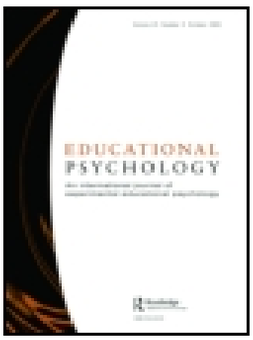

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Social perception: relationships with general intelligence, working memory, processing speed, visual-spatial ability, and verbal comprehension

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ABSTRACT

Social perception is important because it can affect the way intelligence is expressed during social interactions at school, home, and work. This study ($N = 800$) of adolescents and adults (age range = 16–91) examined which specific aspects of intelligence are associated with social perception (a composite of affect labelling, linking prosody to facial expressions, and interpreting the intent of a speaker). Women scored higher on social perception than men. Verbal comprehension (VC), perceptual reasoning (PR), working memory (WM), and processing speed (PS) accounted for 20% of the social perception variation, significantly ($p < .05$) more than did Full Scale IQ alone. VC had the largest effect on social perception, followed by PS and PR. WM had a non-significant effect on social perception. Implications for theory and research on intelligence and emotional intelligence are discussed along with implications for educational practice.

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Intelligence; social cognition; emotional intelligence; working memory; verbal comprehension

Social perception is the process through which we form impressions of and make inferences about other people. Social perception is an important aspect of psychological well-being and is an aspect of emotional intelligence (Mayer & Geher, 1996). Adolescent students with higher social perception of emotions experience more positive affect due to mastery goals than students with lower social perception (Vassiou, Mouratidis, Andreou, & Kafetsios, 2016). Furthermore, among adolescents, social perception predicts listening comprehension and reading comprehension, which are core academic skills (Froiland & Davison, 2019). Adults with autism, schizophrenia, antisocial behaviour, and opiate use have significantly lower levels of social perception than non-clinical controls (Addington, Saeedi, & Addington, 2006; Green et al., 2008; Marsh & Blair, 2008; McDonald, Darke, Kaye, & Torok, 2013).

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The importance of specific intellectual abilities in predicting social perception

In their megamodel of talent development, Olszewski-Kubilius, Subotnik, and Worrell (2016) posit that both general intelligence and specific abilities (e.g. verbal intelligence) are important for talent development. Importantly, adolescents and adults do not optimally develop their talent if they do not develop psychosocial strengths, such as emotional intelligence and intrinsic motivation. However, more research is needed to find out how specific abilities and general intelligence work in concert to promote psychosocial strengths and talent development (Olszewski-Kubilius et al., 2016). Social perception can be viewed as an expression of cognitive intelligence that depends upon the understanding of verbal concepts (sad, happy, disgusted), memory for interpersonal events, perception of facial expressions, and rapid processing of social events. Emotional intelligence is important for everyday life because it entails 'hot' information processing, which is processing information about the things that matter the most to many people such as relationships, social interactions, and related feelings. People often experience significant psychological distress and social difficulty when they struggle with social perception, understanding emotions, or other aspects of emotional intelligence (Mayer, Caruso, & Salovey, 2016). This makes understanding factors that promote emotional intelligence all the more important. Schneider, Mayer, and Newman (2016) argued for the merging of CHC theory with their model of hot and cool intelligences. Based upon their model, working memory (WM) predicts managing emotions, but not social perception. Likewise, their model posits that visual-spatial ability predicts social perception, but that processing speed (PS) and verbal comprehension (VC) do not. It is important to test this model, because we posit that PS is vital to social perception, in that many social-emotional cues are presented to people in real time and faster processing helps one keep up with it all. Likewise, VC may be the strongest intellectual predictor of social perception, which has been found in the past (MacCann, Joseph, Newman, & Roberts, 2014), because people often reason verbally through social and emotional information and language gives us a way of analysing emotions.

Green et al. (2008) found that social cognition mediates the positive effect of cognition on social functioning. McDonald et al. (2013) found that intelligence is a moderate predictor of social perception. Although they measured various aspects of intelligence, they only used a general intelligence score in their analyses. Most studies that examine the relationship between social perception and intelligence measure a few subtests of intelligence tests or use a brief intelligence test, rather than a full intellectual battery (Ibanez et al., 2013). Although these findings are valuable and it may save time to test one aspect of intelligence, a comprehensive battery with all of the major index scores provides the opportunity to examine the extent to which different aspects of intelligence better predict social perception. For instance, Agnoli et al. (2012) found a small positive relationship between Raven's matrix reasoning scores and emotional intelligence but did not examine other key aspects of intelligence, such as VC, WM, and PS. On the other hand, other researchers have solely studied how verbal intelligence predicts social perception and related constructs, such as emotional intelligence and social cognition. For instance, Hogan et al. (2010) found that verbal intelligence is moderately positively associated with emotional intelligence

(e.g. understanding emotions and understanding others) among 192 high school students in Canada. As an example of the advantage of studying multiple facets of intelligence and social perception (Holdnack, Goldstein, & Drozdick, 2011) found that adolescents and adults with autism have lower VC, PS, and social perception than non-clinical adults. Interestingly, many clinicians have long thought that visual-spatial ability is the strongest intellectual predictor of social perception due to the idea that much of communication is nonverbal. Yet, people with high functioning autism often have better visual-spatial ability, at least when dealing with simple information (Caron, Mottron, Rainville, & Chouinard, 2004). Prima facie, this seems to contradict the finding that adolescents and adults with autism have lower social-emotional intelligence than non-clinical samples (Celani, Battacchi, & Arcidiacono, 1999; Holdnack et al., 2011). However, the current study could shed light on this issue by examining which aspect of intelligence is the best predictor of emotional intelligence. If VC and PS better predict emotional intelligence than visual-spatial ability, it would make sense that youth and adults with autism often have lower emotional intelligence. The current study is the first to comprehensively examine the specific relationships between various aspects of cognitive intelligence and social perception among a nationally representative sample of adolescents and adults.

Social perception as a vital aspect of emotional intelligence

Mayer and Salovey's (1997) four branch model of emotional intelligence includes social perception (accurately perceiving emotions in others) as part of one of the four branches. Intertwined with that branch is accurately perceiving one's own emotions. The other three branches of emotional intelligence include facilitating thought with emotions, understanding emotions, and managing emotions. MacCann et al. (2014) found that a three-pillar model better fits the data, such that social perception, understanding emotions, and managing emotions are the three core aspects of emotional intelligence. Their research based upon CHC theory indicates that social perception has a modest positive relationship with Gc (VC) and Gf (fluid intelligence), while having weaker yet significant relationships with quantitative reasoning, visual processing, and retrieval ability (MacCann et al., 2014). However, that study did not control for socio-economic status and it relied upon self-ratings of social perception. Accurate social perception helps one to better understand and manage emotions. Importantly, social perception and other aspects of emotional intelligence can be objectively measured via ability tests, much like cognitive intelligence (Mayer & Salovey, 1997). Namely, much like psychologists are often trained to measure fluid reasoning and vocabulary, psychologists can also measure emotional intelligence by seeing how well people perform various tasks (e.g. recognising the emotions behind tone of voice and facial expression; identifying the intent of someone speaking in a social situation; Mayer et al., 2016).

Model of intelligence

The Wechsler Adult Intelligence Scale (WAIS) is the most used intellectual test in the world. It is used by educational, school, clinical, and neuropsychologists serving

adolescents and adults of all ages (Hartman, 2009). The WAIS-IV measures four key aspects of intelligence: VC, PS, WM, and Perceptual Reasoning (PR) (a mix of Fluid Reasoning and Visual-Spatial Ability; Wechsler, 2008). The WAIS-IV measures four of the CHC theory broad abilities as follows: VC measures Crystallized Intelligence (Gc); PR measures Fluid Intelligence (Gf) and Visual Processing (Gv); WM measures Short-Term Memory (Gsm); and PS measures PS (Gs) (Alfonso, Flanagan, & Radwan, 2005). Therefore, the WAIS-IV measures four of CHC's broad intellectual abilities, while not including others, such as Long-Term Storage and Retrieval (Glr) or Auditory Processing (Ga) (Schneider & McGrew, 2012). Although the WAIS-IV does not measure as many factors as measures derived from CHC theory, the four-factor model is more in line with CHC theory than the previous three-factor model (Taub et al., 2004). The Wechsler model of intelligence posits that the four aspects of intelligence are usually more clinically and educationally informative than the Full Scale IQ (FSIQ, Wechsler, 2008), yet prior studies either studied only one aspect of intelligence (e.g. verbal ability) or FSIQ in relation to social perception. Findings with the WAIS will be especially relevant to practitioners because it is likely that they have the WAIS readily available and/or regularly use it with their students or clients.

The current study

Intelligence is one of the strongest predictors of academic performance (Deary, Strand, Smith, & Fernandes, 2007), only rivalled in magnitude by prior individually assessed achievement (Froiland & Davison, 2016; Froiland & Oros, 2014). However, emotional intelligence is important for success and happiness in school, work, and life. Gaining more insight into the relationships between intelligence and social perception (an important aspect of emotional intelligence) could help educational psychologists better understand what contributes to social perception. For instance, if VC is a strong predictor of social perception, future studies may wish to examine whether rigorous vocabulary interventions help students improve in social perception. Furthermore, most school psychologists in the USA either do not assess emotional intelligence or they assess it with self-report questionnaires. By linking a rigorous psychologist administered test of emotional intelligence to insights from the most commonly used cognitive intelligence test in the USA, school psychologists, neuropsychologists, and educational psychologists are more likely to gain insights into what contributes to the emotional intelligence of adolescents and adults.

The current study was designed to address the dearth of studies involving a comprehensive IQ assessment and the lack of research within the general adolescent and adult population in the USA. More research is needed concerning whether the relationships between social perception and IQ remain after controlling for such things as gender, ethnicity, and education. Gender is an important variable to control because women usually have somewhat higher levels of emotional intelligence than men, perhaps due to a higher degree of socialisation towards recognising and valuing the emotions of others (Mayer, Caruso, & Salovey, 1999; Puccioni, Baker, & Froiland, 2019; Van Rooy, Alonso, & Viswesvaran, 2005). We used regression to examine our hypotheses. The regression models included intelligence (VC, PR, WM, and PS), education level,

sex, and ethnicity. We hypothesised that (1) women would have stronger social perception than men even after accounting for differences in intelligence, education level, and race/ethnicity, (2) each aspect of intelligence would be positively associated with social perception, and (3) that the aspects of intelligence (VC, PR, WM, and PS) would account for social perception better than FSIQ. Race/ethnicity was a control variable but not a focus of study.

Method

Participants

This study involved 800 adolescents and adults proportionally representative of the US population in terms of ethnicity and education level. This is the standardisation data from the Advanced Clinical Solutions (ACS) for the WAIS-IV, data which was obtained with permission from the publisher (Pearson Assessment, 2009). The average age was 50.27 years (SD = 22.5; range = 16–91). Race/ethnicity was distributed as follows: 2.5% Asian American; 11.5% African American; 12.1% Latino American; 72.1% European American; and 1.8% other ethnicity. Fifty-three percent of participants were female and 47% were male.

Measures

Wechsler Adult Intelligence Scale-fourth edition

The WAIS is known for excellence in measuring overall intelligence (i.e. FSIQ), as well as high reliability and validity for each of the Index scores: VC (vocabulary, verbal reasoning, and fund of information); PR (a mix of fluid reasoning with visual-spatial ability); PS (how quickly simple information is processed); and WM (e.g. ability to hold and manipulate digits and letters within working memory; Wechsler, 2008). Scale scores were used for FSIQ and each of the four indices. Each of these standardised scale scores is age-normed.

Advanced clinical solutions for WAIS-IV and WMS-IV

Social perception is a composite of the following: affect labelling (i.e. identifying which of seven emotions is exhibited on pictures of faces); linking prosody to facial expressions (i.e. matching the tone of on an audio clip to the pictures of faces displaying eight different emotions); and interpreting the intent of a speaker during social interaction (i.e. indicating the true intent of a speaker based on tone of voice, facial expression, and body language). The measure covers perception of both facial and vocal expression of emotion (Cecilione et al., 2017; Kring & Sloan, 2007; Schlegel, Grandjean, & Scherer, 2014; Young et al., 2017). The social perception measure has shown evidence of adequate validity (Kandalaft et al., 2012); for example, it has distinguished between adults with autism (Holdnack et al., 2011), schizophrenia (Pearson Assessment, 2009) and non-clinical controls. Social perception was also significantly positively correlated with multiple aspects of memory on the Wechsler Memory Scale, Fourth Edition (e.g. Pearson Assessment, 2009). Across ages 16–90, the reliability

coefficients averaged 0.78 for social perception (range = 0.70 to 0.84). Test-retest reliability over the course of a few weeks is adequate ($r = 0.70$).

Control variables

Gender was coded such that 1 = Female and 0 = Male. Education level was coded as follows: 1 = Never attended high school; 2 = Attended but did not graduate high school; 3 =High school graduate or equivalent; 4 = Some college; and 5 = College degree or beyond. For examinees ages 16–19, parent education was utilised. The education variable was used as an indicator of family socio-economic status. Race/ethnicity was coded into four dichotomous variables designating Asian, Black, Hispanic, and White race/ethnicities, respectively.

Data analysis plan: hypotheses 2 and 3

The analysis for Hypothesis 1, a sex difference in social perception controlling for the covariates, is familiar and will not be explained here. Next, we regressed social perception onto FSIQ and the covariates to examine whether there was an association between FSIQ and social perception after controlling for the covariates.

Then we examined Hypothesis 2 by running four separate regressions, one for each index VC, PR, WM, and PS. For each analysis, the predictors included one index and the covariates. Here, we were interested in whether social perception was related to each of the indices separately controlling for the covariates.

Finally, we examined our third hypothesis. Here we were interested in whether all of the social perception variations accounted for by intelligence could be accounted for by FSIQ alone, without including any of the indices, or whether the four indices would account for more variation than FSIQ alone. Essentially, we were interested in whether a full model including the four indices as predictors, would account for more variation than a reduced model with only one predictor FSIQ. To examine this question, one must test the hypothesis that the variation accounted for by the full and reduced models is the same: $H_0 : R_F^2 = R_R^2$ where R_F^2 and R_R^2 are the multiple correlations for the full and reduced models, respectively. In order to test this hypothesis, we substituted the total score $T = \mathrm{VR} + \mathrm{PR} + \mathrm{WM} + \mathrm{PS}$ for FSIQ as the correlation between T and FSIQ was 0.996 and, for purposes of correlational analysis, T and FSIQ are virtually equivalent. From Davison and Davenport (2002), the model that includes only the predictor T is a hierarchically embedded special case of the model that includes the four indices as predictors. Therefore, if one defines the full model as before, a model that includes the four indices as predictors, and the reduced model as one that includes only the total score T (in place of FSIQ) as a predictor, one can test the hypothesis $H_0 : R_F^2 = R_R^2$ using the F-statistic

$$F = \frac{R_F^2 - R_R^2}{1 - R_F^2} * \frac{N - P - 1}{P - 1} \tag{1}$$

where R_F^2 and R_R^2 are the squared multiple correlations for the full and reduced model, N is the sample size, and P is the number of predictors in the full model. This F-statistic will have $(P - 1, N - P - 1)$ degrees of freedom. A reader interested in more information about the F-test should consult Davison and Davenport (2002) description

Table 1. Means, standard deviations, and correlations of education intelligence and social perception variables.

	Mean	SD	Ed	FS	VC	PR	WM	PS	SP
Ed	3.53	1.17	1	0.53**	0.54**	0.35**	0.44**	0.35**	0.22**
FS	100.25	14.43	0.53**	1	0.84**	0.85**	0.81**	0.70**	0.42**
VC	100.34	14.70	0.54**	0.84**	1	0.57**	0.61**	0.42**	0.38**
PR	100.50	14.50	0.35**	0.85**	0.57*	1	0.60**	0.49**	0.32**
WM	100.08	14.45	0.44**	0.81**	0.61**	0.60**	1	0.46**	0.28**
PS	99.90	14.36	0.35**	0.70**	0.42**	0.49**	0.46**	1	0.35**
SP	9.99	3.09	0.22**	0.42**	0.38**	0.32**	0.28**	0.35**	1

SD: standard deviation; Ed: education; FS: Full Scale IQ; VC: verbal comprehension; PR: perceptual reasoning; WM: working memory; PS: processing speed; SP: social perception.
*$p < .05$, **$p < .01$.

of Criterion-Related Profile Analysis (CRPA). Thus, we examined Hypothesis 3 by comparing two models, a full model that included the four indices as predictors and a reduced model with only *T* as a predictor (in place of FSIQ). This analysis is similar to that of Wiernik (2016) who used regression to analyse the components of the Big Five personality trait Openness much as we have analysed the components of FSIQ. We also compared the full and reduced models using the Akaike Information Criterion (AIC; a smaller AIC is better), the Bayesian Information Criterion (BIC; a smaller BIC is better), the adjusted multiple correlations, and cross-validated multiple correlations.

Results

Preliminary statistics

Table 1 shows the means, standard deviations, and correlations among several variables in this study. The correlations of social perception with each of the four index scores were as follows: .38 ($p < .001$) for VC, .32 ($p < .001$) for PR, .28 ($p < .001$) for WM, and .35 ($p < .001$) for PS. In Table 1, the correlation between FSIQ and social perception was $r = 0.42$ ($p < .001$). Age was not significantly related to social perception ($r = -0.05$, $p = .17$). Furthermore, age had weak relationships with intelligence index scores, the strongest relationship being with WM ($r = -0.13$, $p < .01$), which is quite small. Because the standard scores used for all measures in the study are age-normed and there is no significant relationship between age and social perception, age was not included in subsequent analyses.

Sex differences in social perception

In accordance with Hypothesis 1, females had stronger social perception than males, with social perception means and standard deviations (in parentheses) of 10.43 (3.08) and 9.47 (3.05), respectively, differed significantly ($t_{798} = 4.42$, $p < .001$, $g = 0$ .07), but the effect size $g = 0.07$ was small. The difference remained significant after controlling for FSIQ or for the four intelligence indices VC, WM, PR, and PS. It still remained significant ($p < .001$) controlling for the four aspects of intelligence, education level, and race/ethnicity. The data supported a gender difference favouring females, a difference that could not be attributed to intelligence, education level, or race/ethnicity. This result suggests that social perception may be an expression of intelligence

variables, but it is something more, in that there are systematic effects on the social perception variable that are unrelated to intelligence.

Full Scale IQ

When we regressed social perception onto FSIQ adding the several control variables of female, education level, and race/ethnicity the FSIQ effect remained significant ($p < .001$). The regression weights and squared multiple correlation for this analysis are shown in Table 2. Female was the only control variable with a significant effect in the model, which confirms the first hypothesis. Thus, there was an association between social perception and FSIQ that cannot be attributed to sex, education level, or race/ethnicity.

Intelligence index scores

In order to investigate Hypothesis 2, we regressed social perception onto each of the four indices separately controlling for female, education level, and race/ethnicity. Table 2 shows the regression weights and squared multiple correlations for each of these analyses. In each of these four analyses, the effect of the index was statistically significant ($p < .05$). Female was a significant effect ($p < .01$) in all four models. Education had a significant effect in the models including PR and WM, but not those including VC and PS. The results in Table 2 support our second hypothesis that all four aspects of intelligence are related to social perception even after controlling for female, education, and race/ethnicity. These associations in Table 2 indicate that various aspects of cognitive IQ are positively associated with social perception.

Full Scale IQ and the four indices as predictors of social perception

The intelligence model of the WAIS-IV is hierarchical with general intelligence indexed by FSIQ at the top and the four aspects of intelligence at the second level down indexed by VC, PR, WM, and PS (Wechsler, 2008). This leads naturally to the question of whether we need the four constructs at the second level to account for the associations between social perception and intelligence or whether FSIQ alone is sufficient to account for those relationships. This question corresponds to our third hypothesis, and we have predicted that FSIQ alone is not sufficient.

To address this question, we turned to analysis, CRPA (Davison, Davenport, Chang, Vue, & Su, 2015; Davison & Davenport, 2002) described above. At first glance, this analysis does not seem appropriate, since it is designed to test the null hypothesis that a total test score, the simple sum of subtest scores, is sufficient to account for relationships between test performance and an outcome criterion so that subtest scores are not needed to account for those relationships. In our situation, it would be used to test the hypothesis that the simple sum (VC + PR + WM + PS) is sufficient to account for relationships with social perception so that the separate scores are not needed. However, in our situation, for correlational purposes, FSIQ and the total (VC + PR + WM + PS) are virtually equivalent, because they are almost perfectly linearly

Table 2. Results of regressing social perception onto Full Scale IQ and separately onto each of the index variables controlling for sex, education, and race/ethnicity.

	FSIQ			VC			PR			WM			PS		
IQ variable	*B*	*SE*(*B*)	*β*	*B*	*SE*(*B*)	*β*	*B*	*SE*(*B*)	*β*	*B*	*SE*(*B*)	*β*	*B*	*SE*(*B*)	*β*
Intercept	0.912	1.016		1.310	1.020		2.643*	1.045		3.449**	1.050		2.710**	1.032	
FSIQ	0.083**	0.008	0.388												
VC				0.079**	0.008	0.375									
PR							0.055**	0.008	0.254						
WM										0.046**	0.008	0.216			
PS													0.055**	0.008	0.256
Female	1.006**	0.198	0.162	1.175**	0.202	0.190	1.034**	0.205	0.166	1.014**	0.206	0.163	0.534*	0.209	0.086
Ed	0.045	0.100	0.0170.	0.044	0.101	0.017	0.343**	0.092	0.130	0.323**	0.097	0.122	0.329	0.093	0.125
Asian	−0.312	0.963	−0.016	−0.311	0.970	−0.016	−0.496	0.997	−0.025	−0.238	10.005	−0.012	−0.102	0.989	−0.005
Black	−0.731	0.796	−0.075	−0.912	0.800	−0.094	−0.831	0.823	−0.086	−1.036	0.829	−0.106	−0.892	0.817	−0.092
Hispanic.	−0.094	0.789	−0.010	−0.042	0.795	−0.004	−0.264	0.816	−0.028	−0.091	0.824	−0.10	−0.116	0.810	−0.012
White	0.200	0.749	0.029	0.185	0.755	0.027	0.315	0.775	0.046	0.474	0.781	0.069	0.631	0.768	0.092
R^2	0.213**			0.200**			0.164**			0.149**			0.169**		

B: unstandardised regression weight; *SE*(*B*): standard error of *B*; *β*: standardised regression weight; Ed: education; FS: Full Scale IQ; VC: verbal comprehension; PR: perceptual reasoning; WM: working memory; PS: processing speed; SP: social perception. *$p < .05$, **$p < .01$.

Table 3. Results of fitting the full model of Equation (2) with four index variables (Model 2), and the restricted models of equation with either Full Scale IQ (Model 1a) or Total IQ (Model 1b).

	Model 1a			Model 1b			Model 2		
	B	*SE*(*B*)	β	*B*	*SE*(*B*)	β	*B*	*SE*(*B*)	β
Intercept	1.021	0.701		−1.137	0.865		−1.387	0.861	
FSIQ	0.089**	0.007	0.417						
Tot IQ				0.028**	0.002	0.418			
VC							0.055**	0.009	0.260
PR							0.018*	0.009	0.086
WM							−0.006	0.010	−0.027
PS							0.046**	0.008	0.216
R^2	0.174**			0.175**			0.196**		
Adj. R^2	0.173			0.174			0.191		
AIC	1641.17			1640.76			1626.48		
BIC	1650.52			1650.11			1649.86		

B: unstandardised regression weight; SE(B): standard error of B, β: standardised regression weight; Ed: education; FS: Full Scale IQ; VC: verbal comprehension; PR: perceptual reasoning; WM: working memory; PS: processing speed; SP: social perception; AIC: Akaike information criterion; BIC: Bayesian information criterion. *$p < .05$, **$p < .01$.

related. The correlation between FSIQ and the total is 0.996. Therefore, to test the hypothesis that FSIQ is sufficient to account for the relationships with social perception, we used CRPA to test the hypothesis that the simple total score is sufficient to account for relationships with social perception; the separate index scores are not needed. From this test, we can draw conclusions about whether FSIQ is sufficient since, from a correlational perspective, it is virtually equivalent to the total score.

As described above, CRPA involves fitting two models. The first is a reduced model with the total score *T* as the only predictor, Model 1b in Table 3. For comparison, we have also included results for a model that includes FSIQ, instead of *T*, Model 1a in Table 3. For the reduced model, the correlation was $R^2 = 0.175$ ($p < .001$). This compares to the correlation $R^2 = 0.174$ ($p < .001$) for the model with FSIQ, rather than *T*.

The second CRPA model, the full model, involves regressing social perception onto the four indices *VC*, *PR*, *WM*, and *PS*, Model 2 in Table 3. As shown by Davison and Davenport (2002), our reduced model, Model 1b, is a hierarchically embedded special case of the full model, Model 2. For the full model (Model 2 in Table 3), $R^2 = 0.20$. Since the reduced model (Model 1b) is hierarchically embedded in the full model (Model 2), one can test the null hypothesis that $R_F^2 = R_R^2$ using the *F* in Equation (1) above. In our data, $F_{3,\ 788} = 6.86$ ($p < .001$) leading to rejection of the null hypothesis that the reduced and full models account for equal amounts of variation in social perception. By rejecting the null we are rejecting the hypothesis that FSIQ by itself is sufficient for predicting social perception.

To further compare the reduced and full models, we computed adjusted squared multiple correlations for both 0.17 and 0.19 for the reduced and full models, respectively. On double cross-validation, the squared correlations were 0.15 and 0.18 for the reduced and full models, respectively in the first sample. In the second sample, the corresponding figures were 0.20 and 0.22 for the reduced and full models, respectively. These cross-validation results also favour the full model.

Finally, we computed AIC (smaller is better) and BIC (smaller is better) statistics for the reduced and full models. As shown in Table 3, the AIC was smaller for Model 2

(full model) than Model 1b (reduced). While the BIC was also smaller for the full model, there was little difference between the BICs for the two models. With the possible exception of the BIC, the statistical test in Equation (1), the adjusted R^2 values, the cross-validated R^2 values, and the AIC all favour the full model over the reduced model and lead us to reject the hypothesis that FSIQ is a sufficient statistic for predicting social perception. Social perception is better accounted for by the four indices; VC, PR, WM, and PS; than by FSIQ alone.

In Model 2, the regression weight for WM was not significant ($p > .05$). This suggests that any effect of WM on social perception may be an indirect effect mediated by one or more of the other indices. The two indices VC and PS had larger regression weights than did either PR or WM. This means that conditional on a Total IQ score (or FSIQ), the pattern of IQ scores matters in that two people with the same Total IQ or FSIQ will not necessarily have the same expected social perception score. As explained in more detail elsewhere (Culpepper, 2008; Davison et al., 2015; Davison & Davenport, 2002), people with relative strengths in the areas with larger regression weights, VC and PS, will have higher expected social perception scores than those with relative strengths in the areas with smaller regression weights, PR and WM. To illustrate this conclusion given the intercept and regression weights for Model 2 in Table 3, consider two hypothetical score profiles (VC = 110, PR = 100, WM = 95, and PS = 105) and (VC = 95, PR = 105, WM = 110, and PS = 100), both of which have the same sum 410 and probably very similar FSIQ. Given the Model 2 intercept and regression weights in Table 3, these profiles have different predicted social perception scores 10.72 and 9.45, respectively. Despite the fact that both profiles would have equal sums and nearly equal FSIQ, the first profile with relative strengths in VC and PS, would have a higher predicted social perception score than the second profile with relative strengths in PR and WM. Conditional on FSIQ, the pattern of scores on VC, PR, WM, and PS does matter in prediction of social perception. The importance of VC may reflect the fact that verbal communication is central to social interaction. The importance of PS may reflect the fact that events in social interactions occur in real time and therefore must be processed quickly.

Discussion

Like prior studies (Agnoli et al., 2012; Hogan et al., 2010), we found an association between IQ and social perception. Going beyond prior studies, we found that all four aspects of intelligence; VC, PR, WM, and PS; were associated with social perception to varying degrees. When all four IQ aspects were used to predict social perception, VC, PR, and PS were significant predictors, but not WM. We confirmed Pearson Assessment's (2009) findings of an association with WM by itself, but not after controlling for the other aspects of intelligence. Our finding is consistent with Schneider et al. (2016) model that integrates CHC theory with emotional intelligence. They posit that WM will help with the managing of emotions, but not with social perception. WM effects on social perception may be mediated by other aspects of intelligence. Counter to Schneider et al. (2016) model, we found that VC and PS both predicted social perception, suggesting that their model needs to be refined. Strong VC enables

people to label emotions and analyse them verbally in thought, writing, and during discussions. Likewise, high PS enables people to keep up with all of the social and emotional cues available in real time in various social situations at school, home, and work. In accordance with previous studies (Mayer et al., 1999; Van Rooy et al., 2005), we also found that women had a small but significant advantage in social perception over men. This finding is important because we studied a nationally representative sample of adolescents and adults across the United States.

The fact that VC and PS were much stronger predictors of emotional intelligence than visual-spatial ability (PR), sheds light on part of the reason that people with autism often have lower emotional intelligence. Whereas people with Autism have higher visual-spatial ability when dealing with simple information (Caron et al., 2004), they have lower verbal ability and PS (Holdnack et al., 2011). Verbal ability gives one a way to label emotions and social information and think through them systematically, while PS helps one to keep up with all of the quick real-time information that is available in social settings.

The fact that VC was the strongest predictor of social perception gives educational psychologists and educators even more impetus for developing and applying research-based vocabulary interventions for adolescents and young adults. Namely, it is possible that future studies will find that vocabulary interventions will lead to increases in social perception as well as vocabulary, which is a key component of VC. While vocabulary interventions have been somewhat successful with adolescents and adults (Torgerson, Porthouse, & Brooks, 2005), they are often much more successful with children (Fehr et al., 2012) and parent-child shared reading is a robust predictor of vocabulary development (Froiland, Peterson, & Davison, 2013). If studies with children replicate the associations in our findings, future home literacy and vocabulary studies may wish to examine whether vocabulary increases are positively associated with enhanced social perception among children.

Many educational programmes attempt to support the development of emotional intelligence; however, relatively few use science-based prevention programmes to promote emotional intelligence (Mayer & Cobb, 2000). Recent studies indicate that well designed emotional intelligence intervention programmes help to create a positive classroom climate, promote autonomous motivation to learn, support prosocial behaviour, and stronger achievement outcomes (Brackett, Rivers, & Salovey, 2011; Nathanson, Rivers, Flynn, & Brackett, 2016). However, achievement outcomes for emotional intelligence programmes are often modest. Because we found that vocabulary and other forms of VC are significantly linked to emotional intelligence above and beyond FSIQ, we suggest that future emotional intelligence interventions could be paired with effective vocabulary and reading comprehension interventions, in order to potentially strengthen academic achievement and emotional intelligence outcomes. It is also possible that autonomy-supportive home-based parent involvement will promote the development of academic engagement, reading achievement and emotional intelligence simultaneously (Froiland, 2014; Froiland, 2015; Puccioni, Froiland, & Moeyaert, 2020).

Using the multiple regression analysis of profiles (Davison et al., 2015; Davison & Davenport, 2002) and the fact that FSIQ and the sum of the four indices were virtually

equivalent variables for correlational purposes, we rejected the null hypothesis that FSIQ accounted for as much variance as did the four IQ indices. The multiple regression analysis of profiles also leads to the conclusion that conditional on the sum (or FSIQ), people with different patterns of the four IQ indices (VC, PR, WM, and PS) have different expected levels of social perception. Conditional on the sum (or FSIQ), those with relative strengths in the areas of VC and PS have higher predicted social perception scores than do those with relative strengths in PR and WM. For purposes of researching relations of social perception and intelligence, a single Full IQ score by itself does not seem adequate. In accordance with both the Wechsler model and CHC theory, understanding a person's various broad intellectual abilities helps psychologists better understand his or her risk for lower emotional intelligence or likelihood of having higher emotional intelligence. Researching relationships of social perception and IQ may require a full battery of measures rather than a screener that yields only on overall IQ score. Likewise, practicing educational and school psychologists who find cognitive profiles with low vocabulary and PS may want to assess social perception, because people with such profiles are at-risk for lower social perception.

Limitations and future directions

This study involved one wave of data. Future studies should longitudinally examine the relationship between aspects of intelligence and social perception. This could provide insight into whether the relationship between different aspects of intelligence and social perception is bi-directional. Previous studies indicate that social perception and other signs of emotional intelligence (e.g. self-motivation) contribute to achievement and emotional health (Froiland, 2018; Froiland & Oros, 2014; Froiland & Worrell, 2017; Kowalski & Froiland, 2020; Vassiou et al., 2016). Therefore, future studies may also wish to examine whether higher verbal intelligence, PS, and visual-spatial ability predict achievement and emotional health via social perception, above and beyond the effects of motivation. Future studies may want to include more than four of the CHC theory broad abilities, which could be done by using a measure directly derived from CHC theory, such as the Woodcock Johnson-IV Test of Cognitive Abilities (Schrank, McGrew, & Mather, 2014). In addition, the current study focussed on the relationships between analytic forms of intelligence and social perception. Based upon the triarchic theory of intelligence, it is also worthwhile to investigate the relationships between creative intelligence, practical intelligence, and social perception (Sternberg, 2000).

Conclusion

The importance of VC and PS in predicting social perception is important for educational researchers and practitioners to consider. VC may be particularly important because verbal communication plays a major role in social interactions, which are an important part of the learning process in high school, college, and during training at work. Furthermore, rigorous vocabulary interventions could lead to improvements in social perception. PS, the second strongest predictor of social perception, may be

particularly important because social interaction involves a continuous flow of events requiring rapid processing of events as those events appear only for an instant and are quickly followed by subsequent events. For instance, imagine all of the social cues, facial expressions, tones of voice, and affect-laden verbal content that a college student might encounter during a group debate in class. Students who score low in VC and PS are at-risk for low social perception scores. Thus, educational and school psychologists who notice such a cognitive profile may be wise to administer a measure of social perception (e.g. the ACS) or a broader measure of Emotional Intelligence, such as the Multifactor Emotional Intelligence Scale (MEIS; Mayer et al., 1999).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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