The Rutgers Alcohol Problem Index for Adolescent Alcohol and Drug Problems: A Comprehensive Modern Psychometric Study

YUSUKE SHONO, PH.D.,^{a,*} SUSAN L. AMES, PH.D.,^b MICHAEL C. EDWARDS, PH.D.,^c & ALAN W. STACY, PH.D.^b

^a*Department of Psychiatry and Behavioral Sciences, University of Washington School of Medicine, Seattle, Washington*

^b*School of Community and Global Health, Claremont Graduate University, Claremont, California*

^c*Department of Psychology, Arizona State University, Tempe, Arizona*

ABSTRACT. Objective: The Rutgers Alcohol Problem Index (RAPI) has been used extensively as a measure of alcohol-related problems experienced by adolescents and young adults. The present study aimed to comprehensively examine the psychometric profile and criterion-related validity of an 18-item RAPI adapted to measure negative consequences resulting from alcohol and other drug use in an at-risk adolescent population. **Method:** Categorical confirmatory factor analysis and the graded response model were used for evaluations of the latent factor structure, item properties, test information, and item invariance across gender, age groups (middle vs. late adolescence), and drug use profiles (readily available drugs vs. other illicit drugs), as well as computation of the item response theory scale scores for each of 617 alternative high

school students (44% female). **Results:** A reduced set of 16 RAPI items provided plausible evidence of unidimensionality and good measurement precision at a relatively wide range of the latent trait continuum. All but two items were invariant across the drug use profiles. The other illicit drug group had higher levels of the latent substance-related problems than the readily available drug group. Criterion-related validity was supported using a measure of past-year polysubstance use. **Conclusions:** The RAPI can be effectively modified to measure negative consequences resulting from alcohol and other drug use and reflects a sufficiently wide range of the latent continuum of problem use. (*J. Stud. Alcohol Drugs*, 79, 658–663, 2018)

THE RUTGERS ALCOHOL PROBLEM INDEX (RAPI; White & Labouvie, 1989) was originally developed to assess alcohol-related problems and has been adapted to measure negative consequences from use of other substances including marijuana (Simons et al., 2000, 2005) and general drug use (Ginzler et al., 2007; Peterson et al., 2006; Willem et al., 2014). In the RAPI, respondents are asked about the frequency of occurrence of negative experiences because of their use of a target substance. Total composite scores, considered reflective of the severity of target substance-related problems, have been used as an outcome measure in clinical trials (Larimer et al., 2007; Martens et al., 2013), in etiological studies (Lindgren et al., 2016; Thush et al., 2007), and as a predictive measure of alcohol-related diagnosis (Dick et al. 2011).

Despite the wide use of RAPIs in research, only a limited number of studies have conducted comprehensive psychometric evaluations using modern psychometric methods such as item response theory (IRT) modeling. Further, the few IRT-based psychometric investigations focused exclusively

on alcohol-related problems (Cohn et al., 2011; Neal et al., 2006). To fill the gap, this study used modern psychometric approaches to evaluate a range of psychometric characteristics of the RAPI adapted to assess substance-related negative consequences.

There are good reasons to focus on the measurement of negative consequences resulting from substance use in general, beyond the use of particular substances. First, widespread adolescent polysubstance use (Conway et al., 2013) may make it difficult for respondents to differentially remember negative consequences from a specific substance. Uncertainty may be minimized by asking about negative events resulting from the use of any substance. Second, despite the use of the modified RAPI assessing general substance-related problems (Peterson et al., 2006; Willem et al., 2014), only one study to date has evaluated the psychometric properties of the substance-related RAPI. In a study with a homeless adolescent sample, Ginzler et al. (2007) obtained strong internal consistency reliability and evidence of concurrent validity with substance use outcomes. These findings are informative, but modern psychometric methods allow for more comprehensive psychometric evaluations.

The overarching goal of this study was to evaluate and refine psychometric characteristics of an 18-item RAPI assessing negative consequences from general substance use among alternative high school (AHS)¹ students known to be

Received: June 2, 2017. Revision: February 2, 2018.

This work was supported by National Institute on Drug Abuse Grants DA024659 and DA023368 and National Institute on Alcohol Abuse and Alcoholism Grant AA007455.

*Correspondence may be sent to Yusuke Shono at the Department of Psychiatry and Behavioral Sciences, University of Washington School of Medicine, 1100 NE 45th Street, Suite 300, Box 354944, Seattle, WA 98195, or via email at: ys138@uw.edu.

¹AHS is also known as a continuation high school in California (Sussman et al., 2012).

susceptible to substance use problems (Grana et al., 2010; Sussman et al., 1995). Specifically, IRT measurement models were used to examine the latent structure of the item sets and item and test properties. Additionally, given that poly-substance use is associated with an increased risk of various negative consequences (Connor et al., 2014), it is crucial to assess if the RAPI items function equivalently across the type of substances being used. To answer this question, differential item functioning (DIF) tests were conducted to examine item invariance across two drug use profiles: readily available drugs (RADs) included alcohol, marijuana, and/or cigarettes, whereas other illicit drugs (OIDs) included one or more of the OIDs. Given that some RAPI items exhibited DIF across genders and age groups in studies on the original RAPI (e.g., Neal et al., 2006), DIF was also assessed across these subgroups.

Method

Participants

Data were drawn from baseline assessments of a longitudinal study of drug use and neurocognitive processes in AHS students. Students were recruited from 42 AHSs randomly selected out of more than 100 AHSs in southern California.² Students are typically referred to AHSs by school counselors, administration, or self-referral for lack of sufficient credits to graduate because of various behavioral problems including substance abuse. A total of 3,088 students were eligible for participation, of which 1,176 (49%) consented to participate. Of these, 775 (66%) took the baseline assessments. The analytical sample consisted of 617 students (44% female; 65% Hispanic) after excluding 158 students who had not used alcohol or other drugs in the past year. The mean age was 16.7 years ($SD = 0.10$) ranging from 14 to 19 years.

Measures

Substance-related negative consequences. The 18-item RAPI (White & Labouvie, 2000) was adapted to assess frequencies of various negative consequences from the use of alcohol and/or drugs in the last 6 months. The response categories were 0 (*never*), 1 (*once or twice*), 2 (*3–5 times*), and 3 (*more than 5 times*), but categories 2 and 3 were aggregated in analyses to avoid possible convergence issues in IRT parameter estimation.

Polydrug use. This study defined polydrug use as the use of multiple substances on either the same or separate occasions in the past year. It was assessed based on participants' responses to a self-reported questionnaire for

the past-year use of the following substances ($\alpha = .83$): alcohol, marijuana, cigarettes, cocaine, Ecstasy (3,4-methylenedioxymethamphetamine [MDMA]), methamphetamine, opiates, hallucinogens, inhalants, tranquilizers, and Ritalin/Adderall (Stacy et al., 1990). Responses to each substance type were dichotomized such that 0 = *not used* and 1 = *used*. Polydrug use scores were created by summing the number of substance types used in the past year (range: 1–11).

Analytic plan

IRT analyses were performed with the graded response model (GRM; Samejima, 1969) since the RAPI items had three ordered categories. In the GRM, the probability of responding in category j or above conditional on a latent trait can be modeled by slope and threshold parameters. In the RAPI, the slope parameter indicates how strongly related each RAPI item response is to latent substance-related problems. The threshold parameter represents the location on a latent continuum at which the probability of responding in category j or above is 50%. Thus, the higher the threshold, the higher the substance-related problems respondents must possess to endorse the item.

First, the IRT assumptions of unidimensionality and local independence (LI) were tested. The unidimensionality of the RAPI item sets was examined with categorical exploratory factor analysis (CEFA) and confirmatory factor analysis (CCFA). Both CEFA and CCFA models were estimated on the polychoric correlation matrix using weighted least squares with mean and variance adjustment as an estimator, with Mplus 6.11 (Muthén & Muthén, 2011). The LI assumption was tested using three methods: (a) modification indices for residual correlations in CCFA, (b) the Jackknife Slope Index (JSI; Edwards et al., 2018), and (c) the standardized local dependence chi-square statistics ($LD \chi^2$). LD was considered non-ignorable and subjected to further inspection if the modification index value exceeded 20, the summed JSI value was greater than a critical value, and/or the $LD \chi^2$ value was greater than 5.

Next, DIF tests were performed for drug use profiles (RADs vs. OIDs), gender, and age groups. The age groups represented middle adolescence (ages 14–16 years) and late adolescence (ages 17–20 years). To link the metric between subgroups, anchor items were identified using an iterative anchor purification approach (Woods et al., 2013).

The GRMs were estimated with marginal maximum likelihood with an expectation-maximization (EM) algorithm, and the latent trait estimates for each student were obtained with maximum a posteriori estimation. All the IRT and DIF analyses were performed using flexMIRT (Cai, 2012). Criterion-related validity was assessed by examining associations between latent substance-related problems and polydrug use using zero-truncated Poisson regression models.

²Selected AHSs did not provide any drug education programs to their students.

Results

Substance use³

Alcohol (71.1%), marijuana (58.6%), and cigarettes (46.8%) were the most commonly used substances during the last year. Close to half had used OIDs (44.8%). Almost two thirds of the sample were recent polysubstance users. Prevalence of past-30-day use was 53.3% for alcohol, 44% for marijuana, 35.7% for cigarettes, and 25.2% for OIDs. These numbers were comparable to past studies on AHS students (Beauvais & Oetting, 1986; Clark et al., 2010; Grana et al., 2010; Grunbaum et al., 2001).

IRT assumptions: Unidimensionality and local independence

The scree plot suggested one or two possible common factors. However, the two-factor model indicated no plausible substantive interpretations. The single-factor CCFA model fit the data well, $\chi^2(135) = 327.79$, $p < .01$, Tucker–Lewis Index = .977, and root mean square error of approximation (RMSEA) = .047 with 90% CI [.041, .054], suggesting sufficient evidence of unidimensionality of the RAPI item set. The LD detection procedure revealed one possible LD item pair (“Got into fights with other people” and “Caused shame or embarrassment to someone”). Because these items were similar in their content as related to social interaction problems from substance use, they were determined likely LD, and the latter item was set aside from subsequent analyses. “Tried to control your use of alcohol or other drugs” was identified as a misfit item ($S - \chi^2 = 76.6$, $p = .005$) and was excluded from subsequent model fitting. With the reduced set of 16 RAPI items, the fit of the single-factor CCFA remained good. CTT-based analyses revealed strong inter-item reliability ($\alpha = .91$). The item-total correlations ranged between .48 and .70.

Differential item functioning

Across drug use profiles, the two items (“Went to work or school high” and “Noticed a change in your personality”) showed significant threshold DIF. For example, the RAD group would have to be experiencing a higher level of substance-related problems than the OID group to have equal probability of having gone to work or school high at least three times in the last 6 months. No item indicated evidence of DIF across gender and age groups.

Multiple-group graded response model

A multiple-group GRM, modeled to account for the two DIF items, showed an acceptable fit (RMSEA = .03). As

depicted in Figure 1, all 16 items were strongly related to the latent trait ($1.18 < a < 2.80$). The threshold parameter b_1 ranged from -0.83 to 0.83 for the RADs and from -1.00 to 0.83 for the OIDs, providing varying levels of latent substance-related problems at which the probability of selecting category 1 (*once or twice*) or higher was 0.5. Similarly, b_2 covered a good range of the latent trait where the probability of selecting category 2 (*three or more times*) was 0.5. The latent mean of substance-related problems for the RADs was about 1 SD below that of the OIDs ($Z = -10.63$, $p < .001$). Figure 2 shows that the substance-related RAPI was most informative in measuring the latent trait at approximately a half SD above the mean latent trait level.

Criterion-related validity

A zero-truncated Poisson regression model indicated that the higher the latent substance-related problems, the greater the number of substance types ($\beta = .44$, $p < .0001$). The number of substance types used among the RAD users was predicted to be 1.35 ($\beta = .30$, $p < .0001$), and the OID users would be expected to use approximately four times as many substance types as would the RAD users ($\beta = 1.38$, $p < .0001$).

Discussion

This first comprehensive psychometric evaluation of the substance-related RAPI provided multiple lines of evidence supporting the usefulness of this assessment. Our analyses included 16 of the 18 RAPI items because of LD and item misfit. Regarding an LD item pair (“Got into fights with other people” and “Caused shame or embarrassment to someone”), the latter item may have shown LD because it was primarily endorsed in adolescents who got in fights; the two items likely assessed memory for the same aggressive and embarrassing event and were thus redundant. Regarding the misfit item (“Tried to control your use of alcohol or other drugs”), it is possible that many adolescents do not yet appreciate, or have not yet experienced, loss of control. Thus, this item simply did not fit in the present sample.

The substance-related RAPI data were sufficiently unidimensional, consistent with previous studies on the original RAPI (Cohn et al., 2011; Neal et al., 2006). However, Martens et al. (2007) presented a three-factor model (dependent symptoms, social consequences, and personal consequences) of the original RAPI. All the RAPI items contributed to the measurement of latent substance-related problems and covered a good range of the latent trait. “Got into fights with other people” and “Neglected your responsibilities” represented the two most probable items to be endorsed among the entire at-risk adolescent sample, and “Went to work or school high” was the easiest among the OID users. Adolescents with the mean latent trait level were most likely

³Substance use reported here was based on the entire sample of AHS students ($N = 775$).

FIGURE 1. Trace lines for the revised substance-related RAPI items. The x-axes indicate the level of the latent trait of substance-related problems. The y-axes indicate the probability of selecting each RAPI category. Note that Items 4 and 11 were DIF items, and the trace lines were shown separately for the other illicit drug group (solid) and readily available drug group (dashed).

to have gotten into fights and neglected their responsibilities once or twice in the past 6 months. In contrast, “Relatives avoided you” and “Passed out or fainted suddenly” were among the most difficult items. These results suggest that personal and social problems resulting from substance use tend to be experienced even by those with relatively lower latent trait levels, whereas items denoting alcohol depen-

dence require higher levels of the latent trait to be endorsed. Similar findings were reported in previous studies in a college population (Cohn et al., 2011; Neal et al., 2006). Except two items exhibiting substance type DIF, all the RAPI items functioned equivalently across gender, age groups, and drug use profiles. In the adolescent sample, the RAPI items appear relatively bias free regardless of a target substance. The

FIGURE 2. Test information function (TIF; solid line) and standard error function (dashed line) for the other illicit drug group. The x-axis represents the level of theta, or the latent trait of substance-related problems, with 0 representing the mean level of theta. The y-axis on the left represents the amount of information (I), an index of how precisely the RAPI estimates the latent trait at every level of theta. The y-axis on the right displays standard error of estimation, which is the inverse of the square root of test information. Although not shown, TIF for the readily available drug group was almost identical to the one for the other illicit drug group.

other IRT-based DIF analyses (Neal et al., 2006) also identified only one gender DIF item (not included in the current RAPI) in a high school sample.

At the test level, the substance-related RAPI provided a good measure from moderately low to high levels of the latent trait. The results differ from those of Cohn et al. (2011) and Neal et al. (2006) in that their alcohol-related RAPIs offered slightly narrower coverages of the latent trait. It cannot be determined whether this observation reflects differences in target substances or just differences in samples (i.e., college students or adolescents). Future research should be undertaken to explore these questions. Importantly, latent mean comparisons showed that the OID group had higher levels of latent substance-related problems than the RAD group. Adolescents who had used a variety of substances, including hard drugs, are likely to experience more negative consequences as a result of their substance use. To support this idea, latent substance-related problems was found to be positively correlated with past-year polysubstance use. This finding adds to previous research reporting associations between negative consequences and polysubstance use (Connor et al., 2014). These findings also underscore the importance of interventions in adolescent populations (Sussman et al., 2012), especially those that have been repeatedly found to report high levels of drug use (Sussman et al., 1997).

Several limitations should be noted. This study considered only a reflective measurement model assuming that the latent substance-related problems caused variations in item response patterns. However, Arterberry et al. (2016) elegantly presented a formative measurement model of the original RAPI as an alternative framework that should be considered

in future research. Also, polydrug use in the present study was measured by the number of substance types used while not taking into account frequency and consumption quantity. Finally, results can be generalized only to the population of AHS students. Despite these caveats, this study has comprehensively demonstrated that the RAPI can be effectively modified to measure negative consequences resulting from substance use in general. The substance-related RAPI provides measurement precision at a relatively wide range of the latent trait continuum.

Acknowledgment

The authors thank Amy Custer for her work on this project.

References

- Arterberry, B. J., Chen, T. H., Vergés, A., Bollen, K. A., & Martens, M. P. (2016). How should alcohol problems be conceptualized? Causal indicators within the Rutgers Alcohol Problem Index. *Evaluation & the Health Professions, 39*, 356–378. doi:10.1177/0163278715616440
- Beauvais, F., & Oetting, E. R. (1986). Drug use in an alternative high school. *Journal of Drug Education, 16*, 43–50. doi:10.2190/NPKN-6Q2V-FFYP-UKBK
- Cai, L. (2012). *flexMIRT: A numerical engine for multilevel item factor analysis and test scoring* [Computer software]. Seattle, WA: Vector Psychometric Group.
- Clark, H. K., Ringwalt, C. L., Hanley, S., Shamblen, S. R., Flewelling, R. L., & Hano, M. C. (2010). Project SUCCESS effects on the substance use of alternative high school students. *Addictive Behaviors, 35*, 209–217. doi:10.1016/j.addbeh.2009.10.004
- Cohn, A. M., Hagman, B. T., Graff, F. S., & Noel, N. E. (2011). Modeling the severity of drinking consequences in first-year college women: An item response theory analysis of the Rutgers Alcohol Problem Index. *Journal of Studies on Alcohol and Drugs, 72*, 981–990. doi:10.15288/jsad.2011.72.981
- Connor, J. P., Gullo, M. J., White, A., & Kelly, A. B. (2014). Polysubstance use: Diagnostic challenges, patterns of use and health. *Current Opinion in Psychiatry, 27*, 269–275. doi:10.1097/YCO.0000000000000069
- Conway, K. P., Vullo, G. C., Nichter, B., Wang, J., Compton, W. M., Iannotti, R. J., & Simons-Morton, B. (2013). Prevalence and patterns of polysubstance use in a nationally representative sample of 10th graders in the United States. *Journal of Adolescent Health, 52*, 716–723. doi:10.1016/j.jadohealth.2012.12.006
- Dick, D. M., Aliev, F., Viken, R., Kaprio, J., & Rose, R. J. (2011). Rutgers Alcohol Problem Index scores at age 18 predict alcohol dependence diagnoses 7 years later. *Alcoholism: Clinical and Experimental Research, 35*, 1011–1014. doi:10.1111/j.1530-0277.2010.01432.x
- Edwards, M. C., Houts, C. R., & Cai, L. (2018). A diagnostic procedure to detect departures from local independence in item response theory models. *Psychological Methods, 23*, 138–149. doi:10.1037/met0000121
- Ginzler, J. A., Garrett, S. B., Baer, J. S., & Peterson, P. L. (2007). Measurement of negative consequences of substance use in street youth: An expanded use of the Rutgers Alcohol Problem Index. *Addictive Behaviors, 32*, 1519–1525. doi:10.1016/j.addbeh.2006.11.004
- Grana, R. A., Black, D., Sun, P., Rohrbach, L. A., Gunning, M., & Sussman, S. (2010). School disrepair and substance use among regular and alternative high school students. *Journal of School Health, 80*, 387–393. doi:10.1111/j.1746-1561.2010.00518.x
- Grunbaum, J. A., Lowry, R., & Kann, L. (2001). Prevalence of health-related behaviors among alternative high school students as compared with

- students attending regular high schools. *Journal of Adolescent Health*, 29, 337–343. doi:10.1016/S1054-139X(01)00304-4
- Larimer, M. E., Lee, C. M., Kilmer, J. R., Fabiano, P. M., Stark, C. B., Geisner, I. M., . . . Neighbors, C. (2007). Personalized mailed feedback for college drinking prevention: A randomized clinical trial. *Journal of Consulting and Clinical Psychology*, 75, 285–293. doi:10.1037/0022-006X.75.2.285
- Lindgren, K. P., Neighbors, C., Teachman, B. A., Baldwin, S. A., Norris, J., Kaysen, D., . . . Wiers, R. W. (2016). Implicit alcohol associations, especially drinking identity, predict drinking over time. *Health Psychology*, 35, 908–918. doi:10.1037/hea0000396
- Martens, M. P., Neighbors, C., Dams-O'Connor, K., Lee, C. M., & Larimer, M. E. (2007). The factor structure of a dichotomously scored Rutgers Alcohol Problem Index. *Journal of Studies on Alcohol and Drugs*, 68, 597–606. doi:10.15288/jsad.2007.68.597
- Martens, M. P., Smith, A. E., & Murphy, J. G. (2013). The efficacy of single-component brief motivational interventions among at-risk college drinkers. *Journal of Consulting and Clinical Psychology*, 81, 691–701. doi:10.1037/a0032235
- Muthén, B., & Muthén, L. (2011). *Mplus (Version 6.11)*. [Computer software]. Los Angeles, CA: Authors.
- Neal, D. J., Corbin, W. R., & Fromme, K. (2006). Measurement of alcohol-related consequences among high school and college students: Application of item response models to the Rutgers Alcohol Problem Index. *Psychological Assessment*, 18, 402–414. doi:10.1037/1040-3590.18.4.402
- Peterson, P. L., Baer, J. S., Wells, E. A., Ginzler, J. A., & Garrett, S. B. (2006). Short-term effects of a brief motivational intervention to reduce alcohol and drug risk among homeless adolescents. *Psychology of Addictive Behaviors*, 20, 254–264. doi:10.1037/0893-164X.20.3.254
- Samejima, F. (1969). Estimation of latent ability using a response pattern of graded scores. *Psychometrika*, 34, Supplement 1, 1–97. doi:10.1007%2FBF03372160
- Simons, J., Correia, C. J., & Carey, K. B. (2000). A comparison of motives for marijuana and alcohol use among experienced users. *Addictive Behaviors*, 25, 153–160. doi:10.1016/S0306-4603(98)00104-X
- Simons, J. S., Gaher, R. M., Correia, C. J., Hansen, C. L., & Christopher, M. S. (2005). An affective-motivational model of marijuana and alcohol problems among college students. *Psychology of Addictive Behaviors*, 19, 326–334. doi:10.1037/0893-164X.19.3.326
- Stacy, A. W., Flay, B. R., Sussman, S., Brown, K. S., Santi, S., & Best, J. A. (1990). Validity of alternative self-report indices of smoking among adolescents. *Psychological Assessment: A Journal of Consulting and Clinical Psychology*, 2, 442–446. doi:10.1037/1040-3590.2.4.442
- Sussman, S., Dent, C. W., & Galaif, E. R. (1997). The correlates of substance abuse and dependence among adolescents at high risk for drug abuse. *Journal of Substance Abuse*, 9, 241–255. doi:10.1016/S0899-3289(97)90019-5
- Sussman, S., Stacy, A. W., Dent, C. W., Simon, T. R., Galaif, E. R., Moss, M. A., . . . Johnson, C. A. (1995). Continuation high schools: Youth at risk for drug abuse. *Journal of Drug Education*, 25, 191–209. doi:10.2190/HDQH-XD21-GJT0-9G8V
- Sussman, S., Sun, P., Rohrbach, L. A., & Spruijt-Metz, D. (2012). One-year outcomes of a drug abuse prevention program for older teens and emerging adults: Evaluating a motivational interviewing booster component. *Health Psychology*, 31, 476–485. doi:10.1037/a0025756
- Thush, C., Wiers, R. W., Ames, S. L., Grenard, J. L., Sussman, S., & Stacy, A. W. (2007). Apples and oranges? Comparing indirect measures of alcohol-related cognition predicting alcohol use in at-risk adolescents. *Psychology of Addictive Behaviors*, 21, 587–591. doi:10.1037/0893-164X.21.4.587
- White, H. R., & Labouvie, E. W. (1989). Towards the assessment of adolescent problem drinking. *Journal of Studies on Alcohol*, 50, 30–37. doi:10.15288/jsa.1989.50.30
- White, H. R., & Labouvie, E. W. (2000). Longitudinal trends in problem drinking as measured by the Rutgers Alcohol Problem Index [Abstract 416]. *Alcoholism: Clinical and Experimental Research*, 24, Supplement S5, 76A.
- Willem, L., Bijttebier, P., Claes, L., Vanhalst, J., & Raes, F. (2014). The cross-temporal associations between rumination subtypes and substance use in adolescence: Exploring the moderating role of gender. *Journal of Psychopathology and Behavioral Assessment*, 36, 143–154. doi:10.1007/s10862-013-9373-2
- Woods, C. M., Cai, L., & Wang, M. (2013). The Langer-improved Wald test for DIF testing with multiple groups: Evaluation and comparison to two-group IRT. *Educational and Psychological Measurement*, 73, 532–547. doi:10.1177/0013164412464875