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Differential Associations Between Perceived and Objective Measurement of Distress Tolerance in Relation to Antiretroviral Treatment Adherence and Response Among HIV-Positive Individuals

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The present study sought to extend prior work, showing an association between self-reported distress tolerance and self-reported antiretroviral treatment (ART) adherence, by conducting a multimethod test of the association between distress tolerance and objective measures of ART adherence among a sample of 140 individuals (23.6% female) with human immunodeficiency virus (HIV). Findings indicated that, after accounting for negative affectivity and ART side-effect severity, distress tolerance was significantly associated with pill count adherence as well as viral load. Specifically, a differential association was observed whereby self-reported distress tolerance was associated with pill count adherence, whereas behavioral distress tolerance was associated with viral load. Importantly, no associations were observed between either measure of distress tolerance and CD4 count. Findings are discussed in terms of the importance of both behavioral and perceived distress tolerance assessment among patients with HIV as well as potential clinical implications related to the integration of distress tolerance-focused treatments into existing interventions for individuals with HIV.

Keywords: adherence; distress tolerance; HIV; medication

DIFFICULTY ADHERING TO LONG-TERM antiretroviral (ART) regimens is a well-established (Haynes, Ackloo, Sahota, McDonald, & Yao, 2008) and primary cause of treatment failure among individuals living with human immunodeficiency virus (HIV; Atkinson & Petrozzino, 2009). Fundamentally, patient behaviors are paramount to effective HIV management such as establishing optimal

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lifelong adherence to medications (i.e., medication regimen persistence; Volberding & Deeks, 2010), and consistent attendance at HIV clinic appointments (Mugavero, Norton, & Saag, 2011; Mugavero et al., 2009). These adherence-related behavioral requirements often occur in the face of stigma-related distress and negative affect (Blashill, Perry, & Safren, 2011; Tegger et al., 2008; Vanable, Carey, Blair, & Littlewood, 2006) and/or aversive and unwanted side effects from the medications themselves (Este & Cihlar, 2010). Indeed, the literature is rife with data indicating that ART side effects are strongly related to poor ART adherence (Al-Dakkak et al., 2012; Atkinson & Petrozzino, 2009; Protopopescu et al., 2009). In addition, there is substantial evidence that negative affect is also associated with ART nonadherence (Blashill et al., 2011; Carrico, Johnson, Colfax, & Moskowitz, 2010; Gonzalez, Batchelder, Psaros, & Safren, 2011; Johnson et al., 2003; Weaver et al., 2005). Accordingly, an inability to tolerate negative affect (including HIV-related distress) may interfere with ART adherence and persistence.

Given the enduring prevalence and clinical significance of suboptimal ART adherence among HIV-infected individuals (World Health Organization, 2010), examination of malleable transdiagnostic processes related to indices of HIV management is critical from an intervention standpoint. Distress tolerance is one such potentially important transdiagnostic variable. Here, and throughout the literature, distress tolerance is defined as perceived and/or behavioral persistence in the presence of unpleasant stressors or emotional/physical states (Simons & Gaher, 2005; Zvolensky, Leyro, Bernstein, & Vujanovic, 2011). Distress intolerance is characterized by the tendency to rapidly alleviate or escape negative emotional experiences when in crisis or distressing situations, which interferes with engaging in goal-oriented actions (Linehan, 1993; Simons & Gaher, 2005). Distress intolerance has been established within various models of problematic behaviors and psychopathology (e.g., substance use, treatment attrition, self-harm; Leyro, Zvolensky, & Bernstein, 2010; Zvolensky et al., 2011); hence its consideration as a transdiagnostic psychological vulnerability factor.

Accordingly, in the context of HIV management, one's ability to effectively tolerate distress is crucial because discomfort and/or distress are part of the treatment process and cannot be altogether avoided (Este & Cihlar, 2010; O'Cleirigh, Ironson, & Smits, 2007). Attempts to avoid discomfort and distress may lead to suboptimal ART adherence (Gonzalez et al., 2007; Heath, Singer, O'Shaughnessy, Montaner, & Hogg, 2002), with suboptimal adherence defined as less than 95% adherence to older regimens and less than 80% adherence to newer regimens (Kobin & Sheth, 2011; Martin et al., 2008). Suboptimal ART adherence may, in turn, lead to eventual increases in viral load and potential ART-resistant HIV strains (Bangsberg, Perry, et al., 2001; Bangsberg et al., 2004; Paterson et al., 2000). To illustrate, one may experience difficulty sustaining adequate medication adherence if unwilling to tolerate negative emotions resulting from being reminded of living with HIV when taking ART medications. Thus, low tolerance of unpleasant affective states or behavioral tasks may be a clinically addressable risk factor for poor ART adherence and HIV disease progression.

In addition to recent work showing perceived distress intolerance to be associated with psychological symptoms among individuals with HIV (e.g., Brandt, Zvolensky, & Bonn-Miller, in press), a study conducted by O'Cleirigh and colleagues (2007) revealed that greater perceived distress tolerance was associated with better self-reported ART adherence and HIV disease management. Although this work represents an important first step in the literature, there is a lack of data on the relation between distress tolerance and ART adherence using objective adherence measures or relying on a multimethod approach to DT assessment. As there is inherent difficulty in participants accurately identifying motives for their behavior, along with the potential for inflated correlations with shared-method variance (Lindell & Whitney, 2001), reliance on only self-report methodologies for examining distress tolerance (i.e., perceived tolerance of distress) may be problematic. As such, it is recommended to include both self-report and behavioral measures when assessing distress tolerance (Marshall-Berenz, Vujanovic, Bonn-Miller, Bernstein, & Zvolensky, 2010; McHugh et al., 2011).

To evaluate the explanatory role of distress tolerance as a transdiagnostic vulnerability factor potentially underlying several indices of HIV disease management, the present study sought to evaluate the relation between distress tolerance and ART adherence using objective measures of ART adherence, response to ART, and immunocompromise and two measures of distress tolerance (i.e., behavioral and self-report). Behavioral distress tolerance measures evoke distress "in vivo" thereby capturing one's objective capacity for tolerating distress, whereas self-report measures capture one's "perceived" capacity for tolerating aversive and unwanted psychological experiences (Zvolensky, Vujanovic, Bernstein, & Leyro, 2010).

Given the evidence that poor distress tolerance is associated with negative affectivity (Anestis et al.,

2012; Marshall-Berenz et al., 2010), and negative affectivity and ART side effects are associated with ART nonadherence (Al-Dakkak et al., 2012; Atkinson & Petrozzino, 2009; Blashill et al., 2011; Protopopescu et al., 2009; Weaver et al., 2005), we also sought to clarify the association between distress tolerance and ART adherence when controlling for negative affectivity and ART side-effect severity. We hypothesized that (a) a multimethod model of distress tolerance would be positively related to objective indices of ART adherence, response to ART, and immunocompromise (i.e., poorer distress tolerance was expected to be associated with poorer ART adherence, etc.); and (b) the effect of distress tolerance would be observed above and beyond the contribution of negative affectivity and ART side-effect severity. We also sought to explore whether the two employed measures of distress tolerance would differentially relate to the objective indices of adherence, ART response, and immunological status, given differential relations observed in past work (Marshall-Berenz et al., 2010; McHugh et al., 2011).

Method

PARTICIPANTS

Data were collected as part of a larger cross-sectional study of 180 individuals with HIV (Bonn-Miller, Oser, Bucossi, & Trafton, 2012). To be included in this study, participants had to be (a) HIV positive, (b) currently prescribed at least one ART medication, and (c) undergoing treatment at an HIV outpatient clinic. Participants were excluded from this study if (a) they were not able to provide informed, voluntary, written consent to participate; or (b) they were actively suicidal, which was ascertained during a structured clinical interview. Analyses for the present study were conducted among a subsample of 140 participants (23.6% female) representing those who completed all measures of interest for this study. Some of the participants who were missing data skipped measures and others missed items, hence the decrease in sample size for those completing all items on all study measures. We observed no differences in demographics, HIV regimen variables, or primary study variables of negative affectivity, ART side-effect severity, distress tolerance, ART adherence, viral load, CD4 cell count, or marijuana use between the larger sample of 180 participants and the sample of 140 participants used in the current study (all p values $> .05$). All participants provided informed consent. Approval for human subjects' research was obtained from the relevant affiliated IRBs.

The average age of this sample was 48.1 years (SD = 8.2) and ranged from 25 to 65. In terms of ethnicity, 41.4% of participants identified as Black/non-Hispanic, 27.9% as White/Caucasian, 11.4% as Black/Hispanic, 10.7% as Hispanic, 1.4% as Asian, and 7.1% as "Other." The majority of the sample (83.2%) graduated high school and 20.4% completed either a 2- or 4-year college degree. Based on the structured clinical interview, 84 (60%) participants met criteria for current substance abuse or dependence, 64 (45.7%) met criteria for a current anxiety disorder, and 30 (21.4%) participants met criteria for a current mood disorder.

MEASURES

Descriptive Characteristics

Demographic characteristics include age, gender, ethnicity/race, and years of education. HIV characteristics include time since HIV diagnosis, and number of ART medications. These data were collected via questionnaire and the number of ART medications was confirmed during pill count.

Structured Clinical Interview for Diagnostic and Statistical Manual–Non-Patient Version (SCID-I-N/P)

The SCID-I-N/P (First, Spitzer, Gibbon, & Williams, 1995) was administered by trained interviewer and was used to evaluate inclusion/exclusion criteria and psychiatric diagnoses. For more details on the training of interviewers, see Bonn-Miller et al. (2012).

Objective Measure of Adherence

We measured adherence objectively using an objective pill count of ART.

Pill Count. A pill count tracking form (PCTF; Paterson et al. 2000) was used to calculate the percentage of prescribed doses that participants took since their last medication refill. The PCTF is used to track the number of each patient's ART medications, the number of pills that each patient should have remaining (based on pharmacy records), and the number of extra pills that remain. Similar to previous research, overall adherence rate was calculated as the number of doses taken divided by the number expected to be taken as prescribed to yield a total percentage of each patient's adherence to all ART medication(s).

Objective Indicators of ART Response and Immunocompromise

Viral Load and CD4 Count. Viral load and CD4 count were used in the present study as a reflection of the participant's response to ART and HIV-related immunological status, respectively (U.S. Department of Health and Human Services, 2011). Participant viral load (copies/mL) was derived from a medical record of each participant's most recent blood test at his or her HIV clinic.

Consistent with prior work (e.g., Mellors et al., 1997), viral load was dichotomized as undetectable if <50 copies/mL and detectable if >50 copies/mL (e.g., coded as 0 = *undetectable* and 1 = *detectable*). Most recent CD4 counts were also obtained via medical record. Viral load has been shown to be the best indicator of response to ART, with viral load capturing response to ART over a longer duration than CD4 count (U.S. Department of Health and Human Services, 2011). CD4 cell count is an indicator of immunocompromise, as well as an indicator of ART effectiveness. As HIV disease progresses, the number of CD4 cells decreases (Wood et al., 2004), with suboptimal adherence to ART often leading to increasing viral load and decreasing CD4 cell counts; these are key indicators of HIV disease progression (Bangsberg, Hecht, et al., 2001).

AIDS Clinical Trials Group HIV Symptom Checklist (ACTG)

The ACTG is a 20-item measure that was developed by the AIDS Clinical Trials Group to assess 20 common symptoms/ART side effects associated with HIV (Chesney et al., 2000). The HIV symptoms/ART side effects are assessed on a 5-point Likert-type scale (0 = *I do not have this symptom* to 4 = *I have this symptom and it bothers me a lot*). Similar to prior work (Ammassari et al., 2001), we did not differentiate between HIV symptoms and ART side effects due to their significant overlap. A total score was used to index the frequency/severity of self-reported HIV symptoms/ART side effects over the past 4 weeks, with lower scores suggesting a relative absence of bothersome symptoms/side effects. Throughout this paper, we refer to this variable as "ART side-effect severity." This measure demonstrated high internal consistency (α = .91).

Positive and Negative Affect Schedule (PANAS)

The PANAS (Watson, Clark, & Tellegen, 1988) is a 20-item self-report measure of positive and negative affect experienced during the previous week. We used the 10-item negative affectivity subscale (PANAS-NA), which asks respondents to rate degree of experiencing 10 negative emotions (e.g., upset, shame, irritability) on a 5-point Likert scale. Summing the 10 times derived a total PANAS-NA score. Higher scores indicate higher negative affectivity. Cronbach's α = .89 for this sample.

Distress Tolerance Scale (DTS)

The DTS (Simons & Gaher, 2005) is a 15-item self-report scale measuring perceived tolerance of affective distress ("I can't handle feeling distressed or upset") on a Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*). Lower scores indicate tendency to experience psychological distress as unacceptable, intolerable, and as interfering with functioning. The DTS has high internal consistency and good test–retest reliability. Cronbach's α = .87 for this sample, indicating good internal consistency.

Mirror-Tracing Persistence Task

The MTPT-C (Quinn, Brandon, & Copeland, 1996) is a computerized task developed to behaviorally measure distress tolerance. Participants are instructed to use the computer mouse to trace a star displayed on the computer screen. The mouse was programmed to trace the mirror image of the star and a loud buzzer sounds following each error after which the participant must start again from the beginning. Participants were instructed to press any computer key when they wish to terminate the task. No reward was provided for longer persistence or performance on this task. The length of time participants engaged in the task before discontinuing represents the measure of behavioral distress tolerance. Subjective units of distress (SUDS; Wolpe, 1969) were assessed both before and immediately after engaging in the mirror-tracing task as an assessment of distress induction during the task. The SUDS scale ranges from 0 to 100, measuring the following domains: irritability, frustration, anxiety, and difficulty concentrating.

PROCEDURE

Interested persons, responding to flyers posted in community outpatient HIV clinics, contacted the research team via telephone and were provided with a detailed description of the study. Participants were then initially screened for eligibility and, if eligible, scheduled for an appointment. Participants were instructed to bring all of their ART medications to the study appointment. Upon arrival to the laboratory, each participant provided written consent to participate in the research study. Participants were then administered the SCID-I-N/P by trained interviewers to assess for psychopathology and inclusionary/exclusionary criteria. Eligible participants then completed a battery of self-report measures, the computerized MTPT-C, and participated in a pill count. At the conclusion of this assessment, participants were compensated $50 for their time and effort. Following the appointment, information from the most recent viral load and CD4 cell count was obtained from each participant's medical record.

DATA ANALYTIC PLAN

First, descriptive statistics were produced for all study variables. Second, age, gender, ethnicity, and education level were considered as covariates, using

Pearson correlations and chi-square tests, as these demographic variables have been shown previously to be significantly associated with objective adherence to ART, viral load, and/or CD4 cell count (Golin et al., 2002; Hinkin et al., 2004; Puskas et al., 2011; Smith et al., 2004). We also conducted a manipulation check to evaluate whether participants' ratings of distress actually increased during the behavioral distress tolerance task (i.e., MTPT-C).

Three regression models were computed to investigate the relation between the two measures of distress tolerance and the three criterion variables (adherence, viral load, and CD4 count), while adjusting for negative affectivity and ART side-effect severity. Negative affectivity was selected as an a priori covariate in our regression models because of its inverse association with ART adherence (Blashill et al., 2011; Weaver et al., 2005) and distress tolerance (Anestis et al., 2012; Marshall-Berenz et al., 2010). ART side effects was also selected as an a priori covariate because of its negative association with ART adherence (Al-Dakkak et al., 2012; Atkinson & Petrozzino, 2009; Protopopescu et al., 2009). In each regression, negative affectivity (PANAS-NA) and ART side-effect severity (ACTG) served as covariates at Step 1. At Step 2, both measures of distress tolerance (i.e., DTS and MTPT-C) were simultaneously entered as predictors. The three criterion variables, each examined in its own regression, were (a) pill count adherence, (b) dichotomous viral load (i.e., detectable vs. nondetectable), and (c) CD4 cell count. Linear regressions were employed for continuous criterion variables, whereas binary logistic regressions were employed for dichotomous criterion variables. All statistical analyses were conducted using SPSS 19.0.

Results

DESCRIPTIVE ANALYSES

Examination of normality across primary study predictor variables revealed that only the behavioral measure of distress tolerance (MTPT-C; time to task discontinuation) evidenced significant skewness and kurtosis. Log transformation remedied the nonnormality (Kolmogorov–Smirnov = .06, p = .20, skewness –0.8, kurtosis = 2.3), therefore the log-transformed MTPT-C was used in all primary analyses and is indicated as such. Descriptive

Table 1
Descriptive Statistics (N = 140)

Variable	*M* (*SD*)	Ranges	Bivariate correlations		
Age in years	48.1 (8.2)	25–65			
Male (%)	76.4	–			
Race/ethnicity (%)					
Black/non-Hispanic	41.4	–			
White/Caucasian	27.9				
Black/Hispanic	11.4				
Hispanic	10.7				
Other	7.1				
Asian	1.4				
Education (%)					
Part college	34.3	–			
High school graduate	21.2				
Graduated from college	20.4				
Did not graduate high school	16.8				
Part of graduate/professional school	3.6				
Completed graduate/professional school	3.6				
Total # of medications	2.4 (1.1)	1–6			
Number of years HIV infected	14.6 (8.0)	1–31			
Negative affect	18.3 (7.9)	6–40			
ART side-effect severity	31.5 (17.2)	0–68			
Distress tolerance–perceived	3.0 (0.9)	1.2–5.0			
Distress tolerance–task persistence in seconds	67.2 (94.2)	.10–725.6			
			Pill count	VL	CD4
Pill count adherence (%)	81.4 (26.2)	7–100	–	–.19*	.13
Viral load status (% detectable)	36.4	–	–	–	–.40**
CD4 cell count	525.0 (285.3)	8–1,547	–	–	–

Note. VL = viral load; Spearman's rho correlation coefficients were used for correlations with viral load; Pearson's correlation was used for CD4 count and pill count adherence. *p < .05 (one-tailed); **p < .01 (one-tailed).

Table 2
Self-Reported Ratings of Distress During the Mirror-Tracing Persistence Task–Computerized Version

Variable	Pretask *M* (*SD*)	Posttask *M* (*SD*)	*t* test
Ratings completed during the MTPT-C [a]			
Anxiety	16.69 (23.28)	26.51 (30.72)	-4.77**
Frustration	12.39 (18.40)	37.29 (33.14)	-9.27**
Irritability	16.03 (22.11)	32.85 (32.97)	-7.48**
Difficulty Concentrating	19.36 (25.96)	31.83 (33.12)	-5.70**

[a] Ratings were recorded on a Likert scale (0 = *none* to 100 = *extremely high*).
** $p < .01$.

information is detailed in Table 1. No significant relations were revealed for age, gender, ethnicity, or education level in terms of the three adherence measures (all p values > .05). Participants were living with HIV an average of 14.6 years (SD = 8.0) and prescribed an average of 2.4 (SD = 1.1) ART medications. According to pill counts, average adherence to ART was 81.4% (SD = 26.2%); notably lower than the 95% adherence rate recommended for protease inhibitor-based ART to be effective (Bangsberg, Perry, et al., 2001; Paterson et al., 2000) but in the acceptable adherence range (>80%) for newer ARTs (Kobin & Sheth, 2011; Martin et al., 2008). Over one third (36.4%) of our sample had a detectable viral load (lower than the 72% documented as having a detectable viral load in the United States; Centers for Disease Control and Prevention, 2011), and average CD4 count was 525.01 (SD = 285.25). Average ART side-effect severity (M = 31.5, SD =17.2) fell at approximately midpoint in the range (0–68), with higher scores indicating greater severity and frequency of the 20 side effects listed. Average negative affectivity (PANAS-NA) scores (M = 18.3, SD =7.9) were slightly higher than adult norms (M =16.0 – 17.4; Crawford & Henry, 2004; Watson et al., 1988). Self-reported distress tolerance (M = 2.95, SD = .87) was slightly lower than that observed in the HIV+ sample from the O'Cleirigh et al. (2007) study (M = 3.21, SD = .91). Scores on the MTPT-C have not been assessed among HIV+ patients in the published literature; however, as compared to a substance-using and affective disorder clinical sample (M = 294.7 seconds, SD = 272.2; McHugh & Otto, 2012a), our participants fared worse on task persistence (M = 67.2 seconds, SD = 94.2). Using a paired sample t test, all SUDS ratings in each of the four distress domains significantly increased from pre- to post-mirror-tracing task (all p's < .01), indicating that the MTPT-C induced significant increases in distress (Table 2). Self-reported distress tolerance, as measured by the DTS, was not significantly associated with the behavioral measure of distress tolerance (r =.09, p = .27) consistent with prior work (Marshall-Berenz et al., 2010; McHugh et al., 2011).

PRIMARY ANALYSES

In terms of pill count adherence, a hierarchical linear regression analysis revealed that, after controlling for negative affectivity and ART side-effect severity, the full model including both measures of distress tolerance was significant, $F(4, 135) = 5.36$, $p < .001$, and accounted for 14% of the variance in pill count adherence, consistent with expectation. Furthermore, the DTS was incrementally significantly associated with pill count adherence (β = .23, p = .01), whereas the log of MTPT-C was not (β = .01, p = .91; see Table 3).

Next, a hierarchical logistic regression analysis was performed to assess the impact of distress tolerance in terms of viral load status (detectable vs. undetectable).[a] After accounting for the negligible contribution of negative affectivity and ART side effects in relation to viral load status at Step 1 (p values > .05), the inclusion of distress tolerance at Step 2 significantly improved the estimation of viral load status, $\chi^2(2, N = 140) = 6.8$, p = .03. In terms of the individual explanatory power of the two employed measures of distress tolerance, the log of latency to task termination (MTPT-C; OR = .43, p = .01) but not DTS (OR = 1.0, p = .92), was reliably associated with viral load status above and beyond the covariates, with longer duration in task persistence associated with a lower likelihood of a detectable viral load (Table 3).[b]

The third and final regression model revealed that neither measure of distress tolerance to be significantly associated with CD4 count after

[a] Results held when using log viral load as a continuous criterion variable in a linear regression model. Only MTPT-C emerged as significantly inversely related to log viral load (β = –.17, p = .05).
[b] All regression model results held when including the non-transformed MTPT-C variable.

Table 3
Linear and Logistic Regression Analyses (N = 140)

Predictor variable	β	*OR*	*p* value	95% CI
Dependent variable: Pill count adherence				
Step 1 (ΔR^2 = .09; F = 6.57, $p < .01$)				
PANAS-NA	–.08	–	.38	–.01, .00
ART side-effect severity	**–.25**		**.01** *	–.01, .00
Step 2 (ΔR^2 = .05; F = 3.9; p = .02)				
DTS	**.23**	–	**.01** *	.02, .12
Log of MTPT-C	.01	–	.91	–.07, .08
Dependent variable: Viral load				
Step 1				
PANAS-NA	–	1.00	.99	.95, 1.05
ART side-effect severity	–	1.01	.25	.99, 1.04
Step 2				
DTS	–	1.00	.92	.97, 1.03
Log of MTPT-C	–	**.43**	**.01** *	.22, .84
Dependent variable: CD4 count				
Step 1(ΔR^2 = .00; F = .02; p = .98)				
PANAS-NA	.02	–	.84	–6.21, 7.67
ART side-effect severity	–.01		.92	–3.33, 3.00
Step 2 (ΔR^2 = .00; F = 1.0; p = .37)				
DTS	–.01	–	.93	–4.28, 3.90
Log of MTPT-C	.12	–	.16	–23.72, 145.85

Note. PANAS-NA = Positive and Negative Affect Schedule–Negative Affectivity; ART = Antiretroviral Therapy; DTS = Distress Tolerance Scale; MTPT-C = Mirror-Tracing Persistence Task–Computerized Version; viral load status was coded as 0 = *undetectable* and 1 = *detectable*.
* $p < .05$.

adjusting for negative affectivity and ART side effects (p values > .05; Table 3).[c,d]

Discussion

To our knowledge, this is the first study to examine both objective and perceived assessment of distress tolerance in relation to objective measures of ART adherence, ART response, and immunocompromise. Our hypotheses were mostly supported. Consistent with prediction, lower levels of distress tolerance were significantly related to lower ART adherence and greater likelihood of having a detectable viral load. These data suggest that HIV+ patients with suboptimal adherence may have a propensity to escape or alleviate unpleasant emotional states and be less able or willing to persist in goal-directed efforts despite experiencing distress. Importantly, these associations were observed above and beyond level of negative affectivity and ART side-effect severity, which have been shown in previous studies to be predictors of poor adherence (Al-Dakkak et al., 2012; Atkinson & Petrozzino, 2009; Carrico et al., 2010; Johnson et al., 2003; Protopopescu et al., 2009; Weaver et al., 2005). Also consistent with past work (Al-Dakkak et al., 2012; Atkinson & Petrozzino, 2009; Protopopescu et al., 2009), ART side-effect severity was significantly negatively associated with ART adherence, as measured by pill counts. In addition to the severity of distress (i.e., negative affect and bothersome medication side effects), the degree to which one is able and/or willing to tolerate such distress appears to be further influencing ART medication adherence and viral load status in our sample.

Contrary to expectation, no significant relations emerged between distress tolerance measures and CD4 cell counts. The most likely explanation for

[c] Based on evidence that cannabis use is negatively related to ART adherence (Bonn-Miller et al., 2012), regression analyses were repeated with cannabis use category serving as an additional covariate in the regression models. With this additional covariate, the distress tolerance self-report scale remained positively significantly related to pill count adherence (β = .21, p = .01) and the MTPT-C held as incrementally increasing the likelihood of achieving an undetectable viral load (OR = .38; p = .01) above and beyond significant effects of the cannabis-dependent group related to greater likelihood of a detectable viral load status (OR = 5.61; $p < .001$).

[d] All primary results remained the same when examining each distress tolerance measure separately in each of the three respective models. Neither the DTS (β = .01, p = .92) nor the MTPT-C (β = .12, p = .16) was significantly related to CD4 cell count. The DTS was significantly associated with pill count adherence (β = .23; p = .01) and the MTPT-C was significantly associated with viral load (OR = .43; p = .01) when each was entered separately in the regression models.

this null finding is that CD4 cell count is a measure of immune function, sensitive to a host of factors affecting the immune system beyond adherence and response to ART (U.S. Department of Health and Human Services, 2011). In concert with this explanation, Ironson et al. (2005) found that ART medication adherence was significantly related to viral load changes over time, but not to CD4 cell count changes. Indeed, once patients have started ART, clinical guidelines recommend using viral load as the key biomarker for detecting timely changes in HIV disease progression as viral load may be more immediately responsive to ART than CD4 cell count (U.S. Department of Health and Human Services, 2011). In light of these measurement limitations, it is not surprising that psychological measures were not significantly associated with CD4 cell counts.

We also found that different measures/aspects of distress tolerance predicted different measures of ART adherence. Perceived capacity or willingness to tolerate affective distress and greater task persistence in the face of distress were related to better ART adherence and viral load, respectively. Although only replication in future work would determine whether the observed differential associations remain, one potential explanation for the observed associations could relate to measurement type/error. Indeed, one could argue that task persistence and viral load are both objective measures with little room for individual error, while self-reported distress tolerance and pill count adherence are more likely subject to individual-level factors and influence (e.g., the number of pills brought to the assessment, subjective assessment of distress tolerance). The association between task persistence and viral load also makes conceptual sense as viral load is a reflection of ART response and adherence over a longer duration (U.S. Department of Health and Human Services, 2011), which is functionally similar to the MTPT-C, which involves persistence in an effortful task while distressed/frustrated.

The lack of relation between MTPT-C and pill count adherence indicates that pill count adherence does not serve as an indirect pathway between MTPT-C persistence and viral load. However, research indicates other potential pathways that might help explain the association between MTPT-C task persistence and viral load, such as problematic substance use. Indeed, substance dependence has been closely linked to both persistence on the MTPT-C (Leyro et al., 2010), as well as higher viral load (e.g., Bonn-Miller et al., 2012). Though the present cross-sectional data do not allow for the examination of these hypothesized temporal associations, future work would benefit from the prospective examination of substance dependence as a potential mediator of the association between distress intolerance, as indexed by the MTPT-C, and heightened viral load.

It is important to also note that, consistent with prior studies (Marshall-Berenz et al., 2010; McHugh et al., 2011), we observed self-report distress tolerance (DTS) not to be significantly associated with the employed behavioral measure of distress tolerance (i.e., MTPT-C). Here, the contexts in which the two forms of distress tolerance were assessed differ. The behavioral persistence measure was administered in the presence of induced distress; whereas perceived distress tolerance was not. Moreover, the perceived inability to handle distress is defined as a cognitive factor, broadly, whereas task persistence in the face of distress is defined behaviorally (McHugh & Otto, 2012b). The absence of significant associations between perceived and objective distress tolerance may be in part due to the different types of distress (e.g., anxiety, frustration) and measurement contexts (i.e., in vivo vs. self-reported perceptions; McHugh & Otto, 2012b; McHugh et al., 2011). In addition, the measurement of perceived distress tolerance relies on self-report, which presents a challenge because of the difficulty participants have in accurately reflecting upon and discriminating their sensitivity to distress from their tolerance of distress (McHugh & Otto, 2012b; Sloan & Kring, 2007). Indeed, a strength of this study is that the multimethod approach precludes limitations of shared method variance and difficulty in accurately self-reporting by employing a behavioral and self-report measure of distress tolerance.

Our findings are largely consistent with past work in the areas of ART adherence and distress tolerance, and underscore the clinically relevant role of distress tolerance in models of adherence and disease status among HIV+ patients. As has been initially shown to be effective among substance-using populations and early-lapse smokers (Bornovalova, Gratz, Daughters, Hunt, & Lejuez, 2012; Brown et al., 2008), future interventions for individuals with HIV may benefit from specifically targeting ability/willingness to tolerate distress through cognitive behavioral treatment (CBT) approaches so that individuals may remain adherent in the face of treatment-related burdens. This intervention development approach is in line with recent endeavors to enhance the impact of CBT for improving ART adherence by treating comorbid depression (Safren et al., 2009, 2012), and with Blashill and colleagues' (2011) suggestion to develop combination interventions for other psychosocial problems among individuals living with HIV. Yet, our conceptualization of transdiagnostic psychological vulnerability factors, such as distress tolerance, may offer a more parsimonious

approach for addressing psychosocial comorbidities. Although there has been much work developing and testing CBT interventions for promoting ART adherence, there is still room for improvement because traditional multicomponent CBT interventions for ART adherence result in small to medium effect sizes (Amico, Harman, & Johnson, 2006; Simoni, Pearson, Pantalone, Marks, & Crepaz, 2006; Thompson et al., 2012).

Overall, the current study extends the literature on distress intolerance as a psychological vulnerability factor among people living with HIV. However, there are some limitations that provide opportunities for future research. First, the present study was cross-sectional, limiting inferences that can be made about directionality. Indeed, it is just as likely that low levels of distress tolerance lead to poor adherence as it is that poor adherence is prospectively associated with low levels of distress tolerance. This may be particularly relevant among immunocompromised individuals living with HIV. For instance, if poor adherence leads to an increasing viral load, then one's immune system is mobilized to contend with the growing viral load. This is a physiological stressor and stress increases one's drive to escape from unpleasant situations (Trafton & Gifford, 2011). Thus, it is feasible that stress due to immunological reactivity from an increasing viral load further limits one's capacity to exercise tolerance of distress. It is plausible that poor adherence resulting in an increasing viral load may subsequently increase one's vulnerability to distress intolerance. Prospective work is needed to better elucidate the temporal ordering of the observed relations. Following, as adherence was measured using pill count at only one time point, we were unable to establish a baseline level of adherence and MEMS caps would have provided a more precise indicator of adherence. Third, as mentioned earlier, though a strength of the study was the multimethod measurement of distress tolerance, future work would benefit from employing additional objectives (e.g., breath holding; Asmundson & Stein, 1994) and newly refined subjective (e.g., distress intolerance index; McHugh & Otto, 2012b) measures to better understand differential relations between multiple facets of distress tolerance and HIV adherence. Future work would also benefit from assessing tolerance of HIV symptom-related distress, specifically, and the impact of distress tolerance on other clinically relevant HIV outcomes (e.g., quality of life). Finally, though the present study was quite ethnically diverse, a majority of the sample was male. Future work would benefit from recruiting a more gender-diverse sample from different geographic areas.

Promoting tolerance of affective distress and distressing tasks associated with the high-adherence demands of ART for HIV management are worthwhile to consider in future research. Future investigations are needed to examine relations prospectively to identify the role of distress intolerance in the development and maintenance of poor HIV management, and then verification of clinical implications through intervention process and outcome studies.

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