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Abstract

The Temperament in Middle Childhood Questionnaire (TMCQ; Simonds & Rothbart, 2004) is a widely used parent-report measure of temperament. However, neither its lower- nor higher-order structures have been tested via a bottom-up, empirically based approach. We conducted higher- and lower-order exploratory factor analyses (EFAs) of the TMCQ in a large (N = 654) sample of 9-year-olds. Item-level EFAs identified 92 items as suitable (i.e., with loadings ≥.40) for constructing lower-order factors, only half of which resembled a TMCQ scale posited by the measure's authors. Higher-order EFAs of the lower-order factors showed that a three-factor structure (Impulsivity/Negative Affectivity, Negative Affectivity, and Openness/Assertiveness) was the only admissible solution. Overall, many TMCQ items did not load well onto a lower-order factor. In addition, only three factors, which did not show a clear resemblance to Rothbart's four-factor model of temperament in middle childhood, were needed to account for the higher-order structure of the TMCQ.

Keywords

temperament; middle childhood; exploratory factor analysis; measurement invariance

Middle childhood is a crucial yet perhaps relatively underappreciated phase of human development. Indeed, it is characterized by often dramatic shifts in biological and cognitive development, as well as changes in motivation and social behavior (Campbell, 2011; Del Giudice, 2014), with profound and wide-ranging implications for the development of

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personality, gender identity, and emergent psychopathology (Brock & Kochanska, 2015; Nigg, 2006). Evolutionary models of middle childhood suggest that it is a maturational stage that demands adaptive plasticity, or the ability of an organism to adjust its phenotype to match the local environment in a way that promotes survival (Del Giudice, 2014; West-Eberhard, 2003), and that children this age may therefore show heightened responsivity to environmental inputs (Del Giudice, 2014). Such sensitivity suggests that this may be a period of significant consolidation in child temperament, and that children's personality trait manifestations start to increasingly resemble those of adults through a process of increased differentiation and hierarchical integration as described by some developmental researchers (e.g., Shiner, 1998). For these reasons, the availability of valid and reliable measures of temperament during this period is crucial for gaining a better understanding of children's individual difference factors during this important developmental transition.

Based on seminal work by Thomas and Chess (1977) as well as Buss and Plomin (1984), Rothbart and colleagues (Rothbart, 1981; 2007; Rothbart & Ahadi, 1994; Rothbart & Bates, 2006) developed one of the most currently influential models of child temperament, conceptualizing it in terms of individual differences in emotional reactivity and self-regulation (i.e., the ability to modulate reactive processes). This conceptualization has been instantiated in the Temperament in Middle Childhood Questionnaire (TMCQ; Simonds, 2006; Simonds & Rothbart; 2004), a widely used parent-report measure of temperament spanning ages 7–10. Comprised of 157 items, 17 lower-order scales, and four higher-order factors, the TMCQ was developed via a top-down, theory-driven approach. More specifically, the TMCQ scales were adapted from temperament dimensions that had been studied in both adults and infants via the Children's Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001), the Hampton Individual Differences Questionnaire (Baker & Victor, 2001), the Childhood Temperament and Personality Questionnaire (CTPQ; Victor, Rothbart & Baker, 2006), and the Berkeley Puppet Interview self-report version of the CBQ (Ablow & Measelle, 1993). In support of its predictive validity, temperament assessed via the TMCQ has been related to important outcomes such as emerging symptoms of psychopathology, information processing biases, and emotion regulation (e.g., Herzhoff & Tackett, 2012; Herzhoff, Tackett, & Martel, 2013; Kotelnikova, Mackrell, Jordan, & Hayden, 2015; Noguera, Alvarez, Carmona, & Parra, 2015; Simonds, Kieras, Rueda, & Rothbart, 2007). Further, the study of cultural differences in child temperament is facilitated by the fact that this measure has been translated into numerous languages (e.g., Dutch, Spanish, Italian, Portuguese, Polish, Romanian, and Taiwanese).

However, despite its popularity, the literature on the validation and psychometric properties of the TMCQ is extremely sparse. To our knowledge, such information is limited to a poster presentation by Simonds and Rothbart (2004) and an unpublished dissertation by Simonds (2006). In the poster presentation, Simonds and Rothbart (2004) reported results of a higher-order exploratory factor analysis (EFA) performed on a computerized child self-report version of the TMCQ in 30 7-year-olds, 30 8-year-olds, 44 9-year-olds, and 89 10-year-olds (total $N = 193$); structural results were described as inconclusive by the authors. However, a four-factor solution consisting of Extraversion/Surgency, Negative Affectivity (NA), Effortful Control (EC), and Sociability/Affiliation obtained in this sample was subsequently described by Simonds (2006) in her unpublished dissertation. Simonds (2006) examined the

psychometric properties of this earlier version of the TMCQ (both self-report and parent-report) in 147 children of unknown age, noting that TMCQ scales with α levels below .60 were revised, and these improved scales included in the current version of the TMCQ. This research appears to constitute the sole psychometric work on the TMCQ.

Aside from the lack of more extensive work documenting the descriptive and internal consistency statistics for the scales of the most recent version of the measure, there are other outstanding questions regarding the TMCQ. First, it is a rather lengthy measure consisting of 157 items, taking approximately 30 minutes to complete (Simonds, 2006). In noting its length, it bears mentioning that the TMCQ shows a substantial overlap with its predecessor, the CBQ (Rothbart et al., 2001), a widely used parent-report measure of temperament in preschoolers. Indeed, approximately a third of the TMCQ items were taken verbatim from the CBQ, and 13 of the 17 TMCQ scales show conceptual overlap with the CBQ. While this overlap facilitates the examination of continuity of temperament from early to middle childhood, the quality of the CBQ items appears mixed. Specifically, it was recently reported that more than half of the CBQ items did not load strongly onto a lower-order scale, and more than half of the lower-order scales did not replicate using item-level factor analysis in a very large sample of preschoolers (Kotelnikova, Olino, Klein, Kryski, & Hayden, 2016). These results indicate that more than half of the CBQ items do not tap the constructs that they purport to tap; given that many of the CBQ items are also in the TMCQ, it is important to address their functioning in this measure.

It is also unclear how well the higher-order structure of the TMCQ maps onto the four-factor model proposed by Simonds and Rothbart (2004), given the small sample of participants used for the previously reported EFA (Simonds & Rothbart, 2004) and the inconclusive results noted by the authors. The TMCQ higher-order Extraversion/Surgency factor consists of the following lower-order scales: Activity Level, High Intensity Pleasure, Impulsivity, Shyness (reversed), and Assertiveness/Dominance; the higher-order NA factor consists of Anger/Frustration, Sadness, Fear, Discomfort, and Falling Reactivity/Soothability (reversed), and the higher-order EC factor consists of Attentional Focusing, Inhibitory Control, Low Intensity Pleasure, Perceptual Sensitivity, and Activation Control. The fourth factor, labeled Sociability/Affiliation, combines Agreeableness and Openness to Experience. In the study of the CBQ previously mentioned (Kotelnikova et al., 2016), higher-order factor analyses yielded a model that showed only minimal resemblance to that proposed by Rothbart and colleagues (2001); in particular, while NA-like and Extraversion/Surgency-like factors were found, no clear EC factor was recovered (Kotelnikova et al., 2016). Given the item overlap between the TMCQ and CBQ noted earlier, and the lack of extensive factor-analytic work on the TMCQ, further analyses of its higher-order structure are clearly needed.

With these gaps in knowledge in mind, the current study examined the lower- and higher-order structure of the TMCQ in a large sample of 9-year-olds. Our goals were two-fold: first, we aimed to identify any items that might be functioning poorly, and we also planned to compare the structures we obtained using more of a bottom-up approach to those obtained by Simonds and Rothbart (2004). Thus, we first conducted an item-level EFA to derive lower-order factors, dropping poorly functioning items (i.e., those with loadings < .40). An

item-level EFA of the TMCQ provides empirically grounded information on the nature of its lower-order scales, and aids in the identification of poorly functioning items. Similarly, it allows a comparison between the 17 lower-order scales derived based on theory versus the lower-order structure developed via a bottom-up approach. We then conducted a higher-order EFA on these lower-order scales in order to examine the higher-order structure of the TMCQ, posited to comprise four factors in the small extant body of work on the TMCQ.

Method

Participants

Data from this study were collected as part of larger longitudinal studies conducted at two sites: London, ON, Canada (hereafter referred to as the ON sample; $N = 167$) and Long Island, New York, USA (referred to as the NY sample; $N = 487$). The TMCQ was designed to assess temperament traits in middle childhood, spanning ages 7 through 10. Our participants ranged in age from 8.33 to 10.92 in the NY sample (160 8-year-olds, 304 9-year-olds, and 23 10-year-olds) and from 8.89 to 10.90 in the ON sample (1 8-year-old, 143 9-year-olds, and 23 10-year-olds). Overall, although the age range of participants was determined by the availability of data (i.e., both sites had TMCQ data), the ages of children in our study represent the age range for which this measure was designed, with the exception of 7-year-olds.

The ON sample was recruited for a study of children's emotional and cognitive development through a psychology department database of research volunteers, and advertisements placed in local newspapers and online. The NY sample was recruited through commercial mailing lists for a study of child temperament. In both samples, children with major psychological and medical concerns, as determined by trained study personnel during recruitment, were ineligible. Children in both samples performed within the normal range on the Peabody Picture Vocabulary Test, Fourth Edition (PPVT-IV; Dunn & Dunn, 2007). Overall, participant demographic characteristics were similar across the two samples, suggesting that combining the two datasets for analyses was reasonable (Table 1). We also compared mean TMCQ scale scores between the two samples (see next section; Table 2). To further verify the appropriateness of combining the two samples, we conducted specific tests of structural invariance, as described later in the paper. Finally, we also conducted tests of structural invariance across gender.

Assessment of Temperament

Primary caregivers completed the TMCQ as a measure of their child's temperament at ages 9 at both sites. The current form of the TMCQ (3rd version) consists of 157 items rated on a 5-point Likert scale ranging from 1 (almost always untrue) to 5 (almost always true). Scale means and internal consistency statistics are presented in Table 2, and are comparable to those reported in the extant literature (Simonds, 2006; Simonds et al., 2007; Simonds & Rothbart, 2004). Scale distributions were generally good (see Table 2).

Between-sample differences

Independent-sample t-tests were conducted to examine mean-level differences in scale scores between the two sites, with six TMCQ scales differing significantly (Table 2). Primary caregivers in the NY sample tended to rate their children higher on all of the scales with significant differences, except for Sadness. However, effect sizes for between-sample mean differences on the TMCQ scales were quite small (Table 2), and mean differences on scale scores do not influence structural analyses (Goodwin & Leech, 2006). Also, similar *M*s and *SD*s to those in our samples have been reported by the TMCQ developers in other samples (Simonds, 2006; Simonds et al., 2007).

Proposed Analyses

As a first step, items were subjected to EFAs using Mplus 7 statistical software (Muthen & Muthen, 1998–2012); to our knowledge, this important step in scale development has never before been conducted with the TMCQ, and permits the examination of the extent to which the original scales, constructed based on expert consensus, map onto an empirical approach to scale development. Further, the alternative, a confirmatory factor analytic approach is too restrictive for a complex measure like the TMCQ. More specifically, the CFA approach of fixing many or all cross-loadings of observed indicators to zero may force a researcher to specify a model that is more parsimonious than appropriate for the data (Asparouhov & Muthen, 2009; Hopwood & Donnellan, 2010). Such models often do not fit the data well, requiring extensive model modifications to improve fit. These extensive post-hoc model modifications result in a CFA that is more exploratory than confirmatory in nature (Asparouhov & Muthen, 2009). For our EFA parameter estimation procedures, we used the maximum likelihood robust (MLR) estimator (Muthen & Muthen, 1998–2012) and the geomin oblique rotation method recommended by Browne (2001). This rotation was used for both higher- and lower-order factor analyses. The Kaiser-Guttman criterion for factor retention in an EFA indicates that factors with eigenvalues over 1 should be retained. We also performed a parallel analysis (O'Connor, 2000) in which we ran a simulation with 1000 replications to determine what the eigenvalues would be if there were the same number of cases and variables, but the data were random. If the eigenvalue for a factor from our real data was lower than expected due to chance (i.e., those produced from the parallel analysis), then that factor would not be interpreted as capturing any latent traits present in the data.

The obtained lower-order factors were then computed as averages of their corresponding items with loadings of ≥ .40[1]. Next, to examine the higher-order structure of the TMCQ, the obtained lower-order factors were subjected to a series of EFAs extracting three to five factors. The decision to focus on three- to five- factor models was based on the extant literature on personality and temperament structure (Caspi & Shiner, 2006; Costa & McCrae, 2008; De Pauw & Mervielde, 2010; Rothbart et al., 2001; Watson & Clark, 1993), which suggests that most of the variance in both child and adult temperament/personality is accounted for by three-to-five broad factors (Markon, Kruger, & Watson, 2005), as well as

[1]Although a cut-off of .30 is sometimes used to designate an acceptable loading in EFAs, use of a more stringent cut-off of .40 is also common (Briggs & MacCallum, 2003; Comrey, 1973; Hogarty, Kromrey, Ferron, & Hines, 2004). Notably, similar structures were recovered in our sample using less stringent loading cut-offs, i.e., .35 and .32.

the purported four-factor structure of the TMCQ (Simonds & Rothbart, 2004). We relied on indices of model fit conventionally available in confirmatory factor analysis to compare higher-order EFA models to one another. We used comparative fit index (CFI) values of above .90 and .95 as indices of acceptable and excellent fit (Hu & Bentler, 1999). Additionally, we treated root-mean-square of approximation (RMSEA) values that were lower than .05 as indicating a close fit, with values up to 0.08 indicating acceptable fit (Marsh, Hau, & Wen, 2004). Models with varying numbers of factors were compared using the Satorra-Bentler chi-square difference test (Asparouhov & Muthen, 2009). Due to our large sample size, we adopted a more stringent test of $p < .01$ for comparisons between models for deciding between different models.

As a final step, we followed a step-wise procedure outlined by Little (2013) to ascertain structural invariance of the higher order solution across the two samples. We tested for weak, strong, and strict invariance across the two samples (ON and NY). Tests of weak factorial invariance involve setting each corresponding loading in the two samples to be equal; however, variances, intercepts, and residuals are allowed to vary. Testing strong invariance involves imposing equality constraints on each observed intercept across samples, and tests of strict invariance impose equality constraints on residuals across samples (Little, 2013). Higher levels of factorial invariance are acceptable if the change in model fit from a lower to higher level of invariance is negligible, i.e., if the change in RMSEA and CFI does not exceed .015 (Chen, 2007).

Results

Item-Level Exploratory Factor Analysis

Results of an item-level EFA[2] in the combined sample are shown in Table 3. Initially, this analysis identified 37 factors with eigenvalues over 1; however, only 14 factors with larger eigenvalues than the simulated data sets were extracted based on the results of the parallel analysis (O'Connor, 2000). Model fit of the 14-factor EFA solution was deemed good based on the RMSEA (.03); however, the CFI (.84) was weak. Of the 157 items analyzed, 59 items had primary loadings < .40, and were excluded from subsequent analyses. Items that were excluded from further analyses came from the following original TMCQ scales: Activation Control (nine items), High Intensity Pleasure (eight items), Discomfort (seven items), Fantasy/Openness (five items), Low Intensity Pleasure (five items), Soothability/Falling Reactivity (five items), Fear (four items), Affiliation (four items), Inhibitory Control (four items), Assertiveness/Dominance (three items), Perceptual Sensitivity (three items), Impulsivity (one item), and Sadness (one item). Given that most of the original scales consist of ten or fewer items, excluding more than half of the items from these scales suggests that these constructs may not be adequately represented (e.g., Discomfort and High Intensity Pleasure). Six additional items were excluded as they had high secondary loadings

[2]We also conducted a CFA the original 17 TMCQ scales as well as the original higher-order four-factor structure (Surgency, Negative Affectivity, Effortful Control, and Sociability/Affiliation; Simonds, 2006). Our results were not supportive of these lower- and higher-order structures. In particular, a CFA model of the original 17 TMCQ scales did not converge, and a CFA model of the original four higher-order factors had a very poor fit (RMSEA = .18; CFI = .58).

(i.e., ≥.30), and may therefore not differentiate clearly between the lower-order factors on which they load.

After these steps, 92 items remained with primary loadings ≥ .40 and no secondary loadings ≥.30. Of the 14 factors extracted, one factor was excluded from further analyses as it consisted of a single item ("Gets angry when s/he makes a mistake"). Thus, 13 factors remained for subsequent higher-order EFA analyses (Table 3). Nine of these lower-order factors resembled the original TMCQ scales in their content (i.e., Impulsivity, Activity Level, Attentional Focusing, Shyness, Sadness, Perceptual Sensitivity, Assertiveness/Dominance, Affiliation, and Fantasy/Openness). However, Assertiveness/Dominance, Sadness, Affiliation, and Fantasy/Openness consisted of only about half of the original items. Bivariate associations between the newly derived 13 factors calculated based on the average of their respective items and the original 17 TMCQ scales are presented in Table 4. Correlations between the nine lower-order factors that were similar to the TMCQ scales and these original scales ranged from .77 to .97. The rest of the 13 lower order factors consisted of combinations of items from different original TMCQ scales (e.g., Anger and Sadness) or were too narrow to be considered temperament traits (e.g., Fear of Needles and Fear of Darkness/Burglars).

Higher-Order Exploratory Factor Analysis

The 13 factors identified using the item-level EFA were subjected to a higher-order EFA with a geomin rotation, using MLR estimator; as previously noted, based on theory (Caspi & Shiner, 2006; De Pauw & Mervielde, 2010; Costa & McCrae, 2008; Rothbart et al., 2001; Simonds & Rothbart, 2004; Watson & Clark, 1993), three to five factors were extracted. A three-factor model yielded the only acceptable solution (four- and five-factor models did not converge) and had an acceptable fit (RMSEA = .06; CFI = .93; see Table 5). The first factor of this model combined lower-order factors tapping Impulsivity and Anger/Sadness, the second factor of this model was consistent with Negative Affectivity, and the third factor from this model combined lower-order factors of Affiliation, Fantasy/Openness, and Assertiveness/Dominance, representing a combination of Extraversion/Surgency, Agreeableness, and Openness to Experience traits from the five-factor model of adult personality (McCrae & Costa, 1997).

We also tested for invariance of temperament structures across the two samples (i.e., ON and NY) to determine whether the three-factor solution derived in the joint sample was acceptable[3]. We started by fitting a three-factor model that was equivalent in its configuration in both samples; this baseline model had an acceptable fit (RMSEA = .07; CFI = .93). Table 6 outlines the results of structural invariance tests (i.e., weak, strong, and strict) that were applied sequentially to the three-factor baseline model. Higher levels of factorial invariance are acceptable if the change in model fit from a lower to higher level of invariance is negligible, i.e., if the change in RMSEA and CFI does not exceed .015 (Chen, 2007).

[3]Aside from testing the newly derived three-factor model for invariance of temperament structures across the two samples, we also tested this model for invariance across child sex. The three-factor model passed the weak (loadings) invariance test. This model also passed the strong (intercepts) partial invariance test. Based on the modification indices, intercept equality constraints had to be relaxed for the three lower-order factors: Fantasy/Openness, Affiliation, and Low Attentional Focusing. Following these modifications, the model also passed the strict (residuals) invariance test. These analyses are available upon request from the first author.

Setting each corresponding loading in the two samples to be equal, while allowing variances, intercepts, and residuals to vary (test of weak invariance) did not result in a significant change in the fit indices (ΔRMSEA = .009 and ΔCFI = .002). Imposing equality constraints on each observed intercept across samples (test of strong invariance) also did not yield a significant change in both of the fit indices (ΔRMSEA = .010 and ΔCFI = .037). Finally, imposing equality constraints on residuals across samples (test of strict invariance) also did not result in a significant change in the fit indices (ΔRMSEA = .001 and ΔCFI = .009). Overall, these results indicated that imposition of weak, strong, and strict invariance of the solutions did not significantly diminish model fit. Thus, the factorial structure of the instrument is equivalent across the two samples.

Discussion

We used a bottom-up approach to examining higher- and lower-order structures of a widely used measure of temperament in middle childhood, the TMCQ (Simonds, 2006; Simonds & Rothbart, 2004). To our knowledge, our item-level and higher-order factor analyses of empirically derived lower-order factors of this measure are unique in the literature; this is likely due to the difficulty in acquiring a sufficient sample size for item-level analyses of a measure as lengthy as the TMCQ. Our findings indicated that a large number of TMCQ items (65 items or 42% of the items) did not clearly load onto a lower-order scale. Critically, several lower- and higher-order temperament dimensions (e.g., fear, anger, sadness) that are prominent in most major temperament models (Caspi & Shiner, 2006; De Pauw, Mervielde, & Van Leeuwen, 2009; Rothbart et al., 2001) were poorly represented in the structures derived in our sample, as items putatively tapping these constructs failed to load onto scales. Also, the higher-order structure of temperament in middle childhood did not bear resemblance to the four-factor structure posited by Simonds and Rothbart (2004), nor did it resemble other prominent models of child temperament and personality (e.g., Caspi & Shiner, 2006; De Pauw et al., 2009; Rothbart et al., 2001).

While the TMCQ is a lengthy measure, our findings indicate that a large number of items (65 items out of original 157) did not contribute to lower-order scales, suggesting that the TMCQ is longer than necessary and that many of its items are not effective indicators of the constructs they purport to tap. These item-level results are not surprising. A previous study from our group (Kotelnikova et al., 2016) showed that less than half of the original 195 CBQ items loaded onto lower-order scales. The TMCQ was developed via a top-down approach as an adaptation of the CBQ for older children, and approximately a third of the TMCQ items were taken verbatim from the CBQ. Thirty-one percent of these common items also failed to load onto TMCQ lower-order factors.

Item-level EFAs indicated that approximately half of the factors resembled the original TMCQ scales (i.e., contained similar items) created by Simonds and Rothbart (2004); these were TMCQ Impulsivity, Activity Level, Attentional Focusing, Shyness, Affiliation, Perceptual Sensitivity, Fantasy/Openness, Sadness, and Assertiveness/Dominance. Thus, item-level analyses yielded only nine scales resembling those generated by the developers of the TMCQ based on expert opinion. The remaining lower-order scales derived from EFA were comprised of items from multiple original TMCQ scales (e.g., the Anger/Sadness

lower-order factor we found was a mix of items from the original Anger and Sadness scales), or did not represent constructs broad enough to be deemed temperament traits (e.g., fear of dark and burglars, fear of needles, liking stories).

Putatively distinct facets of NA were poorly differentiated in our analyses. In particular, we recovered a lower-order factor that was comprised of items from both the original Anger and Sadness scales. Difficulty in deriving clear lower-order Anger and Sadness factors may be related to the overlapping language used in the items that tap these constructs in the current version of the TMCQ. Specifically, most of these items describe children's affective responses (either anger or sadness) to similar events (e.g., item 94 "gets angry when s/he has trouble with a task" and item 107 "seems to feel down when unable to accomplish a task"). Of the 15 items comprising the empirically derived Anger/Sadness lower-order factor in our analyses, only six items refer specifically to anger (items 53, 61, 87, 94, 110, and 146), and of these six items, only two (items 110 and 146) do not share similar language with sadness items. Should revisions of the TMCQ be pursued, it may be useful to create additional anger-specific items that do not overlap in language with items tapping sadness. However, it is also possible that children's anger and sadness are highly co-occurring, which would make it difficult for parents to make fineg-rained distinctions between the two emotions. Consistent with this possibility, recent behavior genetic studies (e.g., Clifford, Lemery-Chalfant, & Goldsmith, 2015) have shown that anger and sadness share greater variance in terms of genetic and shared environmental influences than anger does with other facets of negative affect. Finally, studies of observed temperament in preschoolers (Dyson, Olino, Durbin, Goldsmith, & Klein, 2012; Kotelnikova, Kryski, & Hayden, 2015) have also provided evidence that anger and sadness cluster together. If so, striving to create scales that tap these as distinct constructs may prove challenging.

Another key aspect of NA, child fear, may also be poorly tapped by the TMCQ. Specifically, the two fear-like scales that we recovered were too narrow in their scope to be considered temperament traits; specifically, the two scales are Fear of Dark and Burglars and Fear of Needles/Shyness. Indeed, half of items belonging to the original TMCQ scale tapping fear were excluded due to low loadings, suggesting that a revision of the TMCQ should include additional fear items that better tap this important aspect of child temperament.

Analyses of lower-order factors also showed that TMCQ EC items failed to comprise the various EC facets posited by Simonds and Rothbart (2004; Attentional Focusing, Inhibitory Control, Activation Control, Low Intensity Pleasure, and Perceptual Sensitivity). We were able to recover only two scales resembling these, Low Attentional Focusing and Perceptual Sensitivity. Further, many items tapping EC facets were excluded due to low loadings; specifically, ten of the original 15 Activation Control items, four of the eight Inhibitory Control items, six of the eight Low Intensity Pleasure items, and three of the ten Perceptual Sensitivity items were excluded due to low loadings. The remaining Inhibitory Control items loaded on the Impulsivity factor, while Activation Control items loaded primarily with Attentional Focusing items, possibly because these Activation Control items (20, 89, and 93) refer specifically to homework completion. The remaining Low Intensity Pleasure items comprised a three-item factor too narrow to be considered a temperament trait (i.e., Likes Stories). Revision of the TMCQ EC items may be needed in order to tap the various lower-

order facets proposed by Simonds and Rothbart. Another possibility is that the lower-order EC dimensions of Simonds and Rothbart's model do not reflect the multifaceted nature of EC. Given that extant literature supports the notion that EC is a multidimensional construct, there may be alternative ways of parsing EC that more accurately represent the facets of this higher-order construct (e.g., Murray & Kochanska, 2002).

At the higher-order level, we recovered a three-factor structure consisting of Impulsivity/NA, NA, and the third factor combining facets of Fantasy/Openness, Assertiveness/Dominance, and Affiliation. This structure did not bear close resemblance to the original four-factor model proposed by Simonds and Rothbart (2004), comprised of Extraversion/ Surgency, NA, EC, and Sociability/Affiliation. Conceptually, major models of personality and temperament view NA and EC as distinct concepts (e.g., Buss & Plomin, 1984; Caspi & Shiner, 2006; De Pauw et al., 2009; McCrae & Costa, 1997; Rothbart et al., 2001; Tellegen, 1985; Watson & Clark, 1993). However, in our additional exploratory structural equation modeling analyses not reported in full here, constraining loadings of NA-related lower-order factors on higher-order Factor 2 and preventing them from loading on Factor 1 to generate a cleaner structure resulted in an unacceptably poor fit. The third factor in our model was also a mixture of constructs representing lower-order scales tapping Extraversion/Surgency as well as "likes stories" (an unusual lower-order scale), Fantasy/Openness, and Perceptual Sensitivity. Other information published on the structure of the TMCQ was drawn from computerized child self-report (Simonds & Rothbart, 2004) rather than parent report, which could contribute to structural differences. Having said that, given that many TMCQ items were dropped due to low scale loadings and that our lower-order scales were substantially different from those in the original model, it is not surprising that the higher-order structure would differ.

The TMCQ may need new items, as numerous theoretically important, distinct constructs did not emerge as separable lower-order factors, including all of the NA facets, such as Anger/Frustration, Sadness, Fear, Discomfort, and Soothability/Falling Reactivity and some of the EC facets, such as Activation Control, Inhibitory Control, and Low Intensity Pleasure. Indeed, item-level EFA analyses showed that more than half of the items from each of these scales did not differentiate between the concepts they purported to tap. Supplementing the better-functioning existing TMCQ items with newer items that tap underrepresented constructs could prove useful in revising the TMCQ. An extended item pool could then be validated in large samples of children at the item- and higher-order levels using exploratory factor analysis and measurement invariance testing to ascertain validity of the scales and high-order factors and ensure comparable item functioning for boys and girls. Such structural analyses could be followed up by IRT for a more detailed examination of item functioning and further refining of the measure.

Our study is the first item-level analysis of a widely used parent-report measure of temperament in middle childhood. Compared to the analytic methods used in the original scale development (Simonds & Rothbart, 2004), the approach we used is less subject to influence by item properties (Goodwin & Leech, 2006). The large sample size is also a significant strength. However, our study had several limitations. First, the CFI values in our item-level EFA analysis did not reach the recommended value of .90 (Bentler, 1990).

However, other fit statistic (i.e., RMSEA) indicated good model fit. Second, despite the acceptable fit coefficients of the higher-order model presented in Table 4, there were relatively few lower-order factors with high loadings. The main implication of the absence of high loading lower-order factors is that the interpretability of the broader factors is somewhat limited; we therefore tried to be agnostic in how we describe these factors throughout the manuscript. Overall, it cannot be said that the higher-order structures capture most of the scales. Also, some of our EFAs included factors with only two items; such factors may not be especially stable or replicate in future analyses. Finally, both samples were racially/ethnically homogenous and largely middle- and upper-class, which may limit the generalizability of our findings to ethnically diverse children.

Rothbart's family of temperament measures have been extensively used in studies of child temperament for decades. Rothbart's and colleagues' paper on validating the Children's Behavior Questionnaire has been cited over 900 times (Rothbart et al., 2001). In order to facilitate longitudinal research on child temperament, it is extremely important to validate measures that represent an extension of the CBQ to older age groups (i.e., the TMCQ). These measures have also been translated into numerous other languages, facilitating research on child temperament in other countries (e.g., the TMCQ has been translated into eight different languages). The TMCQ is presently the least validated of all Rothbart's measures of child temperament and, therefore, it desperately requires more research on its psychometric properties and structure. Our study provides important new information on a widely used measure of temperament in middle childhood. The results of our study suggest that revisions of the TMCQ are needed, which could include eliminating poorly functioning items and developing new items to tap important temperamental constructs that may not be currently represented well (e.g., NA facets), as well as reconsidering the number of higher-order factors required to fully represent the domain of temperament in middle childhood. These revisions may be of great benefit to researchers in the fields of child development, developmental psychopathology, and child temperament.

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Table 1

Sample Descriptive Statistics

Sample:	**ON**	**NY**
N	167	487
M child age (*SD*)	9.62 (.38)	9.18 (.40)
% boys	43%	54%
M PPVT (*SD*)	112 (12)	108 (11)
% of caregivers who were mothers	87%	93%
M caregiver age (*SD*)	33.87 (12.88)	41.22 (5.25)
Ethnicity:		
Caucasian	89%	80%
African	--	5%
Asian	3%	3%
Hispanic/Latino	--	12%
Other	7%	--
Missing data	1%	--
Family income:		
<20,000	6%	2%
20,001–40,000	7%	5%
40,001 – 70,000	26%	22%
70,001–100,000	26%	16%
>100,000	27%	55%
Missing data	8%	

Note. ON – sample collected in London, ON; NY – sample collected in Long Island, New York, USA.

Table 2

Descriptive Statistics for the 17 Original TMCQ Scales

TMCQ Scale:	ON					NY					*d*
	M	***SD***	**α**	***Skew.***	***Kurt.***	***M***	***SD***	**α**	***Skew.***	***Kurt.***	
1. ActivCn	3.42**	.49	.80	−.49	1.00	3.57**	.49	.77	.03	−.10	.27
2. Activity	3.86	.67	.89	−.05	−1.10	3.95	.68	.89	−.60	−.08	.13
3. Affiliation	4.20	.45	.77	−.59	.08	4.19	.49	.78	−.57	−.09	.01
4. Anger	2.79	.63	.79	.26	.84	2.76	.76	.85	.15	−.33	.04
5. Assertiv.	3.53	.48	.74	.45	.29	3.59	.52	.72	.13	−.06	.12
6. AttnFocus	3.41*	.83	.92	−.35	.05	3.58*	.91	.92	−.56	−.20	.17
7. Discomfort	2.30	.60	.76	.44	−.30	2.38	.61	.71	.31	.02	.01
8. Fantasy	4.07	.53	.80	−.61	−.10	4.08	.53	.75	−.53	.05	.01
9. Fear	2.32*	.67	.75	.51	−.26	2.47*	.67	.75	.43	.08	.19
10. HighPL	3.41	.60	.82	−.06	−.50	3.40	.58	.77	−.09	−.40	.02
11. Impulsivity	2.67	.67	.90	.18	−.01	2.61	.71	.90	.55	.29	.07
12. InhibCn	3.44	.56	.73	−.30	−.12	3.45	.61	.73	−.32	.08	.01
13. LowPL	3.66	.50	.67	−.34	.15	3.64	.57	.68	−.25	−.09	.04
14. PerSen	3.31	.61	.82	−.57	.58	3.36	.58	.78	−.08	.06	.08
15. Sadness	2.50**	.53	.77	.41	−.15	2.32**	.55	.81	.58	.67	.30
16. Shyness	2.57**	.77	.83	.14	−.60	2.29**	.83	.84	.56	.03	.30
17. Sooth.	3.66**	.59	.76	−.45	−.32	3.89**	.65	.83	−.65	.39	.32

Note. The table depicts between sample comparisons of the TMCQ scale means;

** p<.01;

* p<.05; d = .30 is a small, and d = .50 is a medium effect (Cohen, 1988); ActivCn = Activation Control; Activity = Activity Level; Anger = Anger/Frustration; Assertiv. = Assertiveness/Dominance; AttnFocus = Attentional Focusing; Fantasy = Fantasy/Openness; HighPL = High Intensity Pleasure; InhibCn = Inhibitory Control; LowPL = Low Intensity Pleasure; PerSen = Perceptual Sensitivity; Sooth = Soothability/Falling Reactivity

Table 3

Exploratory Factor Analysis of the TMCQ Items

Item#	Scale	Item Description	Impulsivity	Activity	LowAttnFocus	Ang/Sad
16	Impulsivity	SaysFirstThing	0.76			
25	Impulsivity	SaysFirstThingtoMind	0.75			
130	Impulsivity	RushesIntoActivity	0.74			
14	Impulsivity	TouchWithoutPermission	0.61			
83	AttnFocus	RushesNewThings	0.52			
108	Impulsivity	TroubleBecauseNoThinking	0.51			
22	Impulsivity	Interrupts	0.49			
124	Impulsivity	Grabs	0.46			
143	InhibCn	HardSlowingDownToWalk	0.46			
128	Impulsivity	DecidesQuicklyPursues	0.45			
74	Impulsivity	MakesUpMindSuddenly	0.44			
79	InhibCn	HardTimeWaitingTalkWhenExcited	0.43			
72	Impulsivity	CallsOutAnswersEarly	0.43			
96	HighPL	LikesRecklessPlay	0.32			
42	Impulsivity	StopsAndThinks	−0.70			
40	InhibCn	StopFromTooQuick	−0.46			
135	InhibCn	PlanCarefully	−0.43			
37	Activity	LikesPhysicalActivity		0.77		
2	Activity	PhysicallyActive		0.76		
102	Activity	LikesActiveGames		0.75		
23	Activity	SportOverTV		0.73		
43	Activity	LikesRunning		0.72		
127	Activity	LikesRunOutside		0.72		
21	Activity	PrefersOutdoorPlay		0.65		
66	Activity	Energetic		0.63		
46	ActivCn	MakeSelfRunFastWhenTired		0.54		
115	HighPL	EnjoysChase		0.50		
3	HighPL	HighSlides		0.46		

Item#	Scale	Item Description	Impulsivity	Activity	LowAttnFocus	Ang/Sad
149	AttnFocus	DistractedInClass			0.80	
80	AttnFocus	HardTimePayingAttention			0.79	
120	AttnFocus	ToldToPayAttention			0.76	
82	Impulsivity	TeachersTellsPayAttention			0.76	
78	AttnFocus	HardTimeConcentratingActivity			0.75	
17	AttnFocus	LooksAroundHomework			0.66	
7	AttnFocus	EasilyDistractedStory			0.59	
89	ActivCn	DifficultBoringAssignment			0.58	
93	ActivCn	FunActivityInsteadOfHomework			0.50	
20	ActivCn	MakesSelfDoHomework			−0.43	
94	Anger	AngryWhenTaskDifficult				0.66
87	Anger	AngryWhenCannotFindSmth				0.64
110	Anger	TemperTantrums				0.62
105	Sooth	UpsetWhenAngryForFiveMins				0.59
53	Anger	AngryWhenToyTaken				0.54
24	Sadness	SadBrokenPlans				0.49
100	Sadness	FeelingsEasilyHurt				0.48
154	Discomfort	CriesWhenLittleHurt				0.48
61	Anger	AngryWhenAskedToStopPlayEarly				0.47
31	Sadness	SadWhenToldToDoSomething				0.46
107	Sadness	FeelDownWhenNotAccompishTask				0.46
64	Sooth	CriesMoreThanCoupleMins				0.46
19	Sooth	DifficultToSoothe				0.45
146	Anger	MadWhenProvoked				0.43
35	Sadness	CriesToyBroken				0.41

Item#	Scale	Item Description	FearNeedles/Shy	Shyness	Affiliation	LikesStories	PerSen	Sadness	Fantasy	Fear	Assertiv
30	Discomfort	CriesInjection	0.93								
63	Fear	ScaredInjectionsDr	0.82								
55	Shyness	ShyNewPeople		0.81							
118	Shyness	Shy		0.75							
47	Shyness	SelfConsciousAroundPeople		0.54							

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Item#	Scale	Item Description	FearNeedles/Shy	Shyness	Affiliation	LikesStories	PerSen	Sadness	Fantasy	Fear	Assertiv
28	ActivCn	HardSpeakingWhenScared		0.42							
84	Assertiv	FirstSpeakUp		−0.53							
59	Shyness	SaySomethingStrangers		−0.63							
33	Affiliation	GoodFriendEveryDay			0.56						
148	Affiliation	LikesFeelingClose			0.55						
156	Affiliation	LikesBeingWithOthers			0.55						
106	Affiliation	FriendsVeryImportant			0.52						
18	Affiliation	FriendsWithMany			0.46						
129	Affiliation	Confides			0.44						
73	LowPL	EnjoysLookingBooks				0.79					
86	LowPL	LikesQuietReading				0.78					
54	Fantasy	LikesMakeBelieveStories				0.63					
109	PerSen	NoticesSmallEnvironmentChanges					0.61				
123	PerSen	FeelSmoothRough					0.58				
111	PerSen	NoticesThingsOthersDoNot					0.53				
77	PerSen	TouchesSoftMaterial					0.51				
114	PerSen	NoticesSmallSpecksDirt					0.47				
150	PerSen	NoticesNewClothing					0.43				
44	PerSen	NoticesBirdSounds					0.41				
69	Discomfort	BotheredLoudScratchySounds					0.40				
133	Sadness	FrequentlySad						0.64			
144	Sadness	SadWhenOthersHappy						0.61			
97	Sadness	ToldByOthersThatSad						0.58			
27	Sadness	DowncastNoReason						0.51			
71	Fantasy	EnjoysDrawingPictures							0.57		
151	Fantasy	LikesMakingThings							0.55		
104	Fantasy	BigImagination							0.45		
75	Pear	AfraidBurglars								0.58	
140	Fear	AfraidDark								0.58	
153	Fear	FrightenedNightmares								0.55	
155	Assertiv	EnjoysWinningArgument									0.60
122	Assertiv	UsuallyWinsArgument									0.58

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Item#	Scale	Item Description	FearNeedles/Shy	Shyness	Affiliation	LikesStories	PerSen	Sadness	Fantasy	Fear	Assertiv
131	Assertiv	LikesBeingInCharge									0.53
98	Assertiv	ChoosesGamesWithOthers									0.51

Note. Loadings less than |.40| are not included; one lower-order factor had a single item loading on it, i.e., “Gets angry when s/he makes a mistake” which also loaded significantly on another factor; as a result, this scale was excluded from higher-order exploratory factor analysis results in a total of 13 lower-order factors extracted; ActivCn = Activation Control; Activity = Activity Level; Anger = Anger/Frustration; Assertiv. = Assertiveness/Dominance; AttnFocus = Attentional Focusing; Fantasy = Fantasy/Openness; HighPL = High Intensity Pleasure; InhibCn = Inhibitory Control; LowPL = Low Intensity Pleasure; PerSen = Perceptual Sensitivity; Sooth = Soothability/Falling Reactivity; Ang/Sad = Anger/Sadness; FearNeedles/Shy = Fear of Needles/Shyness

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Table 4

Bivariate Associations between the 17 Original TMCQ scales and the 13 New Lower-Order Factors

17 Original	13 New Lower-Order Factors														
TMCQ scales	**Imp**	**Activ**	**Low Attn Foc**	**Ang/ Sad**	**Fear Needles/ Shy**	**Shy**	**Affil**	**Likes Stories**	**PerSen**	**Sad**	**Fant**	**Fear**	**Assert**	***M***	***SD***
ActivCn	−.49**	.37**	−.65**	−.53**	−.16*	−.39**	.25**	.24**	.04	−.42**	.19**	−.24**	.03	3.53	.50
Activ	.12**	.96**	−.02	−.14**	−.12**	−.18**	.31**	−.04	.11**	−.21**	.07	−.08	.10*	3.93	.68
Affil	−.05	.31**	−.15**	−.14**	−.01	−.32**	.92**	.23**	.21**	−.24**	.33**	−.02	.20	4.19	.48
Anger	.52**	−.11**	.42**	.89**	.14**	.22**	−.02	−.15**	.14**	.46**	−.05	.26**	.27**	2.77	.73
Assert	.22**	.24**	−.06	.06	−.02	−.40**	.39**	.17**	.15**	−.06	.18**	−.05	.88**	3.58	.51
AttnFoc	−.75**	.07	−.97**	.41**	−.05	−.05	.03	.35**	−.01	−.35**	.11**	−.20**	−.08*	3.54	.89
Discomf	.27**	−.26**	.27**	.62**	.51**	.24**	−.01	−.04	.34**	.46**	.05	.45**	.10**	2.38	.60
Fant	−.07	.13**	−.18**	−.01	.09*	−.06	.34**	.52**	.30**	−.10**	.83**	−.01	.21**	4.08	.53
Fear	.17**	−.21**	.20**	.41**	.52**	.28**	−.07	−.05	.23**	.33**	.04	.82**	.01	2.43	.68
HighPL	.34**	.61**	.14**	.02	−.13**	−.27**	.26**	−.01	.12**	−.06	.09	−.18**	.31**	3.40	.58
Imp	.98**	.02	.71**	.50**	.04	−.04	.06	−.21**	.10**	.32**	−.06	.20**	.28**	2.62	.69
InhibCn	−.82**	.10*	−.66**	−.38**	−.01	.01	.06	.29**	.04	−.28**	.18**	−.16**	−.14**	3.44	.60
LowPL	−.14**	.13**	−.29**	−.05	.07	−.05	.28**	.73**	.39**	−.09*	.38**	−.06	.16**	3.64	.55
PerSen	−.01	.22**	−.15**	.09*	.03	.02	.25**	.18**	.92**	.05	.30**	.07	.11	3.35	.59
Sad	.36**	−.20**	.36**	.85**	.23**	.40**	.03	−.10*	.27**	.77**	−.01	.36**	.11*	2.36	.55
Shy	−.01	−.17**	.08*	.35**	.13**	.95**	−.23**	−.03	.13**	.39**	−.01	.22**	−.11**	2.36	.82
Sooth	−.45**	.21**	−.45**	.79**	−.19**	−.35**	.10*	.15**	−.18**	−.62**	.10**	−.38**	−.08*	3.83	.64
M	2.56	3.98	2.51	2.71	2.90	2.50	3.98	4.06	3.05	1.57	4.28	2.38	3.35		
SD	.68	.66	.86	.64	1.24	.79	.60	.83	.64	.61	.69	.95	.64		

Note.

** $p<.01$;

[*] $p<.05$; ActivCn = Activation Control; Activ = Activity Level; Anger = Anger/Frustration; Assert = Assertiveness/Dominance; AttnFoc= Attentional Focusing; Fant = Fantasy/Openness; HighPL = High Intensity Pleasure; InhibCn = Inhibitory Control; LowPL = Low Intensity Pleasure; PerSen = Perceptual Sensitivity; Sooth = Soothability/Falling Reactivity; Ang/Sad = Anger/Sadness; FearNeedles/Shy = Fear of Needles/Shyness; Shy=Shyness; Affil=Affiliation; Sad=Sadness; Imp=Impulsivity; Discomf=Discomfort

Table 5

Higher-Order Exploratory Factor Analyses of the TMCQ Lower-Order Scales

Lower-Order Factors	Factor 1	Factor 2	Factor 3
Impulsivity	**0.94**	−0.08	0.00
Activity	−0.01	***−0.32***	***0.31***
Low Attentional Focus	**0.80**	0.02	−0.28
Anger/Sadness	**0.49**	**0.58**	0.03
Fear of Needles/Shyness	0.01	***0.32***	0.08
Shyness	−0.04	**0.56**	−0.24
Affiliation	0.00	−0.13	**0.57**
Likes Stories	***−0.34***	0.04	**0.43**
Perceptual Sensitivity	0.01	0.27	***0.39***
Sadness	***0.35***	**0.56**	−0.12
Fantasy/Openness	−0.17	0.05	**0.48**
Fear	0.19	***0.39***	0.00
Assertiveness/Dominance	0.23	−0.04	**0.42**

Note. Primary loadings ≥40 are bolded; loadings ≥30 are bolded and italicized; Factor 1 correlated with Factors 2, 3, at .13 and .17 respectively; Factor 2 correlated with Factor 3 at .01.

Table 6

Tests of Structural Invariance across the Two Samples (ON and NY): Three-Factor Model

Model Tested	*df*	RMSEA	ΔRMSEA	CFI	ΔCFI	PASS?
Configural invariance	84	.068		.931		YES
Weak invariance	114	.059	.009	.929	.002	YES
Strong invariance	127	.069	.010	.892	.037	YES
Strict Invariance	140	.068	.001	.883	.009	YES