89).

Abbreviation: MSCEIT = Mayer-Salovey-Caruso Emotional Intelligence Test, EI = Emotional Intelligence; Bacs = Brief Assessment of Cognition in Schizophrenia.

^aEffect size Cohen's *d*.**p* < .05; ***p* < .01.

Table 2

Correlation between Emotional Intelligence and cognitive abilities.

BACS (sub-)scale	Verbal memory	Digit sequencing	Token motor task	Verbal fluency	Symbol coding	Tower of London	Composite score
MSCEIT (sub-) scale							
Perceiving emotions	-.02	.01	-.02	.10	-.02	-.09	-.00
Using emotions	.02	.05	-.05	.17 *	.01	-.12	.05
Understanding emotions	.31 **	.15	.01	.36 **	.22 *	.12	.35 **
Managing emotions	-.02	-.07	.10	.06	.01	-.02	.02
Total score	.08	.04	.01	.23 **	.06	-.06	.13

Abbreviations: BACS = Brief Assessment of Cognition in Schizophrenia, MSCEIT = Mayer-Salovey-Caruso Emotional Intelligence Test.

* $p < .05$; ** $p < .01$.

Table 3

Stepwise multiple linear regression: Emotional Intelligence.

Predictor BACS (sub-)scale	β	SE	t	p
<i>Variables in the model</i>				
Sex ^a	.139	.134	1.550	.124
Verbal fluency	.232	.006	2.769	.006
<i>Variables excluded</i>				
Verbal memory	.086	.006	.879	.381
Digit sequencing	.066	.119	.696	.487
Token motor task	.025	.007	.272	.786
Symbol coding	-.018	.009	-.183	.855
Tower of London	-.081	.010	-.814	.417

Notes: Dependent variable: MSCEIT total score.

Abbreviations: BACS = Brief Assessment of Cognition in Schizophrenia, MSCEIT = Mayer-Salovey-Caruso Emotional Intelligence Test.

 $R^2 = .072$, adjusted $R^2 = .058$, $F = 5.131$, $df = 2$, $p < .001$.^aThis variable was retained in the model to ensure that testing for an effect of the BACS subscales in the regression model is performed with adjustment for sex.

Table 4

stepwise multiple linear regression: cognitive abilities.

Predictor MSCEIT (sub-)scale	β	SE	t	p
<i>Variables in the model</i>				
Sex	-.285	1.439	-3.602	<.001
Understanding emotions	.374	.048	4.807	<.001
<i>Variables excluded</i>				
Perceiving emotions	-.031	1.044	-.351	.726
Using emotions	-.008	1.395	-.082	.935
Managing emotions	-.051	1.118	-.584	.560

Notes: Dependent variable: BACS composite score.

Abbreviations: MSCEIT = Mayer-Salovey-Caruso Emotional Intelligence Test, BACS = Brief Assessment of Cognition in Schizophrenia.

$R^2 = .207$, adjusted $R^2 = .195$, $F = 17.182$, $df = 2$, $p < .001$.