Available online at www.sciencedirect.com
ScienceDirect
Behavior Therapy 50 (2019) 755–764
Behavior Therapy
www.elsevier.com/locate/bt

A Latent Structure Analysis of Cognitive Vulnerability to Depression in Adolescence

Richard T. Liu
Alpert Medical School of Brown University

Brae Anne McArthur
Taylor A. Burke
Temple University

Jessica L. Hamilton
University of Pittsburgh and Western Psychiatric Institute and Clinic

Naoise Mac Giollabhui
Temple University

Jonathan P. Stange
University of Illinois–Chicago

Elissa J. Hamlat
University of Illinois–Urbana Champaign

Lyn Y. Abramson
University of Wisconsin–Madison

Lauren B. Alloy
Temple University

Whether cognitive vulnerability to depression exists along a continuum of severity or as a qualitatively discrete phenomenological entity has direct bearing on theoretical formulations of risk for depression and clinical risk assessment. This question is of particular relevance to adolescence, given that cognitive vulnerability appears to coalesce and rates of depression begin to rise markedly during this period of development. Although a dimensional view is often assumed, it is necessary to submit this assumption to direct empirical evaluation. Taxometric analysis is a family of statistical techniques developed directly to test such assumptions. The present study applied taxometric methods to address this question in a community

Preparation of this manuscript was supported in part by National Institute of Mental Health Grants R01MH79369, R01MH101138, R01MH101168, and K23MH112769, as well as a National Science Foundation Graduate Research Fellowship. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

Address correspondence to Richard T. Liu, Ph.D., Department of Psychiatry and Human Behavior, Brown University, Bradley Hospital, 1011 Veterans Memorial Parkway, East Providence, RI 02915; e-mail: rtliupsych@gmail.com

sample of early adolescents (n = 485), drawing on three indices of cognitive vulnerability to depression (i.e., negative inferential style, ruminative response style, self-referent information processing). The results of three taxometric analyses (i.e., mean above minus below a cut [MAMBAC], maximum eigenvalue [MAXEIG], and latent mode [L-Mode]) were consistent in unambiguously supporting a dimensional conceptualization of this construct. The latent structure of the tested indices of cognitive vulnerability to depression in adolescence appears to exist along a continuum of severity rather than as a discrete clinical entity.

Keywords: adolescence; cognitive vulnerability; depression; latent structure; taxometric analysis

Depression is currently the leading cause of burden to society, accounting for 40.5% of disability-adjusted life years attributable to all psychiatric and substance use disorders (Whiteford et al., 2013). Moreover, the number of years lived with disability linked to depression has increased by 43% over the last quarter-century (U.S. Burden of Disease Collaborators, 2013). Characterizing the processes underlying risk for depression is necessary for reducing its prevalence and attendant societal burden.

Among etiological conceptualizations of depression, cognitive vulnerability theories feature prominently, particularly Beck's (1967, 1987) theory, the hopelessness theory of depression (Abramson, Metalsky, & Alloy, 1989), and the response styles theory (Nolen-Hoeksema, 1991). Beck's (1967, 1987) theory proposes that depressotypic schemata involving self-views relating to worthlessness, loss, and inadequacy confer risk for depression through a disproportionate tendency to encode and retrieve negative self-referential information. This theoretical model has received substantial support in the research literature (Beck & Haigh, 2014). According to the hopelessness theory of depression (Abramson et al., 1989), individuals are at greater risk for becoming hopeless if they exhibit a depressogenic inferential style characterized by a tendency (a) to attribute negative life events to stable (persistent over time) and global (likely to occur in many areas of life) causes, (b) to form negative inferences regarding the consequences of these negative events, and (c) to infer negative self-characteristics. This hopelessness, in turn, places these individuals at risk for developing depression. This theoretical model of depression has received considerable empirical support (Liu, Kleiman, Nestor, & Cheek, 2015; Mac Giollabhui et al., 2018). Finally, the response styles theory (Nolen-Hoeksema, 1991) posits that risk for depression is elevated in individuals who tend to ruminate in response to distress (i.e., to focus repetitively and passively on feelings of distress and its potential causes and consequences). As with the two aforementioned cognitive conceptualizations of risk for depression, this theory has been well supported in the existing research literature (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008).

Despite the considerable body of research relating to these cognitive formulations of vulnerability to depression, an issue central to understanding the etiology of this disorder is whether cognitive vulnerability is best conceptualized as existing along a continuum of severity (i.e., dimensional or continuous) or as a discrete phenomenological entity (i.e., taxonic or categorical). Several taxometric studies of youth depression have been conducted (e.g., Hankin, Fraley, Lahey, & Waldman, 2005; Liu, 2016; Richey et al., 2009; Solomon, Ruscio, Seeley, & Lewinsohn, 2006), with mixed support for a dimensional versus taxonic latent structure. Additionally, although it often has been assumed that taxonic phenomena originate from similarly taxonic vulnerability factors and likewise dimensional outcomes from dimensional vulnerabilities, these assumptions often are incorrect despite their intuitive appeal. As just one illustrative example, several studies have reported evidence of a dimensional latent structure for depression in adolescents (e.g., Hankin et al., 2005; Liu, 2016). Despite this finding of dimensionality in depression, some of its risk factors (e.g., biological sex) are inherently taxonic.

Although a dimensional conceptualization of cognitive vulnerability to depression is often assumed, it is necessary for this view to be submitted directly to empirical evaluation. Taxometric methods are uniquely suited directly to address this issue. Yet, only one taxometric study exists examining the latent structure of cognitive vulnerability to depression (Gibb, Alloy, Abramson, Beevers, & Miller, 2004), finding evidence of dimensionality.

The current study aimed to build upon this important early study of the latent structure of cognitive vulnerability to depression in several notable ways. First, whereas this earlier study featured an undergraduate sample, the current investigation drew on a community sample of early adolescents. This decision was influenced, in part, by important developmental considerations in determining the latent structure of cognitive vulnerability to depression. Specifically, cognitive vulnerability factors may undergo a transition from being more malleable constructs in youth to relatively more stable ones in adulthood (Abela &

Sarin, 2002; Cole, 1991; Hankin & Abela, 2005). These vulnerabilities therefore are theorized to transition from mediators to moderators of the relation between negative life events and depression (Cole et al., 2001; Tram & Cole, 2000). Several studies have obtained empirical support for this view (Cole et al., 2001; Tram & Cole, 2000; Uhrlass & Gibb, 2007). Given developmental differences in cognitive vulnerability, it cannot be assumed that evidence of dimensionality in adults (Gibb et al., 2004) is generalizable to adolescents. Also underscoring the importance of clarifying the latent structure of cognitive vulnerability in early adolescence is the dramatic increase in risk for depression that occurs during this developmental period (Hasin, Goodwin, Stinson, & Grant, 2005; Kessler et al., 2003).

The current investigation also aimed to provide a methodological advancement through the inclusion of both behavioral and self-report taxometric indicators of cognitive vulnerability, thereby directly addressing the stated need for taxometric research to move beyond the heavy reliance on exclusively self-report or interview-based methodology (Gibb et al., 2004; Haslam, Holland, & Kuppens, 2012). In addition to limitations relating to shared-method variance, some researchers have expressed concern that relying entirely on self-report data may lead to a greater incidence of spurious taxonic findings (Beauchaine & Waters, 2003), whereas others have suggested that such data may, at times, be insufficient for detecting extreme taxa (Ruscio, Brown, & Ruscio, 2009). To our knowledge, this is only the third taxometric study of psychiatric phenomena or their associated risk not to rely solely on self-report methodology, and the first such study relating to depression.

A third advancement introduced by this study is statistical, and concerns the application of the comparison curve fit index (CCFI) as an objective indicator for determining whether the study data align substantially with a taxonic or dimensional solution or are ambiguous, not clearly adhering to either (Ruscio, Walters, Marcus, & Kaczetow, 2010). This objective index of taxonicity has been described as the most significant recent development in the broader taxometric literature (Haslam et al., 2012). As an objective index for differentiating between taxonic and dimensional data at a high level of accuracy and being robust to a wide array of poor measurement conditions (Ruscio & Kaczetow, 2009), the CCFI supplants the approach adopted in older studies, which relied on subjective interpretation based on visual inspection of taxometric graphical output, which is more vulnerable to spurious taxonic findings.

In summary, the current investigation provided the first taxometric analysis of cognitive vulnerability to depression in adolescence, drawing on both self-report and behavioral data for taxometric indicators used in analyses. Finally, the CCFI was applied to determine objectively whether study data better fit a taxonic or dimensional model.

Method

PARTICIPANTS

Sample Recruitment

The current study sample was derived from a longitudinal study designed to examine risk factors for the onset of depression among a racially and socioeconomically diverse sample of adolescents (Alloy et al., 2012). Adolescents and their primary caregivers were recruited from middle schools through mailings (and follow-up phone calls) sent out to the Philadelphia School District (68% of the sample) and advertisements in local newspapers (32% of the sample). The current study sample included 485 adolescents (mean age = 12.86 years; *SD* = 0.59) who completed the measures of cognitive vulnerability. Overall, 48.5% identified as White, and 52.4% were female.

The study inclusion criteria were: (a) the adolescent was 12–13 years old at study entry; (b) the adolescent identified as White, African American/Black, or biracial; and (c) a mother/female primary caretaker was willing to participate. Exclusion criteria were: (a) either the adolescent or female caretaker did not read or speak English well enough to complete study measures; and (b) either the adolescent or female caretaker exhibited any psychotic disorder, developmental disorder, or severe learning disability that would prevent them from completing study measures. Additional details regarding the study design have been previously reported (Alloy et al., 2012).

PROCEDURES

All data are derived from the baseline assessment for the Adolescent Cognition and Emotion (ACE) Project. Adolescents completed self-report and behavioral tasks measuring a range of cognitive vulnerabilities for depression.

MEASURES

Negative Inferential Style

The Adolescent Cognitive Style Questionnaire–Modified (ACSQ-M; Alloy et al., 2012) measures negative inferential styles as articulated in the hopelessness theory (Abramson et al., 1989). The ACSQ-M assesses inferential styles across three domains: achievement, interpersonal, and appearance. Participants are presented with four hypothetical negative events for each domain, and asked to make inferences about (a) the causes (internal/external, global/specific, and stable/unstable), (b) consequences, and (c) self-characteristics implications of each event. Each item is scored on a 7-point scale, with higher scores indicating a more negative inferential style. Following convention in prior studies (e.g., Alloy et al., 2012; Gibb et al., 2004; Mac Giollabhui et al., 2018), the internal/external items were not used. Internal consistency in this sample was excellent ($\alpha_{\text{Globality-Stability}} = .90$, $\alpha_{\text{Consequences}} = .86$, $\alpha_{\text{Self-Characteristics}} = .88$).

Rumination

The Children's Response Styles Questionnaire (CRSQ; Abela, Vanderbilt, & Rochon, 2004) is a 25-item measure used to assess adolescent ruminative response styles. The CRSQ measures the frequency of adolescents' responses to sad or depressed mood in terms of rumination, distraction, and problem-solving. Adolescents rate the frequency of their thoughts or feelings when they are sad on a 4-point scale. The current study used only the 13-item rumination subscale, with higher scores indicating a greater tendency to use a ruminative response style. The CRSQ has demonstrated adequate validity in previous research (Abela et al., 2004), and $\alpha = .85$ in the current sample.

Self-Referent Encoding Task

The Self-Referent Encoding Task (SRET; Derry & Kuiper, 1981) is a behavioral paradigm for assessing self-referent information processing and memory biases. In the current study, a computerized version of the original task was used. For this task, 22 positive and 22 negative adjectives were randomly presented on a computer screen. Below the adjectives, participants had to respond "Yes" or "No" to one of two questions: "Like Me?" (self-referent) or "Has an E?" (structural). The adjectives were divided evenly, with a total of 11 words in each category (self-referent and negative; structural positive, etc.). The words were selected and matched based on frequency and word length. Immediately after completing the task, adolescents completed a free recall test, in which they verbally recalled as many adjectives as they could remember from the task. The number of negative self-referent words endorsed served as an index of negative self-schema. The number of such words recalled relative to all the positive and negative self-referent words endorsed functioned as an indicator of negative recall bias.

DATA ANALYSIS

A central feature of taxometric methods is the implementation of multiple mathematically nonoverlapping procedures that yield nonredundant results, with each procedure providing a consistency test for the others. Consistency in results produced across multiple procedures provides confidence in the conclusions drawn regarding the latent structure of the construct of interest. Three distinct taxometric procedures were adopted in the current investigation: MAMBAC (mean above minus below a cut; Meehl & Yonce, 1994), MAXEIG (maximum eigenvalue; Waller & Meehl, 1998), and L-Mode (latent mode; Waller & Meehl). MAMBAC requires at least two valid indicators, with one serving as the input indicator and another functioning as the output indicator. The difference in mean scores of the output indicator above and below a sliding cut-off score on the input indicator is plotted as a function of the input indicator cut-points. This procedure is repeated for every possible pair of indicators. In the current study, 50 cuts were made along each input indicator. Each indicator in a pair alternates as the input and output indicator, and thus two graphical MAMBAC plots are generated for each pair of indicators. The results of these analyses are averaged into a single MAMBAC curve. MAXEIG requires a minimum of three indicators. Each indicator functions, in turn, as the input indicator, and the interrelationship between the remaining indicators (i.e., the output indicators) is evaluated in a series of overlapping windows (i.e., subsamples) ordered along the input indicator. The covariance matrix for the output indicators (variance values are replaced with 0's such that only covariances remain) in each window is factor analyzed, with the largest eigenvalue plotted on a graph with the windows of the input indicator on the x-axis. Based on optimal analysis parameters determined in a recent study (Walters & Ruscio, 2010), the sample was split into 25 windows with 90% overlap between adjacent windows. L-Mode also requires at least three indicators. This factor analytic procedure involves calculating the first principal factor of the indicators on a one-factor latent variable, and plotting the distribution of the sample data on this latent factor.

For each taxometric procedure, simulated taxonic and dimensional comparison data were generated, approximating all distribution properties of the empirical data known to influence the shape of taxometric curves. That is, the simulated data were identical to the research data in terms of surface-level statistical properties of the observed indicators, such as sample size, means, standard deviations, indicator skew, and inter-indicator correlations, differing only in terms of latent structure. Following procedures adopted in prior taxometric studies (e.g., Ruscio, 2010), the three taxometric techniques were initially conducted without comparison data so as to obtain mean base rate estimates of the putative taxon, which were then used in generating the simulated data. The results for the empirical data were directly compared with those for simulated taxonic and dimensional data to ascertain which they most closely matched. Data for each model (i.e., taxonic and dimensional) were simulated 100 times to approximate sampling distributions for each model for each of the three taxometric procedures used in the current study. This approach of comparing the empirical data to simulated models of taxonicity and dimensionality with identical statistical properties allows for a more accurate comparison than would with a prototypical model.

The CCFI was calculated for each taxometric procedure as an objective measure of the degree to which the results matched the simulated taxonic or dimensional comparison data. It compares the root-mean-square residual of the fit between the curve for the actual data and for each of the simulated comparison curves. CCFI values range from 0 (dimensional structure) to 1 (taxonic structure), with a value of 0.50 being equally consistent with dimensional and taxonic structures (Ruscio et al., 2010). CCFI values between the dual thresholds of 0.45 and 0.55 reflect ambiguous results (Walters & Ruscio, 2013). These dual thresholds have an accuracy rate of 98.2% for MAMBAC, 95.8% for MAXEIG, and 97.3% for L-Mode (Ruscio et al., 2010). All analyses were conducted using Ruscio's (2013) taxometric packages for the R programming language in MRO 3.3.2.

Results

INDICATOR SELECTION AND SUITABILITY

Taxometric analysis requires multiple indicators reflecting different aspects of the construct of interest (Ruscio, Haslam, & Ruscio, 2006). The ACSQ-M globality-stability, consequences, and self-characteristics subscales, the CRSQ rumination subscale, and SRET negative self-schema and SRET negative recall were screened as potential taxometric indicators. Subscales/indices with very high or low correlations with other subscales/indices were removed (Meehl, 1992), leaving the ACSQ-M globality-stability and self-characteristics subscales, the CRSQ rumination subscale, and SRET negative self-schema as indices of cognitive vulnerability retained for analyses.[1] Taxometric indicator properties were assessed to determine validity of the data for taxometric analysis. To avoid nuisance covariance in indicator construction, it is necessary for indicator correlations to be substantially smaller within the putative taxon and complement than within the full sample (Ruscio et al., 2006). The traditional recommendation is for within-group indicator correlations to be under 0.3, and inter-indicator correlation within the full sample be above 0.3 (Meehl, 1995). More recently, it has been suggested that a more important consideration is for a sizeable difference between the full-sample and within-group indicator correlations (Ruscio et al., 2006; Walters, 2008). Satisfying these requirements, for the four indicators, mean full sample r = 0.37 and mean taxon and complement $rs \leq 0.06$. Finally, it has been recommended that the constructed indicators should separate the putative taxon from its complement at Cohen's $d \geq 1.25$ to achieve an acceptable minimum validity (Meehl, 1995; Meehl & Yonce, 1996). This condition was satisfied in the current study (for all indicators, $d \geq$ 1.25).[2]

TAXOMETRIC ANALYSES

Figure 1 depicts the averaged graphical output relative to simulated taxonic and dimensional data for all three taxometric procedures. The empirical data were consistent in more closely resembling the dimensional distributions. The corresponding CCFIs were similarly consistent in unambiguously favoring dimensional solutions ($\text{CCFI}_{\text{MAMBAC}}$ = 0.237, $\text{CCFI}_{\text{MAXEIG}}$ = 0.194, $\text{CCFI}_{\text{L-Mode}}$ = 0.288, mean CCFI = 0.240).

Discussion

Across three mathematically distinct taxometric procedures, and based on a combination of self-report and behavioral data, the current study found clear and consistent evidence of dimensionality in the latent structure of three indices of cognitive vulnerability to depression in a sample of early adolescents. These findings are consistent with those reported in an earlier taxometric investigation with an adult sample drawing on self-report measures (Gibb et al., 2004). Additionally, invariance in the strength of the association between cognitive vulnerability and depression across different populations in prior studies has been interpreted as suggestive of dimensionality in cognitive vulnerability to depression (Phillips, Hine, & Thorsteinsson, 2010). The results of the current

[1] The ACSQ-M consequences was highly correlated with ACSQ-M globality-stability and self-characteristics ($rs \geq .66$), respectively and so was removed from consideration. SRET negative recall also was removed, being weakly correlated with CSRQ rumination, ACSQ globality-stability, and ACSQ-M self-characteristics ($rs \leq .10$).

[2] Also of note, 12.8% of the sample experienced a major or minor depressive episode (4.5% in the case of only major depression) within the first 12 months of assessment.

investigation provide direct support for this interpretation.

The current findings also have implications for theoretical understandings of cognitive vulnerability to depression. That is, they inform the literature regarding diathesis-stress conceptualizations of this disorder (Ingram & Luxton, 2005; Monroe & Simons, 1991), such as the aforementioned cognitive theories of depression. The dichotomous diathesis-stress model holds that the vulnerability factor of interest exists as a discontinuous entity, with individuals either possessing the vulnerability or not (Ingram & Luxton). Within a pure interaction framework, the implication of this interpretation is that, in the absence of other vulnerabilities, cognitive vulnerability is a necessary condition for depression to manifest, and stress only exerts a deleterious influence in the presence of this diathesis. The current findings are inconsonant with this interpretation in the case of cognitive vulnerability to depression. According to a second perspective, the vulnerability threshold model (Meiser & Esser, 2017), or a variation of it, the quasi-continuous diathesis model (Ingram & Luxton),[3] risk for depression is only conferred above a certain level of the diathesis. As in the case of dichotomous diathesis-stress models, stress does not exert a main effect on depression in the absence of other vulnerabilities and its pathogenic effect is only apparent after the diathetic threshold is met. Although this model describes the diathesis as falling along a spectrum, the presence of a critical threshold in its discontinuous relation with depression is consistent with a taxonic vulnerability, with a discrete threshold qualitatively separating individuals at risk for this disorder from those who are not. The findings of the current study do not support this view.

A contrasting position that has garnered substantial interest is that both vulnerability and stress operate in a graded manner, such that as the diathetic loading increases, the level of stress required to precipitate depression decreases, and conversely as stress increases, a less severe diathesis is necessary for depression to occur (Monroe & Simons, 1991). Of note, the hopelessness theory (Abramson et al., 1989) explicitly subscribes to this titration model. Our findings that cognitive vulnerability to depression exists along a continuum of severity align well with this interpretation. These findings and their support for the titration model have important clinical implications. In particular, our results underscore the challenge of screening and prevention efforts involving identification of at-risk individuals. Unlike taxonic models of cognitive vulnerability, in which such individuals may be categorically identified, dimensional vulnerability factors such as articulated in the titration model and observed in the current study imply that it is possible for depression to develop even at low diathetic loadings. Thus, there is the risk, in attempting to establish a cut-point for classifying individuals based on cognitive vulnerability, that some individuals who eventually develop depression may be missed. Although such cut-points may be adopted for screening purposes from a practical standpoint, appropriate caution should be taken in their interpretation.

Also important to consider are the implications of the current findings for research on the study of cognitive vulnerability to depression. Cut-points on vulnerability measures are used in certain research contexts, perhaps one of the most prominent examples of which is high-risk designs. With high-risk research designs, prospective participants who do not have the disorder in question are screened for being high and low on vulnerability factors for the disorder (see Carter & Garber, 2011; Just, Abramson, & Alloy, 2001). Several examples exist of this approach with respect to vulnerability factors for depression (e.g., the Temple-Wisconsin Cognitive Vulnerability to Depression Project; Alloy et al., 2000; the Northwestern-UCLA Youth Emotion Project; Zinbarg et al., 2010). One reason for the adoption of high-risk research designs is to increase the chance of prospectively capturing a sufficient number of cases of a relatively low base rate phenomenon for statistically powered analyses, with a smaller sample than would otherwise be required, thereby increasing feasibility when resources may be limited. An additional advantage of high-risk designs is that the greater variability in vulnerability constructs they often afford yields greater statistical power to detect the presence of moderating effects by reducing standard errors without compromising parameter estimates (Carter & Garber, 2011; McClelland & Judd, 1993). It should be noted that a dimensional latent structure for a given vulnerability to depression does not invalidate its use in a high-risk design or negate the aforementioned advantages it confers. Indeed, it supports the view that a meaningful range in variability in the vulnerability construct may be achieved by selecting individuals who score high and low on measures of the construct. A dimensional solution for the vulnerability construct, however, also points to the importance of recognizing that the cut-points used in such studies are

[3] This model differs from the vulnerability threshold model in that although both models posit the existence of a taxonic diathesis, the quasi-continuous diathesis model also holds that there is meaningful dimensionality *within* the taxon.

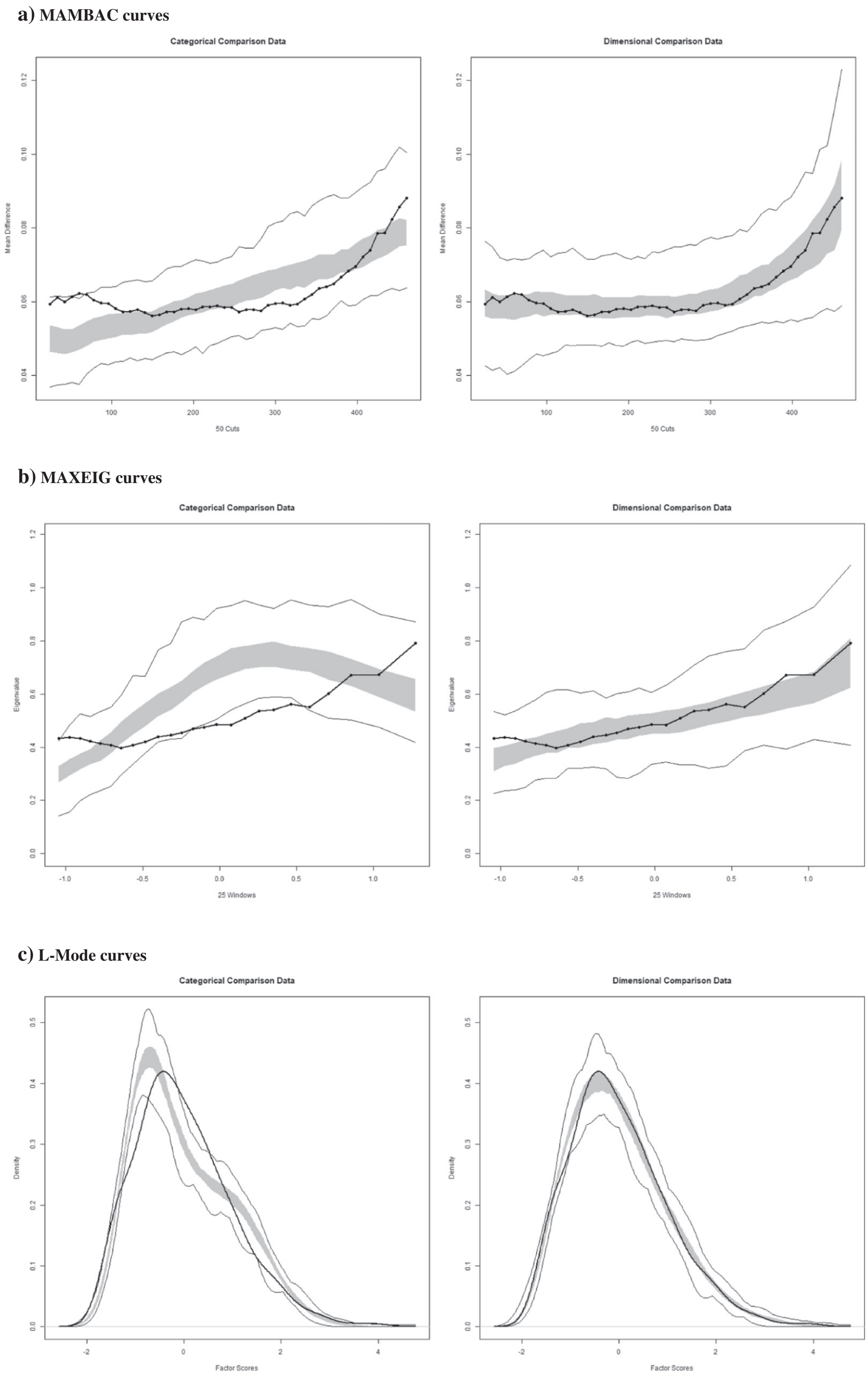

FIGURE 1 Taxometric results with sample data shown relative to simulated taxonic and dimensional data. In each graph, the average curve for the sample data are represented by a dark line, with the gray area reflecting the middle 50% of the simulated values, and the light lines indicating the minimum and maximum simulated values at each data-point. The top panels illustrate results for averaged MAMBAC curves (1a), the middle panels portray averaged MAXEIG curves (1b), and the bottom panels depict results for averaged L-Mode curves (1c).

artificial ones, that they should be interpreted accordingly, and that their adoption is guided largely by practical considerations centering on feasibility and statistical power.

With regards to clinical implications, the adoption of screening measures of cognitive vulnerability is important so as to identify those at risk for depression and to intervene with these individuals prior to depression onset. The current findings do not necessarily indicate that cut-points should be avoided in the screening of risk. They indicate that any attempt to dichotomize individuals based on cognitive vulnerability creates largely artificial and arbitrary distinctions, and thus, that cut-points should be regarded with some measure of caution. That is, although a cut-point in cognitive vulnerability is still of potential practical utility for screening purposes, care should be taken in clinical settings not to mistake the cut-point as reflective of a true dichotomy. In addition to informing the use of screening measures of cognitive vulnerability in preventive intervention strategies, the current findings suggest that assessments of therapeutic change in cognitive risk for depression may benefit from viewing this change as falling along a continuum rather than being characterized by a qualitatively distinct change from at risk to being outside of risk.

Beyond their research and clinical implications for depression, the current findings may also have relevance to our understanding of cognitive vulnerability for psychopathology more broadly. That is, although some aspects of cognitive vulnerability studied here (e.g., as conceptualized within the hopelessness theory of depression) have received some mixed support for specificity to depression (Hankin, Abramson, Miller, & Haeffel, 2004; Liu et al., 2015), there is evidence that certain elements of cognitive vulnerability (e.g., rumination, McLaughlin & Nolen-Hoeksema, 2011; and negative self-referential processing, Mennin & Fresco, 2013) may be transdiagnostic in nature.

A unique strength of the current study is its multimethod assessment of several distinct indices of cognitive vulnerability to depression to derive taxometric indicators for analysis. It should be noted, however, that additional research is necessary to be able to generalize to all aspects of cognitive vulnerability to depression. For instance, future research should examine the latent structure of other markers of cognitive vulnerability to depression (e.g., cognitive control, overgeneral autobiographical memory) to further establish reliability of the current findings. Furthermore, future research could build on these findings through utilizing additional methods of assessment, such as by including neural indices of cognitive vulnerability (e.g., Ray et al., 2005), thus addressing the need for greater adoption of multiple levels of analysis in depression vulnerability research (Hankin, 2012).

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

References

Abela, J. R. Z., & Sarin, S. (2002). Cognitive vulnerability to hopelessness depression: A chain is only as strong as its weakest link. *Cognitive Therapy and Research*, *26*, 811–829. https://doi.org/10.1023/A:1021245618183

Abela, J. R. Z., Vanderbilt, E., & Rochon, A. (2004). A test of the integration of the response styles and social support theories of depression in third and seventh grade children. *Journal of Social and Clinical Psychology*, *23*, 653–674. https://doi.org/10.1521/jscp.23.5.653.50752

Abramson, L. Y., Metalsky, G. I., & Alloy, L. B. (1989). Hopelessness depression: A theory-based subtype of depression. *Psychological Review*, *96*, 358–372. https://doi.org/10.1037/0033-295X.96.2.358

Alloy, L. B., Abramson, L. Y., Hogan, M. E., Whitehouse, W. G., Rose, D. T., Robinson, M. S., Kim, R. S., et al. (2000). The Temple-Wisconsin Cognitive Vulnerability to Depression Project: Lifetime history of Axis I psychopathology in individuals at high and low cognitive risk for depression. *Journal of Abnormal Psychology*, *109*, 403–418. https://doi.org/10.1037/0021-843X.109.3.403

Alloy, L. B., Black, S. K., Young, M. E., Goldstein, K. E., Shapero, B. G., Stange, J. P., Boccia, A. S., et al. (2012). Cognitive vulnerabilities and depression versus other psychopathology symptoms and diagnoses in early adolescence. *Journal of Clinical Child and Adolescent Psychology*, *41*, 539–560. https://doi.org/10.1080/15374416.2012.703123

Beauchaine, T. P., & Waters, E. (2003). Pseudotaxonicity in MAMBAC and MAXCOV analyses of rating-scale data: Turning continua into classes by manipulating observer's expectations. *Psychological Methods*, *8*, 3–15. https://doi.org/10.1037/1082-989X.8.1.3

Beck, A. T. (1967). *Depression: Clinical, experimental, and theoretical aspects*. New York: Harper & Row.

Beck, A. T. (1987). Cognitive models of depression. *Journal of Cognitive Psychotherapy*, *1*, 5–37.

Beck, A. T., & Haigh, E. A. P. (2014). Advances in cognitive theory and therapy: The generic cognitive model. *Annual Review of Clinical Psychology*, *10*, 1–24. https://doi.org/10.1146/annurev-clinpsy-032813-153734

Carter, J. S., & Garber, J. (2011). Predictors of the first onset of a major depressive episode and changes in depressive symptoms across adolescence: Stress and negative cognitions. *Journal of Abnormal Psychology*, *120*, 779–796. https://doi.org/10.1037/a0025441

Cole, D. A. (1991). Change in self-perceived competence as a function of peer and teacher evaluation. *Developmental Psychology*, *27*, 682–688. https://doi.org/10.1037/0012-1649.27.4.682

Cole, D. A., Maxwell, S. E., Martin, J. M., Peeke, L. G., Seroczynski, A. D., Tram, J. M., Hoffman, K. B., et al. (2001). The development of multiple domains of child and adolescent self-concept: A cohort sequential longitudinal design. *Child Development*, *72*, 1723–1746. https://doi.org/10.1111/1467-8624.00375

Derry, P. A., & Kuiper, N. A. (1981). Schematic processing and self-reference in clinical depression. *Journal of Abnormal Psychology*, *90*, 286–297. https://doi.org/10.1037/0021-843X.90.4.286

Gibb, B. E., Alloy, L. B., Abramson, L. Y., Beevers, C. G., & Miller, I. W. (2004). Cognitive vulnerability to depression: A taxometric analysis. *Journal of Abnormal Psychology*, *113*, 81–89. https://doi.org/10.1037/0021-843X.113.1.81

Hankin, B. L. (2012). Future directions in vulnerability to depression among youth: Integrating risk factors and processes across multiple levels of analysis. *Journal of Clinical Child and Adolescent Psychology*, *41*, 695–718. https://doi.org/10.1080/15374416.2012.711708

Hankin, B. L., & Abela, J. R. Z. (2005). Depression from childhood through adolescence and adulthood: A developmental vulnerability-stress perspective. In B. L. Hankin, & J. R. Z. Abela (Eds.), *Development of psychopathology: A vulnerability-stress perspective* (pp. 245–288). Thousand Oaks, CA: Sage Publications.

Hankin, B. L., Abramson, L. Y., Miller, N., & Haeffel, G. J. (2004). Cognitive vulnerability-stress theories of depression: Examining affective specificity in the prediction of depression versus anxiety in three prospective studies. *Cognitive Therapy and Research*, *28*, 309–345. https://doi.org/10.1023/B:COTR.0000031805.60529.0d

Hankin, B. L., Fraley, R. C., Lahey, B. B., & Waldman, I. D. (2005). Is depression best viewed as a continuum or discrete category? A taxometric analysis of childhood and adolescent depression in a population-based sample. *Journal of Abnormal Psychology*, *114*, 96–110. https://doi.org/10.1037/0021-843X.114.1.96

Hasin, D. S., Goodwin, R. D., Stinson, F. S., & Grant, B. F. (2005). Epidemiology of major depressive disorder: Results from the National Epidemiologic Survey on Alcoholism and Related Conditions. *Archives of General Psychiatry*, *62*, 1097–1106. https://doi.org/10.1001/archpsyc.62.10.1097

Haslam, N., Holland, E., & Kuppens, P. (2012). Categories versus dimensions in personality and psychopathology: A quantitative review of taxometric research. *Psychological Medicine*, *42*, 903–920. https://doi.org/10.1017/S0033291711001966

Ingram, R. E., & Luxton, D. D. (2005). Vulnerability-stress models. In B. L. Hankin, & J. R. Z. Abela (Eds.), *Development of psychopathology: A vulnerability-stress perspective* (pp. 32–46). Thousand Oaks, CA: Sage Publications.

Just, N., Abramson, L. Y., & Alloy, L. B. (2001). Remitted depression studies as tests of the cognitive vulnerability hypotheses of depression onset: A critique and conceptual analysis. *Clinical Psychology Review*, *21*, 63–83. https://doi.org/10.1016/S0272-7358(99)00035-5

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Koretz, D., Merikangas, K. R., Rush, A. J., et al. (2003). The epidemiology of major depressive disorder: Results from the National Comorbidity Survey Replication (NCS-R). *JAMA*, *289*, 3095–3105. https://doi.org/10.1001/jama.289.23.3095

Liu, R. T. (2016). Taxometric evidence of a dimensional latent structure for depression in an epidemiological sample of children and adolescents. *Psychological Medicine*, *46*, 1265–1275. https://doi.org/10.1017/S0033291715002792

Liu, R. T., Kleiman, E. M., Nestor, B. A., & Cheek, S. M. (2015). The hopelessness theory of depression: A quarter-century in review. *Clinical Psychology: Science and Practice*, *22*, 345–365. https://doi.org/10.1111/cpsp.12125

Mac Giollabhui, N., Hamilton, J. L., Nielsen, J., Connolly, S. L., Stange, J. P., Varga, S., Burdette, E., et al. (2018). Negative cognitive style interacts with negative life events to predict first onset of a major depressive episode in adolescence via hopelessness. *Journal of Abnormal Psychology*, *127*, 1–11. https://doi.org/10.1037/abn0000301

McClelland, G. H., & Judd, C. M. (1993). Statistical difficulties of detecting interactions and moderator effects. *Psychological Bulletin*, *114*, 376–390. https://doi.org/10.1037/0033-2909.114.2.376

McLaughlin, K. A., & Nolen-Hoeksema, S. (2011). Rumination as a transdiagnostic factor in depression and anxiety. *Behaviour Research and Therapy*, *49*, 186–193. https://doi.org/10.1016/j.brat.2010.12.006

Meehl, P. E. (1992). Factors and taxa, traits and types, differences of degree and differences in kind. *Journal of Personality*, *60*, 117–174. https://doi.org/10.1111/j.1467-6494.1992.tb00269.x

Meehl, P. E. (1995). Bootstraps taxometrics: Solving the classification problem in psychopathology. *American Psychologist*, *50*, 266–275. https://doi.org/10.1037/0003-066X.50.4.266

Meehl, P. E., & Yonce, L. J. (1994). Taxometric analysis: I. Detecting taxonicity with two quantitative indicators using means above and below a sliding cut (MAMBAC procedure). *Psychological Reports*, *74*, 1059–1274. https://doi.org/10.2466/pr0.1996.78.3c.1091

Meehl, P. E., & Yonce, L. J. (1996). Taxometric analysis: II. Detecting taxonicity using covariance of two quantitative indicators in successive intervals of a third indicator (Maxcov procedure). *Psychological Reports*, *78*, 1091–1227. https://doi.org/10.2466/pr0.1996.78.3c.1091

Meiser, S., & Esser, G. (2017). How dysfunctional are dysfunctional attitudes? A threshold model of dysfunctional attitudes and depressive symptoms in children and adolescents. *Cognitive Therapy and Research*, *41*, 730–744. https://doi.org/10.1007/s10608-017-9842-0

Mennin, D. S., & Fresco, D. M. (2013). What, me worry and ruminate about DSM-5 and RDoC? The importance of targeting negative self-referential processing. *Clinical Psychology: Science and Practice*, *20*, 258–267. https://doi.org/10.1111/cpsp.12038

Monroe, S. M., & Simons, A. D. (1991). Diathesis-stress theories in the context of life stress research: Implications for the depressive disorders. *Psychological Bulletin*, *110*, 406–425. https://doi.org/10.1037/0033-2909.110.3.406

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology*, *100*, 569–582. https://doi.org/10.1037/0021-843X.100.4.569

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science*, *3*, 400–424. https://doi.org/10.1111/j.1745-6924.2008.00088.x

Phillips, W. J., Hine, D. W., & Thorsteinsson, E. B. (2010). Implicit cognition and depression: A meta-analysis. *Clinical Psychology Review*, *30*, 691–709. https://doi.org/10.1016/j.cpr.2010.05.002

Ray, R. D., Ochsner, K. N., Cooper, J. C., Robertson, E. R., Gabrieli, J. D. E., & Gross, J. J. (2005). Individual differences in trait rumination and the neural systems supporting cognitive reappraisal. *Cognitive, Affective, & Behavioral Neuroscience*, *5*, 156–168. https://doi.org/10.3758/CABN.5.2.156

Richey, J. A., Schmidt, N. B., Lonigan, C. J., Phillips, B. M., Catanzaro, S. J., Laurent, J., Gerhardstein, R. R., et al. (2009). The latent structure of child depression: A taxometric analysis. *Journal of Child Psychology and Psychiatry*, *50*, 1147–1155. https://doi.org/10.1111/j.1469-7610.2009.02085.x

Ruscio, A. M. (2010). The latent structure of social anxiety disorder: Consequences of shifting to a dimensional diagnosis. *Journal of Abnormal Psychology*, *119*, 662–671. https://doi.org/10.1037/a0019341

Ruscio, J. (2013). *Taxometric programs for the R computing environment: User's manual*.

Ruscio, J., & Kaczetow, W. (2009). Differentiating categories and dimensions: evaluating the robustness of taxometric analyses. *Multivariate Behavioral Research*, *44*, 259–280. https://doi.org/10.1080/00273170902794248

Ruscio, J., Brown, T. A., & Ruscio, A. M. (2009). A taxometric investigation of DSM-IV major depression in a large outpatient sample: Interpretable structural results depend on the mode of assessment. *Assessment*, *16*, 127–144. https://doi.org/10.1177/1073191108330065

Ruscio, J., Haslam, N., & Ruscio, A. M. (2006). *Introduction to the taxometric method: A practical guide*. Mahwah, NJ: Lawrence Erlbaum Associates.

Ruscio, J., Walters, G. D., Marcus, D. K., & Kaczetow, W. (2010). Comparing the relative fit of categorical and dimensional latent variable models using consistency tests. *Psychological Assessment*, *22*, 5–21. https://doi.org/10.1037/a0018259

Solomon, A., Ruscio, J., Seeley, J. R., & Lewinsohn, P. M. (2006). A taxometric investigation of unipolar depression in a large community sample. *Psychological Medicine*, *36*, 973–985. https://doi.org/10.1017/S0033291706007689

Tram, J. M., & Cole, D. A. (2000). Self-perceived competence and the relation between life events and depressive symptoms in adolescence: Mediator or moderator? *Journal of Abnormal Psychology*, *109*, 753–760. https://doi.org/10.1037/0021-843X.109.4.753

Uhrlass, D. J., & Gibb, B. E. (2007). Negative life events, self-perceived competence, and depressive symptoms in young adults. *Cognitive Therapy and Research*, *31*, 773–783. https://doi.org/10.1007/s10608-006-9101-2

US Burden of Disease Collaborators. (2013). The state of US health, 1990-2010: Burden of diseases, injuries, and risk factors. *JAMA*, *310*, 591–608. https://doi.org/10.1001/jama.2013.13805

Waller, N., & Meehl, P. E. (1998). *Multivariate taxometric procedures: Distinguishing types from continua. Advanced Quantitative Techniques in the Social Sciences*, *9*. (pp.) Thousand Oaks, CA: Sage Publications.

Walters, G. D. (2008). The latent structure of alcohol use disorders: A taxometric analysis of structured interview data obtained from male federal prison inmates. *Alcohol and Alcoholism*, *43*, 326–333. https://doi.org/10.1093/alcalc/agm165

Walters, G. D., & Ruscio, J. (2010). Where do we draw the line? Assigning cases to subsamples for MAMBAC, MAXCOV, and MAXEIG taxometric analyses. *Assessment*, *17*, 321–333. https://doi.org/10.1177/1073191109356539

Walters, G. D., & Ruscio, J. (2013). Trajectories of youthful antisocial behavior: categories or continua? *Journal of Abnormal Child Psychology*, *41*, 653–666. https://doi.org/10.1007/s10802-012-9700-1

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., Charlson, F. J., et al. (2013). Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *Lancet*, *382*, 1575–1586. https://doi.org/10.1016/S0140-6736(13)61611-6

Zinbarg, R. E., Mineka, S., Craske, M. G., Griffith, J. W., Sutton, J., Rose, R. D., Nazarian, M., et al. (2010). The Northwestern-UCLA youth emotion project: Associations of cognitive vulnerabilities, neuroticism and gender with past diagnoses of emotional disorders in adolescents. *Behaviour Research and Therapy*, *48*, 347–358. https://doi.org/10.1016/j.brat.2009.12.008

Received: June 22, 2018
Accepted: November 27, 2018
Available online: 6 December 2018