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Emotional Intelligence Is a Second-Stratum Factor of Intelligence: Evidence From Hierarchical and Bifactor Models

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This article examines the status of emotional intelligence (EI) within the structure of human cognitive abilities. To evaluate whether EI is a 2nd-stratum factor of intelligence, data were fit to a series of structural models involving 3 indicators each for fluid intelligence, crystallized intelligence, quantitative reasoning, visual processing, and broad retrieval ability, as well as 2 indicators each for emotion perception, emotion understanding, and emotion management. Unidimensional, multidimensional, hierarchical, and bifactor solutions were estimated in a sample of 688 college and community college students. Results suggest adequate fit for 2 models: (a) an oblique 8-factor model (with 5 traditional cognitive ability factors and 3 EI factors) and (b) a hierarchical solution (with cognitive *g* at the highest level and EI representing a 2nd-stratum factor that loads onto *g* at $\lambda = .80$). The acceptable relative fit of the hierarchical model confirms the notion that EI is a group factor of cognitive ability, marking the expression of intelligence in the emotion domain. The discussion proposes a possible expansion of Cattell-Horn-Carroll theory to include EI as a 2nd-stratum factor of similar standing to factors such as fluid intelligence and visual processing.

Keywords: emotional intelligence, Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT), Cattell-Horn-Carroll (CHC) theory, structural equation modeling (SEM), confirmatory factor analysis (CFA)

Despite the increasing popularity of both research and practice on emotional intelligence (EI), it remains a somewhat controversial psychological construct. Even the definition of EI varies widely under different theoretical frameworks, with some models defining EI as a related set of abilities (ability models) and some models defining EI as a mixture of behaviors, motivations, beliefs, and attitudes (mixed models; e.g., Mayer, Caruso, & Salovey, 2000). Our focus in this article is on an ability conceptualization of EI. Within this conceptualization, EI is defined as the ability to process and reason about emotional information and is therefore measured by tasks that require this ability (Mayer, Roberts, & Barsade, 2008).

Under an ability-based framework for EI, a lingering controversy concerns the legitimacy of EI as a type of intelligence (Brody, 2004; Davies, Stankov, & Roberts, 1998; Mayer, Caruso, & Salovey, 1999; Mayer, Salovey, Caruso, & Sitarenios, 2001; Roberts, Zeidner, & Matthews, 2001). In particular, it is not clear whether EI should be considered as an additional group factor of intelligence with the same status as constructs such as fluid and crystallized intelligence or rather whether EI constitutes a set of primary mental abilities that are already defined by extant constructs (Brody, 2006; Davies et al., 1998; MacCann, 2010). The purpose of the current study is to model EI as an additional group factor within a Cattell-Horn-Carroll (CHC)-based structure of mental abilities (McGrew, 2009). We compare several models that include EI at various levels within CHC theory. These models include a broad range of EI and cognitive ability marker tests: three indicators each of fluid intelligence (Gf), crystallized intelligence (Gc), quantitative reasoning (Gq), visual processing (Gv), and broad retrieval ability (Glr) and two indicators each of emotion perception, emotion understanding, and emotion management. Our analytic strategy includes unidimensional, multidimensional, hierarchical, and bifactor modeling.

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There are two key ways that the current research represents an advance in theory and methodology. First, we draw together the largely separate fields of research on EI and the structure of mental abilities, proposing and testing extensions to the most widely accepted theoretical model of intelligence (CHC theory; McGrew, 2009; Roberts & Lipnevich, 2011). As such, the current article builds on prior work by several EI scholars suggesting that EI should be incorporated into known theoretical models of intelligence (e.g., Côté & Miners, 2006; Davies et al., 1998). The vast majority of prior work on the relationship between EI and cognitive ability has investigated only the relationship between a general EI factor and psychometric *g* (general cognitive ability; e.g., Qualter, Gardner, Pope, Hutchinson, & Whiteley, 2012). The few articles examining relationships between multiple dimensions of EI and multiple dimensions of intelligence have used neither a comprehensive set of intelligence constructs, nor tested a priori theoretical models using confirmatory modeling techniques (Barchard & Hakstian, 2004; MacCann, 2010; MacCann, Roberts, Matthews, & Zeidner, 2004; Roberts, Schulze, & MacCann, 2008). In contrast, the current study models EI and its dimensions as part of a known theoretical model of intelligence using a series of structural equation models. The breadth of intelligence factors included in this study far exceeds any previous investigation (cf. Barchard & Hakstian, 2004). To adequately assess where and whether EI fits into the structure of mental abilities, a comprehensive representation of the structure of mental abilities is required (MacCann, 2010; see also Carroll, 1993), and this study is the first to use such a comprehensive and theory-driven representation.

Second, the current article represents a methodological advance by its use of bifactor models (i.e., models in which each indicator loads onto both a general factor and a specific group factor; Holzinger & Swineford, 1937). Bifactor models of intelligence allow a direct comparison of the relative contribution to each variable from both the general factor of intelligence and a specific group factor (Gustafsson & Balke, 1993; Reise, Morizot, & Hays, 2007). In contrast to hierarchical models, bifactor models include the general factor and specific factors at the same level or stratum, such that it is possible to simultaneously compare the relative contribution to an indicator variable by the general and specific factors. In the current study, bifactor models can determine whether subdimensions of EI define a distinct group factor of EI, as well as measuring general cognitive ability (*g*). Both of these criteria are necessary for EI to attain the status of a broad second-stratum factor of intelligence, of similar standing to Gf, Gc, Gv, and the like: EI tests should reflect a broad *g* factor (i.e., show positive manifold) but should additionally define a unique EI construct that is distinguishable from other mental abilities (Orchard et al., 2009).

Ultimately, the goal of the current article is to determine whether and how EI can be incorporated into existing theories of intelligence. The extent to which EI constitutes an appropriate addition to CHC theory is important for several reasons. First, this provides evidence for construct validity of EI: Results will demonstrate whether emotional *intelligence* can truly be considered as an "intelligence." Second, if EI is part of CHC theory, this changes the definitional boundaries of what it means to be intelligent. The current research tests a possible extension to the best known psychometric model of intelligence and may therefore advance intelligence theory. Third, if EI is a major component of intelligence theory, then EI should also be a major component of intelligence practice. Omnibus intelligence test batteries such as the Woodcock-Johnson III Tests of Cognitive Abilities (which is based on CHC theory) might need to include EI assessments in order to capture the full spectrum of cognitive ability.

Defining EI: The Four-Branch Hierarchical Model

The four-branch hierarchical model is the predominant theoretical model for describing the structure of underlying skills involved in EI. This hierarchical model holds that EI consists of four related sets of abilities (or branches) that monotonically increase in cognitive complexity from the first to fourth branch, with abilities in the higher branches building on abilities in the lower branches. The four branches represent (a) emotion perception (the ability to perceive emotions in oneself, others, and stimuli in the wider world), (b) emotion facilitation of thought (the selective and deliberate generation of emotional states to facilitate performance on different varieties of cognitive tasks), (c) emotion understanding (understanding how emotions combine, change over time, and change over situations), and (d) emotion management (the regulation or management of one's own and other's emotions; Mayer et al., 2008).

This model of EI also theorizes that the lower two branches (perception and facilitation) collectively form the "Experiential EI" area, representing the direct processing of information in one's immediate environment, unmediated by higher-level strategic planning. Similarly, the two higher branches (understanding and management) collectively form the "Strategic EI" area, representing the strategic judgments and higher level deliberate processing of emotional information. The predominant operationalization of the four-branch model is the Mayer-Salovey-Caruso Emotional Intelligence Test Battery (MSCEIT; Mayer, Salovey, Caruso, & Sitarenios, 2003), which offers two tests to measure each of the four branches of EI. The MSCEIT is based on an earlier instrument called the Multifactor Emotional Intelligence Scale (MEIS; Mayer et al., 1999), which contained 12 subtests.

Toward a New Definition of EI: The Three-Branch Model

Structural support for the four-branch, two-area model has been weak, with most results supporting the exclusion of the Facilitation branch. Across several independent studies, emotion facilitation did not emerge as a factor in exploratory factor analyses of the MEIS (Ciarrochi, Chan, & Caputi, 2000; Mayer et al., 1999; Roberts et al., 2001). Structural modeling of the MSCEIT tasks also supports the exclusion of emotion facilitation, with models that exclude emotion facilitation showing better fit to the data (Gignac, 2005; Palmer, Gignac, Manocha, & Stough, 2005; Rossen, Kranzler, & Algina, 2008). In addition, results from a meta-analysis of the eight MSCEIT subtests showed very high correlations between Facilitation and Perception factors ($r = .90$), leading the authors to recommend a three-factor model with factors representing Perception, Understanding, and Management (Fan, Jackson, Yang, Tang, & Zhang, 2010).

There is also increasing awareness that emotion facilitation is not conceptually distinct from the other branches, particularly emotion management (e.g., Allen, Matthews, MacCann, & Roberts, in press; Joseph & Newman, 2010). Joseph and Newman (2010) argue that using emotions to help task performance involves intentionally inducing the desired emotions for the task. Given that induction of emotion is the key essence of emotion regulation (Gross, 1998), emotion facilitation is therefore redundant with emotion management. Mayer, Salovey, and Caruso (2012) argued against this redundancy by claiming that emotion facilitation involves the strategic use of naturally occurring emotions in task planning (e.g., "a person who feels sad decides it is a good time to undertake some detailed proof-reading," p. 404). That is, emotion facilitation involves situation selection. However, we note that situation selection is one of five broad groups of emotion regulation strategies underpinning the process model of emotion regulation (Gross, 2013; Gross & Thompson, 2007) and is enacted as part of one's goal to, "up- or down-regulate either the magnitude or duration of the emotional response," (Gross, 2013; p. 359). As such, emotion facilitation can still be considered a part of emotion regulation and is therefore redundant with emotion management.

In short, there is little support for a separate emotion facilitation branch either structurally or theoretically. For these reasons, we do not include the facilitation branch in our models. In addition, we now refer to this model of EI as the Mayer-Salovey model of EI rather than the four-branch hierarchical model, to avoid confusion (as we are modeling a three-branch rather than four-branch structure).

Intelligence from a CHC Theory Perspective

In the current article, we model the structure of mental abilities using a CHC perspective on the structure of intelligence. Our broad goal is to assess whether EI can be modeled as an additional group factor within a CHC-based structure of mental abilities. The historical background to the development of CHC theory is described below.

Psychometric investigations of intelligence began with Spearman's (1904) proposition that each test of intelligence was composed of two factors: (a) a general factor known as *g*, common to all tests of intelligence, and (b) specific factors known as *s*, common only to a specific test paradigm (e.g., a specific vocabulary factor or a specific matrix reasoning factor). Spearman (1914) originally proposed *g* as a "general fund of mental energy" (p. 103), later describing this fund as the "all-important factor" of intelligence (Spearman, 1938, p. 80). The evidence for *g* was said to be found in the positive manifold among cognitive test intercorrelations—the fact that correlations between intelligence tests are always positive. Conversely, given that Spearman's law of positive manifold predicts that all tests of intelligence will correlate positively, a positive correlation with established intelligence markers constitutes validity evidence that a new construct (e.g., EI) does in fact measure intelligence.

Later methodological developments in factor analysis (such as orthogonal rotation and the concept of simple structure) led to the idea that a monolithic *g* factor was not the only explanation for positive manifold among intelligence tests (Thurstone, 1938). An alternative explanation consisted of several broad varieties of intelligence, which we refer to as group factors. These differed from Spearman's specific factors in their breadth, representing constructs rather than narrow test paradigms or methods. Thurstone (1938) proposed seven group factors of intelligence, believing that abilities such as logical reasoning, the mental transformation of spatial stimuli, and perceptual speed constituted qualitatively different kinds of intelligence. Others proposed that the lack of a singular *g* is evidenced by the fact that *g* changes depending on the composition of measures included in the cognitive test battery (Horn, 1985; Humphreys, 1979). That is, it was argued that *g* may represent nothing more than the first principal component, which varies from situation to situation depending on the measures included in the test battery. We mention this not as a criticism of *g* per se, but rather as a historical note about the path by which some modern, empirically well-founded models of mental ability have come to acknowledge lower order factors of intelligence in addition to the broad *g* factor.

One of the first and most influential delineations of intelligence was Cattell's (1943) distinction between Gf and Gc. Further group factors were added to this model over time, such that the current Cattell-Horn Gf/Gc model consists of more than 10 group factors (Danthiir, Roberts, Pallier, & Stankov, 2002; Horn, 1968; Horn & Cattell, 1966; Horn & Stankov, 1982; Pallier, Roberts, & Stankov, 2000; Roberts, Stankov, Pallier & Dolph, 1997; Stankov, Seizova-Cajíc, & Roberts, 2001). There are thus multiple historical precedents for extending structural models of intelligence by considering the addition of new group factors of intelligence. Specifically, the addition of EI as a group factor of intelligence within Gf/Gc theory has multiple historical precedents such as olfactory ability, kinesthetic ability, and tactile ability.

Carroll (1993) advanced psychometric research on intelligence by examining more than 400 correlation matrices and subsequently proposing an empirically based taxonomy of intelligence that bore strong resemblance to Gf/Gc theory. This taxonomy is known as Carroll's (1993) three-stratum theory. The highest stratum represents *g*. The second stratum consists of eight broad group factors including Gf, Gc, Gv, and Glr, in addition to general memory and learning (Gy), broad auditory perception (Gu), broad cognitive speediness (Gs), and decision speed/reaction time (Gt). The third stratum represents the narrow abilities underlying each broad intelligence factor. For example, Gf includes third-stratum abilities such as induction, sequential reasoning, and temporal tracking. These narrow abilities are referred to as primary mental abilities (PMAs).

Because of the relative similarities between Gf/Gc theory and three-stratum models, McGrew (1997) amalgamated the two models into an umbrella model of cognitive ability, labeled the CHC model. The model neither explicitly excludes nor includes *g* at the apex, in recognition of the disagreements between the original Cattell-Horn (with no *g*) and Carroll (with a higher order *g*) models. The most contemporary version of the CHC model proposes nine broad abilities and a additional six tentatively identified broad abilities (McGrew, 2009; see Figure 1). The CHC model represents a synthesis of previous psychometric work on intelligence and has been recommended for use as a common taxonomy to investigate human cognitive abilities (McGrew, 2009). For this reason, we adopt this framework in this article as a theoretical backdrop to investigate EI within the broader scope of cognitive abilities. This study includes five of the nine broad abilities identified by CHC theory (Gf, Gc, Gq, Gv, and Glr). We omitted the abilities pertaining to sensory modalities and speediness as these were impractical to assess in a group testing environment.

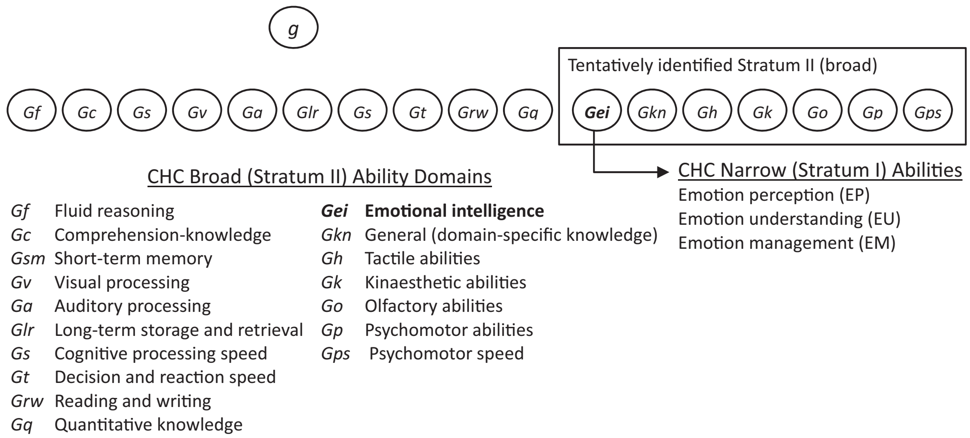

Figure 1. Proposed amalgamation of EI elements within the CHC Framework. Adapted from McGrew, K. S. (2009). "Editorial: CHC Theory and the Human Cognitive Abilities Project: Standing on the Shoulders of the Giants of Psychometric Intelligence Research," by K. S. McGrew, 2009, *Intelligence, 37,* p. 4. Copyright 2009, with permission from Elsevier.

Thus, the history of model development in intelligence research suggests a process where potential new abilities are identified and empirical evidence for their placement within an existing structural model is collected. This is precisely the goal of the current article: EI is proposed and tested as a new second-order factor of intelligence, indexed by the primary mental abilities of emotion perception, emotion understanding, and emotion management.

Emotional Intelligence as a Standard Intelligence

In order for EI to be considered a new group factor of intelligence, three "correlational criteria" are necessary (Mayer et al., 1999, p. 271). First, intercorrelations among the PMAs of EI (the EI dimensions of Perception, Understanding, and Management) must be high enough so that these narrow constructs can be said to define a single higher order factor. Second, EI tasks should correlate positively with other markers known to measure intelligence, thus demonstrating positive manifold. Third, the EI factor should be distinct from any other existing factor of intelligence. These are three primary criteria constituting structural evidence for the validity of EI as a group factor of intelligence (Orchard et al., 2009).

Criterion 1: Relationships Among EI Subconstructs

The first criterion was that the proposed primary mental abilities underlying EI must relate empirically and form a single coherent factor. We evaluated this criterion based on evidence from four different structural models of EI, illustrated in Figure 2: (a) a unidimensional model (Model 1), (b) a hierarchical model where Perception, Understanding, and Management factors load onto a second-order EI factor (Model 2), and (c) a bifactor model of EI where each indicator loads onto both a general EI factor as well as either Perception, Understanding, or Management (Model 3). If EI is truly one single construct, we would expect that: (a) all paths to the general factor are salient and reasonably large in Model 1, (b) substantial factor loadings onto the general factor of EI would be observed in Model 2, and (c) each indicator would contribute strongly to the broad EI factor and less strongly to the PMAs (Perception, Understanding, or Management) in the bifactor model (e.g., if indicators of the Perception branch loaded more strongly onto Perception than EI, this would suggest that these measures do not display strong convergent validity with other measures of EI and therefore are not strong indicators of the EI construct they were designed to capture; Model 3). The bifactor model is a conceptually appropriate way to determine the relative importance of specific abilities within a framework of intelligence (Gustafsson & Balke, 1993). As such, results from a bifactor model of EI can determine whether all three of the proposed subconstructs underlying EI contribute roughly equally to the overall variation in a broad EI construct. Equal contribution to the overall EI factor is important to demonstrate that the EI construct is broader than any one of its subcomponents (e.g., if the Understanding branch showed much higher loadings than the other two branches, this might indicate that EI has a narrow bandwidth composed primarily of understanding emotions).

Criterion 2: Relationships of EI to Conventional Measures of Intelligence

The second criterion for EI to attain the status of an intelligence is that EI should show positive manifold with other established tests of intelligence. Research to date indicates that EI does indeed relate to standard measures of intelligence. The most robust estimation of the relationship between EI and *g* is the meta-analysis of Joseph and Newman (2010). In this meta-analysis, the general factor of intelligence correlated positively with all branches of EI examined ($\rho = .10$ with emotion perception, $\rho = .39$ with understanding, and $\rho = .16$ with management). An earlier meta-analysis demonstrated that all branches of EI were more strongly related to Gc than Gf (Roberts et al., 2008). Specifically, Gc related at $\rho =$ .14, .40, and .18 to Perception, Understanding, and Management, respectively, whereas Gf related at $\rho =$ .10, .14, and .13 to these same PMAs of EI.

Research examining the relationship of EI to other broad factors of intelligence beyond Gf and Gc is sparse, but also indicates a

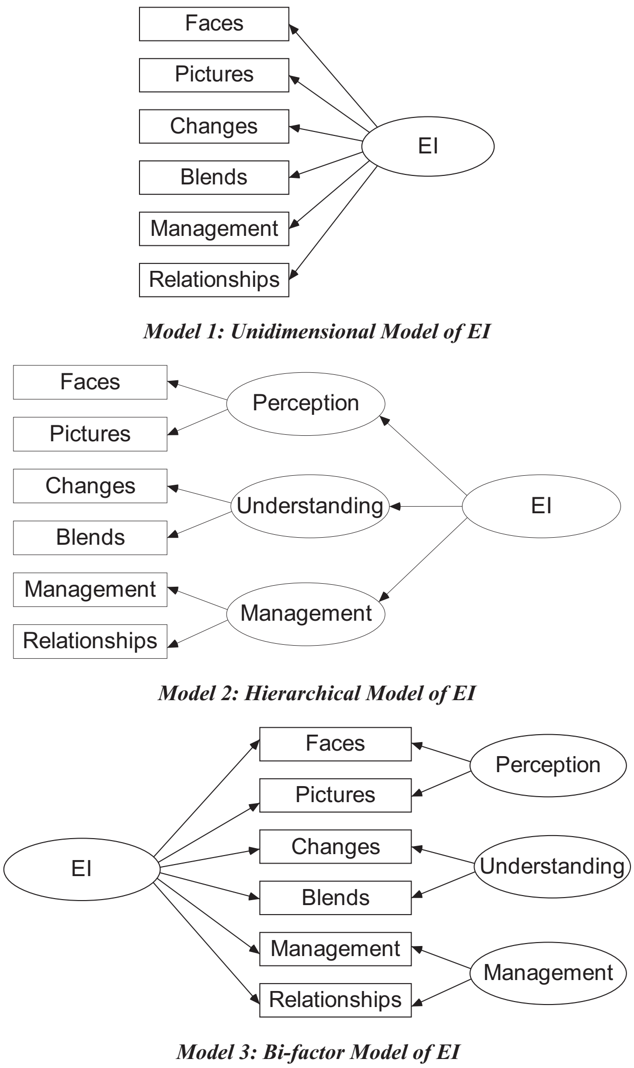

Figure 2. Illustration of the three different models of EI used to test the proposition that the underlying branches of EI cohere to form an overall factor of EI.

positive manifold. To the authors' knowledge, there are only two studies examining the relationship between EI and Gv. Barchard and Hakstian (2004) examined the relationship of Gf, Gc, and Gv to two EI composite scores: (a) a composite of emotion perception, facilitation, and management, and (b) a composite of emotion understanding, social understanding, and social awareness. Both composites correlated positively with all three cognitive ability factors, although relationships were stronger for emotion understanding/social awareness. MacCann et al. (2004) examined the relationship of the two MSCEIT perception tasks (Mayer, Salovey, & Caruso, 2002) to Gf, Gc, and Gv. All relationships were positive, but were trivially small for Gf (r = .03 to .06). In addition, only the Faces test (and not the Designs test) related significantly to Gc and Gv.

Thus, there is evidence that EI does show positive manifold, as well as some preliminary evidence that EI shows differing relationships with existing second-order factors of intelligence. In the current study, the relationship between EI and five broad cognitive ability factors was examined using structural equation modeling.

Criterion 3: Distinction of EI From Existing Measures of Intelligence

The third criterion is that EI must be distinct from other existing group factors of intelligence. That is, although EI should show positive manifold with other intelligence markers (as in Criterion 2), EI tasks should not be similar enough to any particular *one* group factor to merely be a replication of an existing construct. This is a key piece of evidence for the discriminant validity of EI. One of the primary reasons for the decline in interest in social intelligence was that social intelligence could not be distinguished from other broad kinds of knowledge and reasoning (Landy, 2006). As in the case for social intelligence, EI measures often use written text as the test stimuli, such that a test-taker must be able to read and comprehend the information before any sort of emotional ability is subsequently assessed. As such, it is possible that current measures of EI, like previous measures of social intelligence, may simply be a specific emotion-related content domain of verbal or crystallized abilities. Estimates of the correlation between the latent EI factor and latent factors representing other broad group factors can be used to test whether EI is indeed an independent construct, rather than a specific underlying PMA of Gc.

Criteria 2 and 3 are both addressed in five structural equation models involving 21 manifest variables representing five established cognitive ability factors (Gf, Gc, Gq, Gv, and Glr) and three EI factors (Perception, Understanding, and Management). These structural models are illustrated in Figure 3 (labeled Models 4–8, following on from the three models used to test Criterion 1). Models include: (a) a unidimensional model where all EI and cognitive ability markers load onto a g factor (Model 4); (b) an oblique eight-factor model where eight factors of Perception, Understanding, Management, Gf, Gc, Gq, Gv, and Glr correlate freely (Model 5); (c) a hierarchical eight-factor model where the eight factors from Model 4 define an overall g factor (Model 6); (d) a hierarchical model with EI as a second-stratum ability, such that a second-order EI factor is defined by Perception, Understanding, and Management factors and a higher order g factor is defined by Gf, Gc, Gq, Gv, Glr, and the EI factor (Model 7); and (e) a bifactor model where each indicator defined both a g factor and one of the eight broad group factors described in Model 5 (Model 8). The models represent different historical conceptualizations of intelligence, with the EI branches included at various levels. Model 4 represents Spearman's g, Model 5 represents the group factor model of Gf/Gc theory (Horn & Cattell, 1966), and Models 6 and 7 represent Carroll's three-stratum theory (with EI modeled at a different level in Model 6 vs. 7). Model 8 tests a bifactor model of intelligence that includes g and group factors at the same level (Gustafsson & Balke, 1993).

If EI genuinely constitutes an additional group factor of intelligence (as in Criterion 2), we have several expectations about the loadings of EI markers onto a general factor in Models 4 and 8 (the hierarchical and bifactor models). First, factor loadings for EI markers onto a g factor should be of similar magnitude to other markers of cognitive ability. Second, the magnitude of the second-order loadings of EI factors of Perception, Understanding, and Management onto a g factor should be of similar magnitude to second-order loadings observed for more traditional intelligence

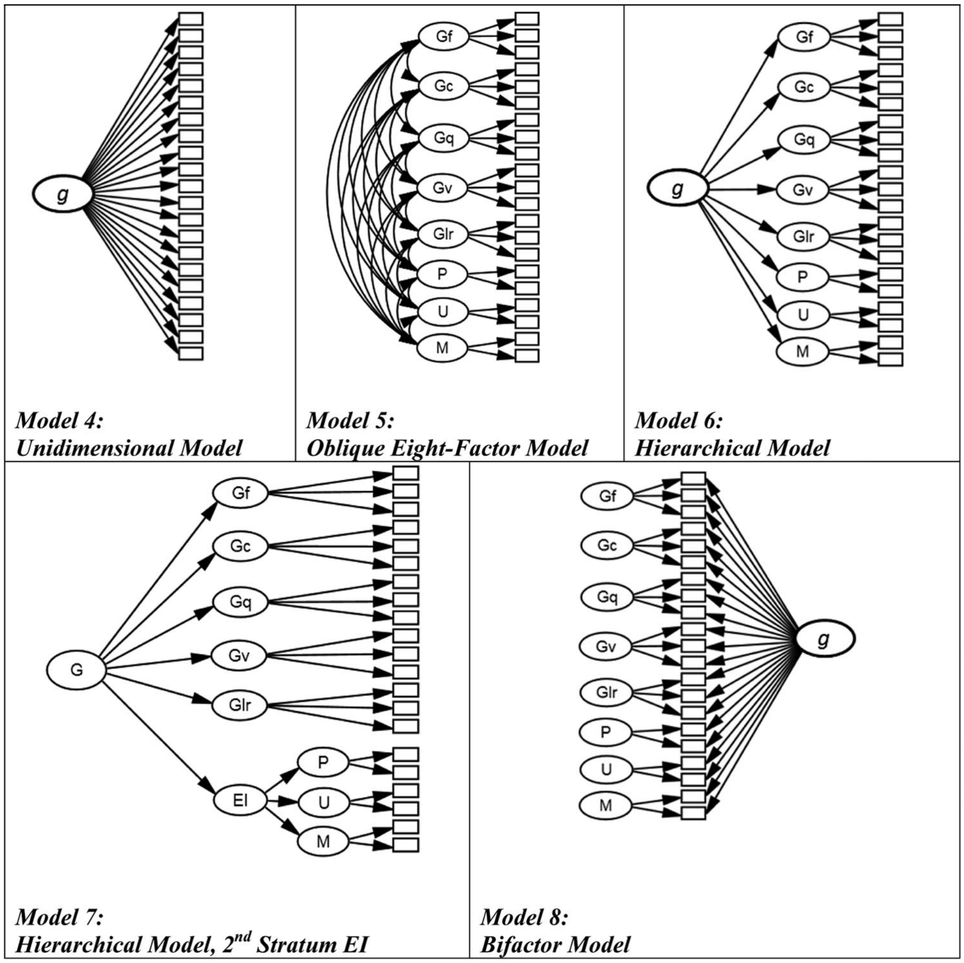

Figure 3. Illustration of the five different models that combine EI subtests with cognitive subtests in order to model the placement of EI within cognitive ability models.

factors (Gf, Gc, Gq, Gv, and Glr). Including both an eight-factor hierarchical model (Model 6) and a hierarchical model with EI at the second stratum (Model 7) allow us to test two things. First, we can examine which stratum of the model is most appropriate for the three component abilities of EI. If Model 6 shows better fit, then Perception, Understanding, and Management represent separate second-stratum factors of intelligence. If Model 7 shows better fit, then EI represents a second-stratum factor of intelligence, with Perception, Understanding, and Management as PMAs underlying EI. Second, higher factor loadings of Perception, Understanding, and Management onto an EI factor (in Model 7) versus a *g* factor (in Model 6) provide evidence for the discriminant validity of these constructs as measures of EI specifically, rather than of intelligence generally.

To test whether EI is distinct from group factors (as in Criterion 3), we can turn to the hierarchical model (Model 5). If correlations between EI factors and Gc (or other cognitive factors) are higher than correlations among the traditional cognitive ability factors (e.g., Gf and Gc or Gf and Gv), then this is an indication that EI does not constitute a new group factor of intelligence, but instead might be a component ability underlying an existing group factor (probably Gc, based on the meta-analytic evidence reviewed earlier).

Summary of Aims

The three aims of this study are essentially in line with the three criteria for EI to be considered as a distinct type of intelligence. First, we will test whether the empirical evidence accords with the revised Mayer-Salovey theoretical model of EI, that is, three subcomponents of EI cohere to form one overall EI construct. Second, we will test whether this factor of EI can truly be considered one of the group factors of intelligence, showing positive manifold and reflecting *g* in bifactor models. Finally, we will ascertain whether EI is in fact independent from other well-known conceptualizations of intelligence, with a particular focus on independence from Gc.

Method

Participants

There were 702 students (414 women) from 2- and 4-year institutions in the United States who participated in the study. Participants were excluded from the data analyses if they indicated that they had a noncorrectible visual impairment ($n = 3$), were deaf or hard of hearing ($n = 6$), or had multiple disabilities ($n =$

5). After exclusion, there were 688 students (405 women). Most students (81.6%) were between 18 and 22 years old, with an overall age range of 17 to 59 ($M = 21.54$, $SD = 5.72$). Students self-reported the following ethnicities: White (64.4%), African American/Black (15.1%), Hispanic (10.1%), Asian (3.9%), or Other (6.5%). Because the proportion of missing data was small (only 17/688 = 2.5% for the most incomplete variables), all analyses were based on the pairwise matrix with an input sample size of 671. With a complete-data rate of 97.5% or higher across variables, there is virtually no missing data bias under pairwise deletion (Newman, 2003, 2009; cf. Marsh, 1998).

Procedure

Participants were recruited from five 2-year colleges and nine 4-year colleges in 11 states of the United States (Colorado, Florida, Georgia, Massachusetts, Maine, Michigan, Nebraska, Oklahoma, Tennessee, Texas, and Virginia). Participants completed a proctored computerized testing session in testing rooms located at their institutions. The testing session lasted up to 8 hours (with appropriate rest breaks), and participants were compensated for their time. Because of the length of the protocol, testing at most sites occurred over two sessions approximately 1 week apart (only 9% of participants completed all protocol in a single testing session). Participants completed computerized tests within one of two randomly assigned test orders. All participants first completed the 15 cognitive tasks in one of the two test orders (in each order, no two tests from the same group factor were administered consecutively) and then completed the MSCEIT. Ordering of items within each assessment was the same across all participants.

Test Battery

The assessment battery was composed of the MSCEIT, 15 cognitive tests, and various experimental measures of EI, personality, coping, and criterion measures (e.g., life satisfaction, academic engagement) that are not relevant to the current study. Parts of this data set have also been used in other publications (e.g., Legree, Pstoka, Robbins, Roberts, & Putka, 2013; MacCann, Fogarty, Zeidner, & Roberts, 2011).

Cognitive Tests

Fifteen cognitive tests were included in the test battery, in order to have three markers for each of the following group factors: Gc, Gq, Gv, Glr, and Gf. All but two of these tests were taken from the Educational Testing Service Kit of Factor Referenced Cognitive Tests (Ekstrom, French, Harman, & Dermen, 1976). The two exceptions were Sentence Completion and Analogies, which were adapted from retired items of testing programs with the permission of the Educational Testing Service. All of these tests were timed, with the computerized tasks timing out after the indicated time limit.

1. Letter sets (Gf). Each item of this 15-item test presented five sets of four letters each, where four of the letter sets were alike according to some specific rule. Participants identified the set that did not fit with the rule (e.g., "QPPQ; HGHH; TTTU; DDDE; MLMM"; answer = QPPQ).

2. Figure classification (Gf). Test takers were presented with 14 stimuli, where each stimulus consisted of two to three groups of three geometric figures, labeled Group 1, Group 2, or Group 3. The figures in each group were alike in some way. For each stimulus, test takers classified eight additional geometric figures into Group 1, Group 2, or Group 3, based on whether the figure also shared the characteristic common to the group.

3. Calendar test (Gf). This 20-item, multiple-choice test presented participants with a depiction of a yearly calendar and seven sentences outlining seasonal changes and work days (e.g., "A circled number is a holiday"; "The first day of Summer is June 21"). Participants were then asked to work out which date was represented by a specific set of directions (e.g., "In the month whose 12th is on a Tuesday, what is the fifteenth working day? (a) 22nd; (b) 23rd; (c) 24th; (d) 27th; (e) Not given"; answer = a).

4. Vocabulary (Gc). In this 36-item, multiple-choice test, each item presented test takers with a target word followed by four possible synonyms (e.g., "Chef—(a) cheese; (b) style; (c) head cook; (d) candle"; answer = c).

5. Analogies (Gc). This 30-item, multiple-choice test presented participants with an initial set of two words that bore a particular relationship to each other. Participants were then asked to select which of five other word-pairs demonstrated the same relationship (e.g., "OSTRICH: BIRD—(a) caterpillar:moth; (b) lizard:frog; (c) bud:leaf; (d) tiger:cat; (e) gust:storm"; answer = d).

6. Sentence completion (Gc). In this 30-item, multiple-choice test, each item presented test takers with a sentence that was missing a key group of words. Test takers were required to select which of four possible word groups would best complete the sentence (e.g., "The decimal numeral system is one of the _____ ways of expressing numbers: (a) useful most world's; (b) world's most useful; (c) useful world's most; (d) most world's useful"; answer = b).

7. Mathematics aptitude (Gq). This task presented 15 multiple-choice questions that required the application of algebraic concepts to obtain a solution (e.g., "What is the largest sum that can be thrown with 11 dice, if no number appears more than three times? (a) 26, (b) 51, (c) 66, (d) 84, (e) 122"; answer = b).

8. Necessary mathematics operations (Gq). This task presented 15 multiple-choice mathematics word problems where test takers were required to identify the numeric operations required to solve each problem (e.g., "A sweater marked $40 was sold for $29.95 during a sale. What was the percent reduction? (a) divide and add; (b) subtract and divide; (c) multiply and subtract; (d) add and divide"; answer = b).

9. Subtraction and multiplication (Gq). A series of 60 items asked participants to subtract two-digit numbers from two-digit numbers or to multiply two-digit numbers by single-digit numbers (e.g., 73×8; answer = 584).

10. Cube comparisons (Gv). Each of 42 items presented test takers with two drawings of a cube, where each side of the cube showed a different design, number, or letter. Test takers decided whether the two pictures represented the same cube, or two different cubes.

11. Hidden patterns (Gv). In this task, participants were shown a geometric figure followed by 200 complex patterns that may or may not have this geometric figure embedded within them. The participants' task was to decide whether or not each pattern contained this geometric figure. They were given 3 min to complete the task.

12. Surface development (Gv). This 60-item test required respondents to visualize how a piece of paper could be folded to form a kind of object. Drawings were presented of solid forms that were made with paper. Accompanying each drawing was a diagram showing how the paper might be cut and folded in order to create the solid form. One part of the diagram was marked with dotted lines or numbered edges to correspond to the same area in the drawing (marked by letters), and respondents were asked to indicate which lettered edges in the drawing corresponded to the numbered edges or dotted lines in the diagram.

13. Word endings (Glr). In this task, participants were given 3 min to write as many words as they could think of ending with the letters AY. They were then given 3 minutes to write as many words as they could think of ending with the letters OW.

14. Word beginnings (Glr). In this task, participants were given 3 min to write as many words as they could think of beginning with the letters PRO. They were then given 3 minutes to write as many words as they could think of beginning with the letters SUB.

15. Opposites (Glr). In this task, participants were asked to generate up to six antonyms for each of eight words (e.g., "Write as many words as you can (up to six) that mean the opposite or nearly opposite of the words below: CALM").

MSCEIT

Participants completed the entire 141-item MSCEIT online (Mayer et al., 2002). Scoring was conducted by Multi-Health Systems, who provided consensus scores for each of the eight subtests of the MSCEIT. Previous work has supported the use of consensus scoring over alternative MSCEIT scoring methods for theoretical and empirical reasons (see MacCann et al., 2004, for a review of these issues), and we therefore chose consensus scoring, the most common scoring method of the MSCEIT, for this article. Note that the two MSCEIT facilitation tests were not used in the current study. The six tests measuring emotion perception, emotion understanding, and emotion management are described below.

1. Faces (emotion perception). For each of four photographs of a face, participants rate the extent to which the facial expression shows each of five different emotions. The rating scale ranges from 1 (*No emotion*) to 5 (*Extreme emotion*).

2. Pictures (emotion perception). Participants are shown six pictures which show either a landscape or an abstract design. Participants rate the extent to which five emotions are present in each picture. Ratings are made on a 1 to 5 scale, where scale points are each anchored by an emoticon cartoon face indicating various levels of the emotion.

3. Changes (emotion understanding). The test consists of 20 five-option, multiple-choice questions for which test takers must identify how an emotion would change according to changes in a situation or time course.

4. Blends (emotion understanding). Participants complete 12 five-option, multiple-choice questions for which they must identify how different emotions interact to form new emotions.

5. Emotion management (emotion management). For each of six vignettes describing an emotional situation, test takers rate four possible responses for their effectiveness in managing the emotions involved. Ratings are made on the following 5-point scale: (a) *Very ineffective*, (b) *Somewhat ineffective*, (c) *Neutral*, (d) *Somewhat effective*, (e) *Very effective*.

6. Emotional relationships (emotion management). For each of three vignettes describing an emotional situation, test takers rate the effectiveness of three possible responses for maintaining or building the social relationships of the vignettes' protagonists. Ratings are made on the following 5-point scale: (a) *Very ineffective*, (b) *Somewhat ineffective*, (c) *Neutral*, (d) *Somewhat effective*, (e) *Very effective*.

Results

Reliability, Descriptive Statistics, and Correlations Between Variables

Reliability, descriptive statistics, and gender differences for all measures are shown in Table 1. Internal consistency estimates were marginal for Mathematics Aptitude and Arithmetic, but were acceptable for all other measures. The three Gq tests were more difficult than the other intelligence markers. Average percentages correct were 27%, 12%, and 28% for Mathematics Aptitude, Arithmetic, and Subtraction and Multiplication, respectively (compared with 42% to 85% for other tests). In terms of gender differences, women showed a small advantage on the three Gf tests and two of the three Glr tests (Word Endings and Opposites) and showed a moderate advantage on the EI tests. Men showed a small advantage on the Mathematics Aptitude test. There were no other significant gender differences. There were very few significant correlations with age, and these were of small effect size: Older participants performed slightly better on Vocabulary, Changes, Blends, and Management and performed slightly worse on Cube Comparison.

Pearson correlations among the 15 cognitive markers and 6 EI markers are shown in Table 2. This matrix demonstrates positive manifold (all correlations are positive). EI markers tend to correlate more strongly with Gf and Gc than with the other cognitive abilities (Gv, Gq, and Glr). This trend is especially noticeable for the emotion understanding and emotion management branches. Correlations among EI markers tend to be higher (average $r = .48$) than correlations of the EI markers with the cognitive markers (average $r = .30$). This correlation matrix was the basis for all additional structural models.

Specification for Structural Models

We considered two sets of models: (a) models of the EI subtests and (b) models of the EI subtests and cognitive subtests together.[1] All models were specified a priori as shown in Figures 1 and 2. To estimate the structural models, we used the correlation matrix represented in Table 2 (technically, the matrix analyzed was carried out to seven decimals, whereas Table 2 is rounded to 2 decimals), with an input sample size of $n = 671$. All models were fit using LISREL 8.71 with maximum likelihood estimation. Fit indices for all eight models are given in Table 3. In interpreting

[1] Note that we also estimated structural models for the 15 cognitive tests in isolation, but did not report them here. These models are available from the authors upon request.

Table 1
Reliability and Descriptive Statistics for All Measures, Gender Differences, and Correlation of Each Measure With Age

			All (N = 671)		Gender: Male (n = 268)		Gender: Female (n = 399)			
	α	No. of items	Mean	*SD*	Mean	*SD*	Mean	*SD*	Gender *d*	Corr with age
Letter sets	.78	15	9.14	3.32	8.75	3.56	9.39	3.15	−0.19*	0.04
Figure classification	.93	160	99.21	21.90	96.36	21.05	101.06	22.35	−0.22**	−0.07
Calendar test	.81	20	11.35	4.18	10.74	4.44	11.76	3.96	−0.24**	0.02
Vocabulary	.82	36	21.92	5.93	21.89	6.19	21.97	5.77	−0.01	0.20**
Analogies	.81	30	13.55	5.32	13.78	6.05	13.40	4.79	0.07	0.03
Sentence completion	.91	30	25.15	5.66	24.69	6.40	25.46	5.11	−0.14	0.04
Mathematics aptitude	.40	15	4.07	2.03	4.33	2.23	3.87	1.85	0.23**	−0.07
Necessary math operations	.56	56	6.66	2.56	6.78	2.80	6.58	2.40	0.08	−0.01
Subtraction and multiplication	.93	60	16.79	9.01	17.31	10.17	16.46	8.16	0.09	0.03
Cube comparison	.72	42	21.75	5.44	21.47	5.60	21.94	5.34	−0.09	−0.20**
Hidden patterns	.97	200	141.70	26.17	143.12	27.88	140.73	24.91	0.09	−0.02
Surface development	.95	60	24.90	13.59	25.27	14.71	24.62	12.84	0.05	−0.06
Word endings	—	—	30.34	9.29	29.16	9.40	31.17	9.16	−0.22**	0.00
Word beginnings	—	—	20.69	8.82	20.73	9.30	20.69	8.48	0.01	0.01
Opposites	—	—	9.76	4.41	9.00	4.40	10.26	4.36	−0.29**	−0.07
Faces	.85	20	0.54	0.14	0.50	0.16	0.56	0.13	−0.45**	0.01
Pictures	.90	30	0.48	0.13	0.45	0.15	0.50	0.12	−0.34**	0.02
Changes	.84	20	0.48	0.14	0.44	0.16	0.50	0.12	−0.45**	0.12**
Blends	.72	12	0.43	0.12	0.39	0.14	0.45	0.11	−0.47**	0.08*
Management	.83	20	0.36	0.11	0.32	0.11	0.38	0.11	−0.57**	0.16**
Relationships	.79	9	0.35	0.13	0.32	0.13	0.37	0.13	−0.42**	0.06

Note. Gender differences were calculated using Hedge's *g*, with negative values indicating a female superiority. It was not possible to calculate internal consistency for the three broad retrieval ability tasks as only the total number of permissible responses was recorded. The table reports Cronbach's alpha (α) for Faces, Pictures, Management, and Relationships. Due to item dependencies, split-half reliabilities were often calculated instead. Split-half reliabilities are .70, .78, .71, and .65 for Faces, Pictures, Management, and Relationships, respectively. Corr = correlation.
* $p < .05$. ** $p < .01$ (for the *t* statistic for mean differences between groups).

model fit, we relied primarily on indices of practical fit—root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis Index (TLI), and standardized root mean square residual (SRMR)—rather than the chi-square index, because chi-square is extremely sensitive to sample size and would signal even trivial model differences in a sample as large as this one.

Structural Models of EI Tests Only

We first described and compared the three structural models of the EI subtests alone (see Figure 2 for a depiction of the models). In order to achieve empirical identification for Model 3, we had to constrain two factor loadings for each pair of indicators to equality (i.e., the two subtest factor loadings onto emotion perception were set equal, the two factor loadings onto emotion understanding were set equal, and the two factor loadings onto emotion management were set equal). With the imposition of these three constraints, Model 3 becomes empirically identical to Model 2, by design (i.e., Models 2 and 3 exhibit identical fit). As such, the only meaningful comparison of fit for the EI models is between Model 1 (unidimensional EI model) and the two alternative model specifications. Fit indices for these models are shown in Table 3 and parameter estimates in Table 4. Before discussing fit indices for these models, we note that the three EI models in Figure 2 are not nested models, such that the chi-square difference test is not appropriate. Instead, we consider differences in the AIC.

As seen in Table 3, Model 1 exhibits questionable practical fit (RMSEA = .127; CFI = .96; TLI = .94; SRMR = .043), with an RMSEA far exceeding the widely cited cutoff of .06 (Hu & Bentler, 1999; cf. Marsh, Hau, & Wen, 2004). In contrast, Models 2 and 3 demonstrate better relative fit (for both models, RMSEA = .046; CFI = .997; TLI = .99; SRMR = .016) and a much lower AIC (AIC = 129.95 for Model 1 vs. AIC = 44.33 for Models 2 and 3). We also judge Models 2 and 3 to have adequate levels of absolute fit. From these model comparisons, it appears that the three lower order EI constructs of emotion perception, emotion understanding, and emotion management are a meaningful aspect of the structure of EI and provide superior fit over a unidimensional structure of EI. Upon inspecting the factor loadings in Table 4, we see uniformly strong factor loadings in Model 2 (the hierarchical factor model of EI). For Model 3 (the bifactor model), we note that EI subtests appear to load slightly more strongly onto the broad EI factor than they do onto the three EI group factors of Perception, Understanding, and Management. These models confirm the existence of the three lower order EI primary mental abilities.

Structural Models Incorporating All Cognitive Ability and EI Markers

This set of analyses assesses the fit of the five theoretically plausible models shown in Figure 3. Fit indices for these models

Table 2
Pearson Correlations Between Indicator Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Letter sets																				
2. Figure classification	.38**																			
3. Calendar test	.62**	.43**																		
4. Vocabulary	.44**	.26**	.54**																	
5. Analogies	.52**	.33**	.60**	.71**																
6. Sentence completion	.57**	.35**	.64**	.63**	.58**															
7. Math aptitude	.35**	.24**	.40**	.31**	.33**	.33**														
8. Math operations	.35**	.34**	.49**	.33**	.40**	.40**	.35**													
9. Submult	.30**	.15**	.33**	.16**	.21**	.24**	.32**	.35**												
10. Cube comparison	.21**	.27**	.25**	.15**	.16**	.18**	.27**	.24**	.15**											
11. Hidden patterns	.49**	.42**	.52**	.40**	.45**	.42**	.30**	.37**	.22**	.22**										
12. Surface development	.51**	.45**	.57**	.39**	.49**	.39**	.35**	.43**	.22**	.41**	.56**									
13. Word endings	.31**	.19**	.30**	.34**	.35**	.33**	.15**	.23**	.22**	.18**	.24**	.27**								
14. Word beginnings	.41**	.24**	.39**	.44**	.46**	.40**	.21**	.31**	.26**	.16**	.33**	.34**	.52**							
15. Opposites	.36**	.28**	.43**	.40**	.40**	.45**	.25**	.29**	.24**	.24**	.28**	.32**	.35**	.46**						
16. Faces	.25**	.19**	.24**	.23**	.21**	.27**	.11*	.13**	.10*	.15**	.18**	.18**	.09*	.13**	.15**					
17. Pictures	.37**	.25**	.34**	.33**	.31**	.43**	.17**	.15**	.12**	.11**	.30**	.27**	.25**	.18**	.22**	.36**				
18. Changes	.52**	.38**	.63**	.58**	.57**	.62**	.25**	.34**	.21**	.10**	.44**	.42**	.25**	.34**	.36**	.37**	.43**			
19. Blends	.48**	.34**	.56**	.58**	.55**	.58**	.24**	.30**	.16**	.13**	.39**	.37**	.26**	.34**	.36**	.31**	.45**	.74**		
20. Management	.45**	.31**	.52**	.41**	.40**	.52**	.16**	.21**	.16**	.05	.34**	.29**	.16**	.26**	.27**	.36**	.39**	.66**	.62**	
21. Relationships	.38**	.27**	.47**	.39**	.40**	.47**	.18**	.22**	.15**	.06	.33**	.28**	.15**	.25**	.24**	.32**	.34**	.61**	.59**	.70**

Note. Math operations = Necessary mathematics operations; Submult = subtraction and multiplication.
* $p < .05$. ** $p < .01$; $N = 671$ to 688.

are shown in Table 3, and parameter estimates are shown in Tables 5 and 6.

Model 4: Unidimensional model. A unidimensional model of the cognitive tests and the EI tests together does not show good fit (RMSEA = .123; CFI = .928; TLI = .921; SRMR = .073).

Model 5: Oblique eight-factor model. An eight-factor oblique model with five lower order cognitive ability factors plus three lower order EI factors fits the data much better than the unidimensional model (AIC = 740.84 vs. 2182.78). Fit indices indicate good fit (RMSEA = .064; CFI = .976; TLI = .968; SRMR = .055). Model 5 shows acceptable factor loadings (from .43 to 1.00) and generally strong correlations among the eight factors (factor correlations range from .31 to .87).

The correlations between the eight latent factors are shown in Table 5. The five cognitive ability markers were more strongly correlated with Understanding than with either Perception or Management, confirming prior research that emotion understanding is the most cognitively saturated of the EI branches (Joseph & Newman, 2010). In fact, Understanding showed higher correlations with Gf and Gc than with Perception or Management in this model. The Gf factor was very strongly related to the four other cognitive markers and to Understanding ($r > .80$), but displayed smaller relationships with Perception and Management. On average, correlations among EI factors (mean $r = .66$) were higher than correlations between EI and cognitive factors (mean $r = .53$).

Model 6: Hierarchical model. Model 6 attempts to model the factor intercorrelations from Model 5 via a single, higher order *g* factor. Indeed, the loadings of the eight lower factors onto the higher order *g* are all fairly strong (ranging from .69 to .97; see Table 5). However, the relative fit of the hierarchical *g* model is

Table 3
Fit Results for Structural Models of EI and of EI Integrated With Traditional Cognitive Abilities

	AIC	χ^2	*df*	RMSEA	CFI	TLI	SRMR	AGFI
EI tests only								
1. Unidimensional	129.95	105.95	9	.127	.963	.938	.043	.883
2. Hierarchical	44.33	14.33	6	.046	.997	.992	.016	.975
3. Bifactor[a]	44.33	14.33	6	.046	.997	.992	.016	.975
Cognitive and EI tests								
4. Unidimensional	2182.78	2098.78	189	.123	.928	.921	.073	.719
5. Oblique 8-factor model	740.84	602.84	162	.064	.976	.968	.055	.887
6. Hierarchical	1028.78	928.78	181	.079	.966	.960	.060	.851
7. Hierarchical (second-stratum EI)	743.97	641.97	180	.062	.977	.973	.052	.893
8. Bifactor[a]	876.98	756.98	171	.072	.973	.967	.055	.869

Note. $N = 671$. EI = emotional intelligence; AIC = Akaike Information Criterion; *df* = degrees of freedom; RMSEA = root mean square error of approximation; CFI = comparative fitness index; TLI = Tucker-Lewis Index; SRMR = standardized root mean square residual; AGFI = Adjusted Goodness of Fit Index.
[a] To achieve model identification, pairs of loadings onto the lower order EI factors were constrained to equality within each pair.

Table 4
Standardized Parameter Estimates for EI Tests Only

		2. Hierarchical			3. Bifactor			
	1. Unidimensional	P	U	M	EI	P	U	M
Lower order factors								
Faces	.43	.55			.43	.38[a]		
Pictures	.51	.66			.51	.38[a]		
Changes	.85		.88		.85		.22[a]	
Blends	.82		.84		.81		.22[a]	
Management	.80			.87	.78			.37[a]
Relationships	.76			.81	.72			.37[a]
Higher order loadings		.78	.97	.89				

Note. Factor names: EI = emotional intelligence; P = Perception; U = Understanding; M = Management.
[a] To achieve model identification, pairs of loadings onto the lower order EI factors were constrained to equality within each pair.

slightly worse than the oblique eight-factor model (RMSEA = .079; CFI = .966; TLI = .960; SRMR = .060), and the AIC is much larger (AIC = 1028.78 vs. 740.84).

Model 7: Hierarchical model, second-stratum EI. To specify EI as a second-stratum ability, the three EI factors of Perception, Understanding, and Management loaded onto an EI factor that in turn loaded onto a *g* factor. The hierarchical second-stratum EI model has adequate fit (RMSEA = .062; CFI = .977; TLI = .973; SRMR = .052). Loadings onto the EI factor were strong, and the loading of EI onto the *g* factor was of a magnitude similar to that of the *g* loadings of the other group factors (Gf, Gc, etc.), supporting the idea that EI may constitute a second-stratum factor of intelligence.

We also compared the relative magnitude of the Perception, Understanding, and Management loadings onto the EI factor with their loadings onto the *g* factor in Model 6. Loadings onto the EI factor were higher for Perception and Understanding, with the same magnitude for Management. This finding indicates that the

Table 5
Standardized Parameter Estimates for Cognitive Tests and EI Tests Together: Models 4, 5, and 6

		5. Oblique 8-factor								6. Hierarchical							
	4. 1-factor	Gf	Gc	Gq	Gv	Glr	P	U	M	Gf	Gc	Gq	Gv	Glr	P	U	M
Letter sets	.71	.73								.74							
Figure classification	.50	.54								.52							
Calendar test	.81	.84								.84							
Vocabulary	.72		.80								.80						
Analogies	.75		.80								.80						
Sentence completion	.78		.80								.80						
Mathematics aptitude	.42			.57								.56					
Necessary math operations	.51			.68								.67					
Subtraction and multiplication	.33			.49								.50					
Cube comparison	.27				.43								.40				
Hidden patterns	.60				.70								.72				
Surface development	.61				.81								.80				
Word endings	.41					.62								.62			
Word beginnings	.53					.76								.76			
Opposites	.52					.63								.63			
Faces	.37						.53								.52		
Pictures	.49						.69								.70		
Changes	.80							.88								.89	
Blends	.76							.84								.83	
Management	.66								.70								.87
Relationships	.62								1.00								.80
Factor correlations																	
Gc		.87															
Gq		.82	.67														
Gv		.88	.67	.75													
Glr		.68	.74	.61	.59												
P		.62	.62	.36	.50	.41											
U		.82	.84	.52	.59	.55	.74										
M		.55	.53	.31	.37	.32	.53	.70									
Second-order loadings										.97	.91	.74	.79	.70	.69	.88	.75

Note. EI = emotional intelligence; Gf = fluid intelligence; Gc = crystallized intelligence; Gq = quantitative reasoning; Gv = visual processing; Glr = broad retrieval ability; P = Perception; U = Understanding; M = Management.

Table 6
Standardized Parameter Estimates for Cognitive Tests and EI Tests Together: Models 7 and 8

	7. Hierarchical (second-stratum EI)								8. Bifactor model								
	Gf	Gc	Gq	Gv	Glr	P	U	M	*g*	Gf	Gc	Gq	Gv	Glr	P	U	M
Letter sets	.73								.72	.24							
Figure classification	.52								.51	.06							
Calendar test	.84								.82	.14							
Vocabulary		.80							.68		1.32						
Analogies		.82							.73		.16						
Sentence completion		.79							.78		.08						
Mathematics aptitude			.57						.42			.37					
Necessary math operations			.68						.51			.36					
Subtraction and multiplication			.49						.33			.50					
Cube comparison				.41					.26				.30				
Hidden patterns				.71					.60				.22				
Surface development				.80					.61				.86				
Word endings					.62				.39					.50			
Word beginnings					.76				.51					.65			
Opposites					.63				.51					.30			
Faces						.54			.36						.44[a]		
Pictures						.68			.49						.44[a]		
Changes							.88		.78							.41[a]	
Blends							.84		.73							.41[a]	
Management								.87	.65								.39
Relationships								.81	.60								.80
Second-order loadings																	
EI						.85	1.02	.75									
g	1.00	.90	.78	.83	.72												
$\lambda_{EI\_onto\_g}$ = .80																	

Note. EI = emotional intelligence; Gf = fluid intelligence; Gc = crystallized intelligence; Gq = quantitative reasoning; Gv = visual processing; Glr = broad retrieval ability; P = Perception; U = Understanding; M = Management; *g* = general cognitive ability.
[a] To achieve model identification, some pairs of loadings onto the lower order EI factors were constrained to equality within each pair.

three EI components are stronger measures of EI than of *g* and provides evidence for the discriminant validity of EI.

Model 8: Bifactor model. We also specified a bifactor model where each of the 15 cognitive subtests plus 6 EI subtests double-loaded, once onto the respective lower order group factor and once onto *g* (see Figure 3; RMSEA = .072; CFI = .973; TLI = .967; SRMR = .055). In the bifactor model, marker tests loaded strongly onto the *g* factor. Across the 21 markers, loadings onto the *g* factor were generally of similar magnitude to loadings onto the group factors (with the notable exception of the indicators of Gf, which uniformly loaded more strongly onto *g* than onto the Gf group factor), indicating roughly equal importance of both *g* and group factors in accounting for covariation among tests.

Although Models 5, 6, 7, and 8 all exhibit roughly adequate fit, comparison of the AIC indexes across models (see Table 3) shows Models 5 and 7 to be superior. These models, respectively, represent the oblique eight-factor model and hierarchical model with EI at the second stratum. That is, these are the two models that propose EI as a second-stratum ability within CHC theory, such that results support the idea that EI can be included as a new ability with the same status as Gf or Gc.

Discussion

In general, results supported the idea that EI meets the three criteria to be considered as an additional second-order factor within the CHC model of intelligence. First, there is evidence that the three primary mental abilities of EI (emotion perception, emotion understanding, and emotion management) together form one coherent construct. Second, EI is clearly related to all of the traditional markers of intelligence, as shown by positive manifold in the zero-order correlation matrix, as well as results from hierarchical and bifactor modeling of the assembled battery of cognitive tests. Third, EI does seem to represent a distinct group factor of intelligence. In the paragraphs below, we elaborate on how results support each of these three criteria and suggest a revised CHC model that includes EI (see Figure 1).

Criterion 1: Relationships Among EI Subconstructs

Results from Models 1 to 3 indicate support for the Mayer-Salovey model of EI, where emotion perception, emotion understanding, and emotion management represent the underlying PMAs of EI. All three branches of EI saliently define one global factor of EI in both the one-factor and bifactor models. However, it is worth noting that loadings are higher for the strategic EI branches (emotion understanding and emotion management), compared with the emotion perception branch. Such a result may be partly a consequence of fewer indicators of experiential EI than strategic EI in the current study (i.e., there were two tests of experiential EI and four of strategic EI). This result may also relate to known conceptual and psychometric problems with the emotion perception scales: Items involve the perception of emotions present in objects, despite the argument that objects cannot emote, and scores often correlate weakly with other measures of emotion perception (Maul, 2012; Mayer et al., 2012).

Criterion 2: Relationships of EI to Conventional Measures of Intelligence

Results clearly demonstrate that EI, as measured by the MSCEIT, appears to be a second-stratum factor of intelligence. The EI markers: (a) demonstrate positive manifold with conventional measures of intelligence in the correlation matrix, (b) load saliently onto the broad *g* factor in the unidimensional and bifactor models, and (c) form a second-order factor that relates to *g* in the oblique and hierarchical models. Moreover, EI loadings onto the broad *g* factor are *not* systematically lower (or higher) than loadings from the other cognitive markers, as would be the case if the broad *g* factor were biased or tilted away from (or toward) the construct of EI.

Although evidence indicates that EI is a group factor of intelligence, the three PMAs of EI show different levels of *g* loading or cognitive saturation: Emotion understanding shows the strongest relationships to *g*, emotion perception shows the weakest relationships to *g* (albeit with the caveat noted above), and emotion management is intermediate between the two. This finding is consistent with previous meta-analyses on the relationship of intelligence with the different elements of EI (Joseph & Newman, 2010; Roberts et al., 2008).

Criterion 3: Distinction of EI From Existing Measures of Intelligence. One of the major concerns about the overlap between EI measures and conventional intelligence was that EI, like social intelligence, may represent a content class of declarative knowledge that is not substantively different from Gc (e.g., Landy, 2006). Evidence from the current modeling of EI with cognitive ability indicates that this rival hypothesis is likely not the case. In the eight-factor oblique model, Perception, Understanding, and Management correlated at .62, .84, and .53 with Gc, respectively. Although these are high factor intercorrelations, they are lower than relationships between group factors of intelligence long known to be distinct: the Gf–Gc relationship ($r = .87$) and the Gf–Gv relationship ($r = .88$). This indication of discriminant validity evidence highlights that EI is more than simply acculturated knowledge about a particular class of stimuli (emotions) and is distinguishable from acculturated knowledge generally. The pattern of gender differences for EI and Gc adds to this argument—women score significantly higher than men on all EI tests, with a medium effect size, whereas there are no significant gender differences on Gc in the current study. These differing patterns of demographic differences constitute an additional indication that EI and Gc are distinct constructs (although both can be considered second-stratum cognitive abilities).

Integrating the Elements of EI into CHC Theory. Based on the evidence at hand, it appears that EI may form part of the CHC structure of human abilities. Models 1 to 3 demonstrate that EI is a coherent single ability, with a hierarchical structure. Models 4 to 8 demonstrate that EI is an intelligence *and* further that EI is a particular kind of intelligence distinct from other group factors of intelligence. The question that remains relates to the *level* of the different EI elements within the model. There are several possibilities: (a) emotion perception, understanding, and management each represent a PMA of the group factor EI (where EI has the same status as conventional group factors such as Gf, Gc, and Gv); (b) emotion perception, understanding, and management might constitute three different group factors within CHC theory (each with the same status as the aforementioned group factors); or (c) emotion perception, understanding, and management represent group factors of intelligence (each with the same status as the aforementioned group factors), and these three factors form an overarching g_{EI} factor with the same status (i.e., same level of abstraction) as *g*.

We argue that the first possibility, illustrated in Figure 1, is the most appropriate theoretical model for several reasons. First, it is the most conservative model, demonstrating the least change to CHC theory. Given the enormous amount of research that has gone into the development of the CHC amalgamation of Cattell's and Caroll's models of intelligence, it seems foolhardy to make any sweeping changes based on a single study. Second, our best fitting models are: (a) the hierarchical model where EI represents a second-stratum factor that loads onto *g* (Model 7) and (b) the oblique model that includes the three branches of EI as part of the eight correlated factors of intelligence (Model 5). Model 7 has the best fit indices according to practical fit, whereas Model 5 has the best fit according to decreases in the AIC (an index of relative fit for non-nested models). Note that the *g* loading of the EI second-stratum factor in Model 7 is at least as high as for the other second-stratum factors (and is in fact higher than for Glr and Gq), suggesting that EI properly belongs as a group factor of intelligence.

Conceptually, Model 5 represents the intelligence structure posited by Horn and Cattell (1966), where there is no overall *g* factor at the apex of the model. Correspondingly, Model 7 conceptually represents Carroll's (1993) model, where the group factors occur at the second stratum and *g* at the third stratum. CHC theory remains agnostic about the importance of the *g* factor (McGrew, 2009; Roberts & Lipnevich, 2011), such that both models are consistent with the inclusion of EI into CHC theory. Figure 1 illustrates our position on the placement of EI within CHC theory, where emotion perception, understanding, and management form the PMAs underlying EI, with EI a second-stratum group factor. Note that we have included EI with the "tentatively identified" group factors at this stage. Further research on the placement of EI within the CHC structure, using multiple different operationalizations of the three EI PMAs, or even other PMAs, is needed to move EI out of the "tentatively identified" box in Figure 1.

As recommended by an anonymous reviewer, we also estimated another alternative model that tested Joseph and Newman's (2010) cascading model of EI (Model 6b). This extra model was an adaptation of the eight-factor hierarchical model (Model 6) in which: (a) there was a cascading pattern linking Perception to Understanding and then Understanding to Management, while still controlling for *g*, and (b) there was no latent EI factor at the second stratum. In this model, the standardized Perception–Understanding path was .11 ($p < .05$), the standardized Understanding–Management path was .29 ($p < .05$), and the model showed good fit (AIC = 792.3; $\chi^2 = 688.3$; $df = 179$; RMSEA = .065; CFI = .975; TLI = .970; SRMR = .054). These fit statistics indicate better overall fit than for Model 6 (the hierarchical model with EI dimensions at the second stratum), but slightly worse fit than Model 7 (the hierarchical model with EI as a second-stratum factor). In essence, evidence is somewhat consistent with both alternative explanations—a second-stratum EI factor (Model 7) or a cascading pattern among the EI dimensions (modified Model 6)—with the evidence slightly favoring the second-stratum EI factor, of which the three EI dimensions are reflective indicators (i.e., Model 7).

Importance of Distinguishing Between Mixed Models and Ability Models of EI

It is important to note that the current findings hold only for one measure of ability-based EI. As a research area, EI is fragmented into two broad paradigms: One that recognizes that EI should be conceptualized and measured with maximum-performance, ability-based tasks such as the MSCEIT (ability models of EI), and the other that argues that EI may be a constellation of emotion-related personality traits, appropriately measured by typical performance tests such as rating scales (mixed models of EI). These two conceptualizations of EI are only moderately related to each other (ρ = .26; Joseph & Newman, 2010) and show different personality and cognitive ability correlates (Mayer et al., 2008). In fact, it appears that they are entirely different constructs, confusingly identified with the same label, as in Thorndike's (1904) jingle fallacy. Thus, the current inclusion of EI in the CHC model of intelligence applies *only* to the ability EI paradigm, noting that EI is both defined and operationalized as a cognitive ability (whereas mixed models appear to be conceptually and empirically closer to personality traits; Mayer et al., 2008).

A Possible Explanation for the Association Between EI and Cognitive Intelligence Factors

The results of the current article suggest that EI meets the psychometric criteria for an intelligence. One possible explanation for the association between EI and cognitive abilities involves the common developmental pathways of cognitive abilities and EI. Specifically, the initial development of EI may rely on existing cognitive resources (Zeidner, Matthews, Roberts, & MacCann, 2003), which is a similar theoretical explanation for the positive manifold among traditional cognitive abilities (i.e., the development of some cognitive abilities relies on existing levels of cognitive abilities). One of the most influential theories to explain why different cognitive abilities are related is Cattell's investment theory, which holds that initial levels of Gf are used to acquire knowledge in other areas (Cattell, 1943, 1987). For example, an individual with greater Gf will acquire more acculturated knowledge than others with the same learning opportunities, leading to a relationship between Gf and Gc. Under investment theory, Gf is the basis for other abilities, such that Gf and *g* should be empirically equivalent (Gustafsson & Balke, 1993; Kvist & Gustafsson, 2008). Our results support this interpretation, with our Gf factor loading at or near unity onto a *g* factor in hierarchical models (λ = .97 and 1.00, respectively) and being rather weakly defined as a separate group factor in bifactor models. Our current results—which rely on an input matrix that also included EI test scores—are therefore consistent with the idea that reasoning (i.e., *g* or Gf) is required to develop EI just as it is required to develop other narrower cognitive abilities.

It is logically feasible that reasoning or *g*/Gf is involved in the initial development of emotion perception, understanding, and management. Specifically, learning to recognize a facial expression of emotion (emotion perception), linking the expression to a situational cause (understanding), and then applying this information to a new situation (management) all involve Spearman's (1927) noegenetic laws of cognition. For example, isolating the relevant stimuli that signal an expression of anger involves the *apprehension of experience* (i.e., the first noegenetic law, which involves a person's ability to observe his or her own cognitions). Linking the anger expression to its behavioral precursor involves the *eduction of relations* (i.e., the second noegenetic law, which involves one's ability to cognitively relate two or more thoughts). The ability to manage one's anger by changing one's behavior involves applying a previous behavior/emotion relationship to a new situation (*eduction of correlates,* or the third noegenetic law, which identifies how thoughts or ideas are associated with known relationships). That is, acquiring the competencies of EI involves the application of basic laws of cognition to emotional information available in the environment. In other words, *g*/Gf is the fundamental cognitive ability that likely aids the development of emotion-related cognitive abilities. Similarly, Joseph and Newman's (2010) cascading model of EI supports the notion that *g* is an antecedent to the development of EI. In short, there are several relevant theories outlining the causal pathways by which cognitive ability might be invested in the development of EI and might therefore account for the empirical relationships between EI and other cognitive abilities.

Future Directions for Research

The fact that EI is clearly related to known forms of cognitive ability suggests the need to control for intelligence when examining the beneficial outcomes of EI. Existing research suggests that EI can predict academic success, workplace success, and health outcomes (e.g., Côté & Miners, 2006; Joseph & Newman, 2010; MacCann et al., 2011; Schutte, Malouff, Thorsteinsson, Bhullar, & Rooke, 2007). Most studies in this area control for at least some form of cognitive ability, but rarely control for multiple aspects of intelligence. Given that both fluid reasoning and crystallized knowledge may contribute to key outcomes and that both are strongly related to EI, it may be necessary to control for both of these (or even other relevant aspects of intelligence) in order to implicate *emotional* abilities rather than more general cognitive functioning in the prediction of valued outcomes from EI.

One of the limitations of our research was the reliance on the MSCEIT test battery, which contains only two markers for each of the EI subconstructs. Generally, a latent factor should be defined by three indicators for optimum modeling. In our case, this concern meant that concessions had to be made for some models to reach convergence (i.e., fixing factor loadings to be equal for the bifactor Models 3 and 8). In addition, the MSCEIT test scores were based on consensus scoring, whereas the 15 cognitive markers were not. In consequence, although the three EI branches all define the same broad factor distinct from other group factors, one possible interpretation is that part or all of this shared variance may be method variance due to consensus scoring. Note, however, that MacCann (2010) found that consensus scoring was not an important method effect and did not explain the factorial distinction of EI from factors representing fluid and crystallized intelligence; see also Legree et al., 2013, who obtained analogous findings to the present study, using profile similarity metrics. One of the obvious future directions for research would be to supplement or augment

EI research with EI markers from outside the predominant MSCEIT battery. This would address both the concern that EI dimensions are defined by only two markers and the concern that unusual scoring rubrics may obscure results by acting as method effects.

An additional characteristic of the MSCEIT is that items are text based, such that getting to a correct answer requires not only knowledge about emotions and emotion management, but also the ability to comprehend the text in the question. Even the emotion perception items involve text-based instruction, such that one potentially feasible interpretation of the current results is that the EI factor represents a form of reading comprehension (note however that the EI factor remained separate from Gc). One way to empirically test this potential interpretation is to use multimedia tests of EI, where stimuli are presented as images and video footage rather than the primarily text-based MSCEIT. Indeed, our current research program is devoted to developing multimedia assessments of EI, along these lines (Roberts et al., in press).

One final potential limitation of the current study was the student sample (where students were attending either community colleges or universities). Students tend to be both younger and more intelligent than the population at large, and different aspects of intelligence are known to show different developmental trajectories over the life span (e.g., Horn & Cattell, 1967). As such, it is possible that the current results might differ if this analysis were undertaken on a different sample. However, descriptive statistics did not indicate ceiling effects for any of the tasks. Moreover, this sample included community college students who show less restriction of range on both age and intelligence than other university samples.

Conclusion

The current study is the most comprehensive examination to date of the placement of EI within an existing framework of intelligence and shows fairly conclusively that tasks involving the processing of emotional information can constitute a separate and distinct group factor of intelligence. CHC theory can be adapted to include EI within its boundaries. We argue that the current inclusion is an important step forward in charting the sphere of human cognitive abilities.

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