

# The Reward Probability Index: Design and Validation of a Scale Measuring Access to Environmental Reward

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Behavioral models of depression implicate decreased response-contingent positive reinforcement (RCPR) as critical toward the development and maintenance of depression (Lewinsohn, 1974). Given the absence of a psychometrically sound self-report measure of RCPR, the Reward Probability Index (RPI) was developed to measure access to environmental reward and to approximate actual RCPR. In Study 1 ( $n=269$ ), exploratory factor analysis supported a 20-item two-factor model (Reward Probability, Environmental Suppressors) with strong internal consistency ( $\alpha=.90$ ). In Study 2 ( $n=281$ ), confirmatory factor analysis supported this two-factor structure and convergent validity was established through strong correlations between the RPI and measures of activity, avoidance, reinforcement, and depression ( $r=.65$  to  $.81$ ). Discriminant validity was supported via smaller correlations between the RPI and measures of social support and somatic anxiety ( $r=-.29$  to  $-.40$ ). Two-week test–retest reliability was strong ( $r=.69$ ).

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In Study 3 ( $n=33$ ), controlling for depression symptoms, hierarchical regression supported the incremental validity of the RPI in predicting daily diary reports of environmental reward. The RPI represents a parsimonious, reliable, and valid measure that may facilitate understanding of the etiology of depression and its relationship to overt behaviors.

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WITHIN THE BIOLOGICAL AND social sciences, research indicates a strong relationship between negative affect and reductions in the frequency and magnitude of environmental reward. Decreased environmental reward is particularly associated with the etiology and persistence of depression (Hopko, Armento, Cantu, Chambers, & Lejuez, 2003; Hopko, Lejuez, Ruggiero, & Eifert, 2003; Hopko & Mullane, 2008; Lewinsohn, 1974; Lewinsohn & Graf, 1973; Martell, Addis, & Jacobson, 2001) and psychological interventions that increase exposure to environmental rewards attenuate symptoms of depression (Cuijpers, van Straten, & Warmerdam, 2007; Ekers, Richards, & Gilbody, 2008; Hopko et al., 2007; Hopko, Lejuez, LePage, Hopko, & McNeil, 2003; Jacobson et al., 1996). Moreover, basic biological research has established a

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neurobiological basis of reward (Cooper & Liebman, 1989; Olds & Milner, 1954), with a brain reward system (BRS) considered a mediating factor in affective change (Herink, 2000; Naranjo, Tremblay, & Busto, 2001). Dysfunction of the BRS within the prefrontal cortex, anterior cingulate gyrus, and temporal lobe areas seem particularly prominent among individuals with major depression (Brody et al., 2001; Drevets, 1998; Gray, 1981; Kennedy, Javanmard, & Vaccarino, 1997; Ketter, George, Kimbrell, Benson, & Post, 1996; Naranjo et al., 2001; Tremblay, Naranjo, Cardenas, Herrmann, & Busto, 2002). Given strong behavioral and neurobiological support for the relationship of decreased environmental reward and depression, it is critical to develop parsimonious and psychometrically sound assessment strategies that measure the degree to which individuals are exposed to rewarding environmental events.

Behavioral theories postulate specific environmental circumstances or setting events that are operative in the etiology and maintenance of depressive symptoms (Ferster, 1973, 1974; Hopko, Lejuez, Ruggiero et al., 2003; Lewinsohn, 1974; Rose & Staats, 1988). The predominant paradigm is that a low rate of response-contingent positive reinforcement (RCPR) is the critical predictor of clinical depression (Lewinsohn, 1974; Lewinsohn & Graf, 1973; Lewinsohn & Libet, 1972). RCPR is defined as an increase in the frequency or duration of a behavior as a result of the presentation of a reinforcer. Minimal environmental (and social) reinforcement results in the extinction of "healthy" adaptive behaviors and consequently the dysphoria, passivity, and other symptoms characterizing depression. Decreased RCPR is a product of (a) a decreased number of events that are potentially reinforcing for an individual, (b) decreased availability of these potential reinforcers in the environment, (c) inability to experience rewarding contingencies due to inadequate instrumental behaviors such as social skills, and (d) increased exposure to aversion in the form of distressing or unpleasant events (Lewinsohn, 1974; Lewinsohn, Sullivan, & Grosscup, 1980).

Important to acknowledge at this juncture are some conceptual distinctions among reward, reinforcement, and contingency. Although positive reinforcers are often experienced as rewarding or pleasurable to an individual, it is also true that environmental events may function as positive reinforcers yet be somewhat aversive in their form or presentation. For example, when harsh verbal criticism of a depressed individual's socially withdrawn behavior has the effect of increasing the frequency and duration of social isolation. For the

purposes of this paper, and consistent with the Ferster (1973) and Lewinsohn (1974) formulations, positive reinforcement was conceptualized as increased behavior that generally is a function of rewarding or pleasant (bodily) responses and a freedom from aversive stimuli, a process that has antidepressant effects (Abreu & Santos, 2008; Skinner, 1953, 1989). Further, in addressing the concept of reinforcement, it is necessary to operationalize the term "contingency." Indeed, there is a sizeable literature on the varying definitions of contingency (Catania, 1998; Fantino & Logan, 1979; Nevin, 1973; Catania & Reynolds, 1968; Skinner, 1953). Although discussion of the definitional distinctions is beyond the scope of this paper, contingency in the current context is used to describe in a simple operant model the relation of a behavior to its consequence. More specifically, it describes how certain environmental behaviors and experiences are associated with the emotional consequence of depression and its behavioral manifestation (e.g., passivity, social withdrawal, crying, and problems with eating and sleeping). Given the inherent difficulties of developing a self-report measure of RCPR or contingent environmental relations that would require documenting behavioral change temporally as a function of specific environmental conditions and consequences (Catania, 1998), the focus was on developing a measure of access to environmental reward that would serve as a proxy measure of RCPR. In other words, the fundamental assertion is that increased environmental reward enhances the probability of reinforcement (increased behavior) and decreases depressive affect (Lewinsohn, 1974).

Supporting behavioral theory, a number of studies demonstrated relationships between pleasant events and mood state, with individuals reporting fewer positive events, decreased environmental reward, and more limited abilities to obtain reinforcement endorsing increased depression severity (Bouman & Luteijn, 1986; Hopko, Armento et al., 2003; Hopko & Mullane, 2008; Lewinsohn & Amenson, 1978; Lewinsohn & Graf, 1973; Lewinsohn & Libet, 1972; MacPhillamy & Lewinsohn, 1974). Depressed individuals also tend to engage in fewer rewarding interpersonal behaviors, suggesting that insufficient social interaction and decreased social reinforcement may elicit negative affect (Joiner, Lewinsohn, & Seeley, 2002; Lewinsohn & Shaffer, 1971; Libet & Lewinsohn, 1973). Treatment outcome research also has convincingly elucidated the influence of environmental reward on depression. Early behavioral treatments demonstrated depression attenuation via strategies that increased reinforcement,

including monitoring of pleasant events and associated mood, activity scheduling, and social skill development (Barrera, 1979; Brown & Lewinsohn, 1984; Lewinsohn & Atwood, 1969; Lewinsohn & Graf, 1973; Lewinsohn & Shaffer, 1971; Lewinsohn & Shaw, 1969; Lewinsohn et al., 1980; Sanchez, Lewinsohn, & Larson, 1980; Zeiss, Lewinsohn, & Munoz, 1979).

More contemporary studies have also shown that behavioral activation (BA) interventions may be highly effective in treating depression. BA is based on the premise that increasing rewarding activities to promote environmental reinforcement leads to improvements in mood, thoughts, and quality of life (Hopko, Lejuez, Ruggiero et al., 2003; Jacobson, Martell, & Dimidjian, 2001; Lejuez, Hopko, & Hopko, 2001; Martell et al., 2001). The efficacy of BA generally is well supported (Cuijpers et al., 2007; Ekers et al., 2008; Hopko, Lejuez, Ruggiero et al., 2003), with the most convincing support coming from a randomized trial comparing BA, cognitive therapy, Paroxetine, and a medication placebo (Dimidjian et al., 2006). BA outperformed other conditions with moderately to severely depressed participants when observed attrition and relapse rates for Paroxetine treatment were considered.

The revivification of behavioral interventions for depression has underscored the need to develop practical and reliable methods of assessing access to environmental reward and exposure to aversive environmental events, the magnitude of which directly affects RCPR and the subsequent manifestation of depression (Lewinsohn, 1974; Lewinsohn et al., 1980). The Pleasant Events Schedule (PES; MacPhillamy & Lewinsohn, 1971) initially was developed to measure the frequency and intensity of pleasant events as a means of assessing RCPR. However, the scale is limited in that it is extensive (i.e., 320 items) and does not assess critical elements of RCPR discussed above (i.e., instrumental behaviors, exposure to aversive stimuli). The Environmental Reward Observation Scale (EROS; Armento & Hopko, 2007) was designed as a brief 10-item measure of self-observed environmental reward. There were strong inverse relationships among the EROS and the empirically validated depression measures ( $r = -.54$  to  $-.69$ ), and a moderate relationship between the EROS and the PES ( $r = .43$ ; Armento & Hopko, 2007). However, the EROS was limited in that it did not sufficiently account for all four dimensions of RCPR (Lewinsohn, 1974; Lewinsohn et al., 1980) and was criticized as incorporating items that overlapped with symptoms of depression such as anhedonia (e.g., "Activities that used to be pleasurable no longer are gratifying"). The Behavioral Activation for

Depression Scale (BADS; Kanter, Mulick, Busch, Berlin, & Martell, 2007) was designed as a treatment outcome measure to evaluate the impact of BA treatments in modifying activity level and avoidance behavior, as well as work and social impairment. Although these are important issues to address, this measure did not address core theoretical elements of RCPR, such as instrumental behaviors essential to eliciting rewarding consequences and exposure to aversive environmental events. Finally, measures of cognitive, behavioral, and experiential avoidance, including the Cognitive-Behavioral Avoidance Scale (CBAS; Ottenbreit & Dobson, 2004) and the Acceptance and Action Questionnaire (AAQ; Hayes et al., 2004) are conceptually related to exposure to environmental reinforcement, but similarly do not directly assess any of the four components of RCPR outlined in behavioral models of depression.

The primary objective of this investigation was to develop and validate a self-report instrument that more directly and precisely measured the four core elements of RCPR (Lewinsohn, 1974; Lewinsohn et al., 1980). The theory behind RCPR may be the most influential behavioral model of depression (Ferster, 1973; Lewinsohn, 1974), in that it is the basis of both traditional and contemporary behavioral treatments and is used as a guiding framework for much psychopathology research. The impetus for this study came from the absence of any valid assessment measure that adequately assesses the core fundamental components of this foundational model. This study aimed to develop and establish the reliability and validity of the Reward Probability Index (RPI) across three studies. Study 1 involved development and exploration of the factor structure of the RPI. Using data from this experiment, Study 2 was designed to assess a revised version of the RPI using confirmatory factor analysis, reliability indices (internal consistency, test-retest), and convergent and discriminant validity data. Study 3 utilized a daily diary procedure (Hopko, Armento et al., 2003; Hopko & Mullane, 2008) that directly assessed experiences of environmental reward to evaluate the predictive validity of the RPI in determining reward value associated with typical daily activities. Hypotheses were as follows: (a) factor analyses would identify the RPI as having four factors consistent with the behavioral model of depression (Lewinsohn, 1974; Lewinsohn et al., 1980); (b) the RPI would positively correlate with environmental reward and social support and negatively correlate with measures of depression and anxiety; and (c) controlling for variance accounted for by depression symptoms, the RPI would account for unique variance in

predicting environmental reward as measured via daily diaries.

## Study 1

### METHOD

#### *Participants and Procedure*

A demographic form and 24-item RPI were administered to 269 students attending undergraduate psychology courses at the University of Tennessee: 180 females (66.9%) and 89 males (33.1%) with a mean age of 19.6 years ( $SD=3.5$  years). The sample consisted of 227 Caucasians (84.4%), 28 African Americans (10.4%), 3 Latinos (1.1%), 4 Asians (1.5%), 1 American Indian (0.4%), and 6 individuals who identified themselves as “Other” (2.2%).

#### *Assessment Measure*

The original 24-item RPI self-report measure was designed to assess the four dimensions of RCPR (Lewinsohn, 1974; Lewinsohn et al., 1980): (a) number of potentially reinforcing events, (b) availability of potential reinforcers in the environment, (c) ability to elicit environmental reinforcement via instrumental behaviors, and (d) exposure to aversive or punishing stimuli in the environment. As per scale development recommendations (Comrey, 1988) approximately half of the items ( $n=11$ ) were reverse items to control for potential respondent response sets. To facilitate content validity, two experts in behavioral theory and intervention were consulted during item development, with six items ultimately identified for each of the four dimensions of RCPR. In terms of construct dimensions, in addition to assessing the four core elements of RCPR, the scale was designed to assess the magnitude of environmental reward (as a proxy for RCPR) over an extended duration of time (past several months). The function of the instrument was to be a brief screening tool broadly applicable to both treatment outcome and basic psychopathology research. Items were rated on a 4-point Likert scale, 1 (*strongly disagree*) to 4 (*strongly agree*), with higher scores indicating higher levels of reinforcement (possible range = 24 to 96). The RPI was developed using established methodologies, including attention to scale length, item composition issues, sample size, and use of factor analytic refinement methods (Comrey, 1988; Floyd & Widaman, 1995; Haynes, Richard, & Kubany, 1995).

### RESULTS

#### *Normative Data*

Prior to conducting an exploratory factor analysis, RPI data were subjected to tests of multivariate normality (Hair, Anderson, Tatham, & Black, 1995).

Both the symmetry (skewness =  $-.40$ ,  $SE=.15$ ) and the flatness (kurtosis =  $.12$ ,  $SE=.30$ ) of the distribution were within acceptable limits (Hair et al., 1995; Tabachnick & Fidell, 1996), and a visual analysis of observed values revealed a normal Q–Q plot with a uniform distribution. Based on independent sample  $t$  tests, neither an ethnicity (Caucasian vs. non-Caucasian) nor a gender effect was identified (females:  $M=73.5$ ,  $SD=9.8$ ; males:  $M=73.9$ ,  $SD=9.9$ ).

#### *Reliability Analyses*

Internal consistency of the RPI was strong ( $\alpha=.90$ ). All corrected item-total correlations were statistically significant ( $p<.01$ ) and ranged from .23 to .66.

#### *Exploratory Factor Analysis*

An exploratory factor analysis was conducted on the 24-item RPI using a principal components extraction and a varimax rotation, with the number of factors specified to four, representing the four core dimensions of the behavioral theory of depression (Lewinsohn, 1974; Lewinsohn et al., 1980). The factor loadings, and related interpretability (i.e., face validity of items), scree-plot analysis (Cattell, 1966), and factor eigenvalues as assessed via parallel analysis procedures (Glorfeld, 1995; Watkins, 2000) were used to determine the optimal factor structure of the RPI. Based on the parallel analysis procedure (variables = 10, participants = 262, replications = 100), only two generated eigenvalues from the exploratory analysis (1 = 7.76, 32.3% variance; 2 = 2.10, 8.8% variance) were greater than the associated critical eigenvalues established via parallel analysis. Based on these data, the limited interpretability (face validity) of two of the four factors, and the observation that few items loaded significantly (rotated factor loadings  $>.40$ ) on Factors 3 and 4 (three and five items, respectively), a second exploratory factor analysis was conducted with the number of factors specified at two. As indicated previously, these two factors accounted for approximately 41% of the variance. To be considered as loading significantly on a factor, items were required to have factor loadings of greater than .40 and have a loading of less than .30 on the secondary factor (Hair et al., 1995). Rotated factor loadings are presented in Table 1. Four items were considered poorly discriminative items in that they did not meet these specified criteria. Accordingly, these items were removed to create a final 20-item two-factor measure. Factor 1 was termed “Reward Probability,” and represented an integration of Dimensions 1 (*potentially reinforcing events*) and 3 (*instrumental behaviors*) (Lewinsohn, 1974). Factor 2 was labeled “Environmental Suppressors,” and involved the integration of originally proposed

Table 1  
RPI Developmental Sample: EFA Structure Coefficients

	Factor Loading	
	Factor 1 Reward Probability	Factor 2 Environmental Suppressors
1. I have many interests that bring me pleasure.	.72	.12
2. I make the most of opportunities that are available to me.	.65	.16
3. My behaviors often have negative consequences.	.19	.52
4. I make friends easily.	.73	.06
5. There are many activities that I find satisfying.	.67	.20
6. I consider myself to be a person with many skills.	.64	.02
7. Things happen that make me feel hopeless or inadequate.	.20	.65
8. I feel a strong sense of achievement.	.60	.30
9. Changes have happened in my life that have made it hard to find enjoyment.	.27	.61
10. It is easy to find good ways to spend my time.	.57	.37
11. I have the abilities to obtain pleasure in life.	.55	.31
12. I have few financial resources, which limits what I can do.	.14	.40
13. I have had many unpleasant experiences.	.06	.71
14. It seems like bad things always happen to me.	.17	.71
15. I have good social skills.	.72	.15
16. I often get hurt by others.	.18	.60
17. People have been mean or aggressive toward me.	.12	.54
18. I have been very capable in jobs I have had.	.49	.09
19. I wish I could find a place to live that brought more satisfaction to my life.	.28	.47
20. I have many opportunities to socialize with people.	.62	.20

Dimensions 2 (*availability of reinforcement*) and 4 (*aversive and unpleasant experiences*) (Lewinsohn, 1974; Lewinsohn et al., 1980). Internal reliability of the RPI after removal of the four items continued to be strong ( $\alpha = .88$ ), as was the internal consistency of Factors 1 ( $\alpha = .80$ ) and 2 ( $\alpha = .87$ ). Inter-item correlations were all significant within each factor [ $p < .01$ : Factor 1 ( $r = .23$  to  $.72$ ); Factor 2 ( $r = .17$  to  $.48$ )]. Factor 1 correlated significantly with Factor 2 ( $r = .50$ ,  $P < .001$ ) and Factors 1 ( $r = .87$ ,  $p < .001$ ) and 2 ( $r = .85$ ,  $p < .001$ ) correlated significantly with the RPI total score.

#### Convergent Validity

The demographic form included a single item that asked participants to indicate how depressed they currently were on a scale of 1 (*not at all*) to 4 (*extremely*). The total and factor scores on the RPI correlated strongly with self-reported depression ( $r = -.51$  to  $-.60$ ,  $p < .001$ ).

## Study 2

### METHODS

#### Participants and Procedure

Study 2 was conducted to further assess reliability, construct validity, and convergent validity of the RPI with measures of environmental reward, depression, anxiety, and social support. These instruments were administered with a demographic questionnaire in the context of introductory psy-

chology undergraduate classes. The sample included 281 students, 168 (59.8%) females and 113 (40.2%) males, with a mean age of 18.8 years ( $SD = 2.5$  years). The sample consisted of 235 Caucasians (83.6%), 33 African Americans (11.7%), 3 Latinos (1.1%), 4 Asians (1.4%), and 6 "Other" (2.2%). Based on a chi-square analysis, participant samples in Studies 1 and 2 did not statistically differ in terms of ethnicity. However, as a function of recruiting exclusively from introductory psychology courses as opposed to also recruiting from more advanced courses, Study 2 participants were slightly younger than those who participated in Study 1,  $t(547) = 2.82$ ,  $p < .01$ . To assess test-retest reliability of the RPI, 103 students, females:  $n = 72$  (69.9%); males:  $n = 31$  (30.1%), completed the RPI exactly 2 weeks following the initial administration. This test-retest sample consisted of 89 Caucasians (86.4%), 9 African Americans (8.7%), 2 Latinos (1.9%), 2 Asians (1.9%), and 1 "Other" (1%), and had a mean age of 18.8 years ( $SD = 3.5$  years).

#### Assessment Measures

The Reward Probability Index (RPI) is a 20-item self-report measure designed as a proxy index of the four dimensions of RCPR via a two factor model: (a) Reward Probability, and (b) Environmental Suppressors. Participants rate each item on a 4-point Likert scale and the total score ranges from 20 to 80,

with higher scores suggesting increased reward probability and fewer environmental suppressors inhibiting access to reinforcement.

The Behavioral Activation for Depression Scale (BADs; Kanter et al., 2007) is a 25-item scale that specifically assesses behaviors presumed to be targeted during BA treatment interventions (Martell et al., 2001). The measure includes four subscales: Activation, Avoidance/Rumination, Work/School Impairment, and Social Impairment. Sample items include "I engaged in a wide and diverse array of activities" (Activation subscale), "I did things to avoid feeling sadness or other painful emotions" (Avoidance/Rumination subscale), and "I stayed in bed for too long even though I had things to do (Work/School Impairment subscale). Internal consistency of the total score and subscales was adequate ( $\alpha = .76$  to  $.87$ ), and good 1-week test-retest reliability was established ( $r = .74$ ). The BADs also correlated strongly with the Beck Depression Inventory ( $r = -.67$  to  $-.70$ ; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), and had good discriminant validity as evidenced by a significant albeit weak relationship with the Beck Anxiety Inventory ( $r = -.19$ ; Beck, Epstein, Brown, & Steer, 1988). Finally, there was some support for the predictive validity of the BADs in that individuals with higher scores on the Avoidance/Rumination subscale were less likely to return for a follow-up assessment (Kanter et al., 2007). In the present study, internal consistency was strong (total score  $\alpha = .91$ ).

The Environmental Reward Observation Scale (EROS; Armento & Hopko, 2007) is a 10-item measure that assesses environmental reward on a 4-point Likert scale. The scale is intended to identify the magnitude of reinforcing events, the availability of reinforcement in the environment, and the ability of an individual to elicit that reinforcement. Sample items include "A lot of activities in my life are pleasurable," "It is easy for me to find enjoyment in my life," and "The activities I engage in usually have positive consequences." The EROS has strong internal consistency ( $\alpha = .85$  to  $.90$ ) and excellent 1-week test-retest reliability ( $r = .85$ ). The EROS also correlated strongly with other commonly administered and psychometrically sound self-report measures of depression and anxiety, as well as the Pleasant Events Schedule ( $r = -.43$  to  $-.71$ ; Armento & Hopko, 2007). Internal consistency was strong in this study ( $\alpha = .86$ ).

The Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) assesses the severity of depressive symptoms and includes 21 items rated on a 4-point Likert scale (score range = 0–63). Higher scores suggest increased depression severity. Sample

items include degree of "sadness" and "loss of pleasure." The instrument has excellent reliability and validity with depressed younger and older adults (Nezu, Ronan, Meadows, & McClure, 2000). In the present study, internal consistency was strong ( $\alpha = .89$ ).

The Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977) is a 20-item self-report questionnaire of depressive symptoms that has adequate psychometric properties. The instrument has been shown to modestly relate to a diagnosis of clinical depression (Myers & Weissman, 1980) and has been recommended as an initial screening measure to assess for this condition (Roberts & Vernon, 1983). In the present study, internal consistency was strong ( $\alpha = .86$ ).

The Beck Anxiety Inventory (BAI; Beck & Steer, 1993) is a 21-item questionnaire that measures cognitive and somatic symptoms of anxiety, with higher scores indicating increased anxiety (score range = 0–63). Sample items include "unable to relax," and "heart pounding or racing." Good psychometric properties have been demonstrated among college, medical, and psychiatric samples (Antony, Orsillo, & Roemer, 2001). In the present study, internal consistency was strong ( $\alpha = .88$ ).

The Multidimensional Scale of Perceived Social Support (MSPSS; Zimet, Dahlem, Zimet, & Farley, 1988) is a 12-item scale that assesses adequacy of social support from family and significant others (score range = 12–84). Higher scores suggest decreased social support and sample items include "my friends really try to help me," and "I can talk about my problems with my family." The instrument has adequate psychometric properties in clinical and nonclinical samples of adults, with internal consistencies ranging from  $.81$  to  $.98$ , strong 3-week test-retest reliability ( $r = .73$ ), and significant inverse correlations with measures of depression and anxiety (Stanley, Beck, & Zebb, 1998; Zimet et al., 1988). Internal consistency of the MSPSS was strong in this investigation ( $\alpha = .96$ ).

## RESULTS

### *Normative Data*

RPI data were first subjected to tests of multivariate normality. Consistent with Study 1, the symmetry (skewness =  $-.51$ ,  $SE = .15$ ) and the flatness (kurtosis =  $.29$ ,  $SE = .29$ ) of the distribution were within acceptable limits, and a visual analysis of observed values revealed a normal Q-Q plot with a uniform distribution. Based on independent sample *t* tests, neither an ethnicity (Caucasian vs. non-Caucasian) nor a gender effect was identified on either the RPI total score (females:  $M = 63.6$ ,  $SD = 8.1$ ; males:  $M = 62.8$ ,  $SD = 7.7$ ) or RPI subscales. Descriptive statistics for the sample (for all assessment measures) are presented in Table 2.

Table 2  
Study 2: Correlations and Descriptive Data Among Self-Report Assessment Instruments

Instrument	1	2	3	4	5	6	7	8	9	<i>M</i>	<i>SD</i>
1. RPI Total	–	.87	.88	.69	.81	-.67	-.65	-.40	-.29	63.3	7.9
2. RPI Factor I		–	.54	.59	.77	-.56	-.51	-.29	-.26	36.2	4.5
3. RPI Factor II			–	.61	.63	-.60	-.60	-.41	-.24	27.1	4.6
4. BADS Total				–	.73	-.73	-.74	-.53	-.23	106.3	22.5
5. EROS					–	-.69	-.67	-.43	-.26	31.1	5.0
6. BDI-II						–	.81	.62	.28	8.9	7.3
7. CES-D							–	.60	.23	13.7	10.0
8. BAI								–	.20	6.6	7.1
9. MSPSS									–	31.5	21.8

Note. RPI=Reward Probability Index, RPI Factor I=RPI Reward Probability, RPI Factor II=RPI Environmental Suppressors, BADS=Behavioral Activation for Depression Scale, EROS=Environmental Reward Observation Scale, BDI-II=Beck Depression Inventory-II, CES-D=Center for Epidemiologic Studies Depression Scale, BAI=Beck Anxiety Inventory, MSPSS=Multidimensional Scale of Perceived Social Support. All correlations significant at the 0.01 level.

### Reliability Analyses

Internal consistency of the RPI was strong at both the initial ( $\alpha = .88$ ) and second (test–retest) administration ( $\alpha = .92$ ). All corrected item–total correlations were statistically significant ( $p < .01$ ) for both Administration 1 (range = .25 to .64) and Administration 2 (range = .33 to .70). Two-week test–retest reliability was excellent for the RPI total score ( $r = .69$ ) as well as Factors I ( $r = .68$ ) and II ( $r = .69$ ).

### Convergent–Discriminant Validity

Given the strong support for the reliability of the 20-item RPI, zero-order correlations were conducted to

examine its relation to other commonly administered measures of depression and anxiety (see Table 2). Supporting the convergent validity of the measure, moderate-to-strong correlations were observed between the RPI total score and other measures of activity and avoidance (BADS = .69), environmental reward (EROS = .81), and depression (BDI-II = -.67; CES-D = -.65). The relationships were largely consistent across both RPI factors. Supporting the discriminant validity of the RPI and its two factors, less robust correlations were evident with measures assessing social support (MSPSS:  $r = -.24$  to  $-.29$ ) and somatic anxiety (BAI:  $r = -.29$  to  $-.41$ ).

Table 3  
Study 2 RPI Replication Sample: Standardized Path Coefficients for RPI Items

	Path Coefficients	
	Factor 1 Reward Probability	Factor 2 Environmental Suppressors
1. I have many interests that bring me pleasure.	.58	
2. I make the most of opportunities that are available to me.	.51	
3. My behaviors often have negative consequences.		.47
4. I make friends easily.	.59	
5. There are many activities that I find satisfying.	.63	
6. I consider myself to be a person with many skills.	.44	
7. Things happen that make me feel hopeless or inadequate.		.60
8. I feel a strong sense of achievement.	.67	
9. Changes have happened in my life that have made it hard to find enjoyment.		.60
10. It is easy to find good ways to spend my time.	.65	
11. I have the abilities to obtain pleasure in life.	.69	
12. I have few financial resources, which limits what I can do.		.28
13. I have had many unpleasant experiences.		.74
14. It seems like bad things always happen to me.		.76
15. I have good social skills.	.66	
16. I often get hurt by others.		.66
17. People have been mean or aggressive toward me.		.48
18. I have been very capable in jobs I have had.	.39	
19. I wish I could find a place to live that brought more satisfaction to my life.		.55
20. I have many opportunities to socialize with people.	.63	

### Confirmatory Factor Analysis

Confirmatory factor analytic procedures were used to assess the adequacy of the previously established two-factor model of the RPI. Fit indices were derived from the LISREL statistical analysis program (Version 8.8). The maximum likelihood method of parameter estimation was used in the analysis and performed on the variance-covariance matrix. For the entire sample, fit indices for the two factors were as follows: RMSEA=.07, NNFI=0.93, NFI=0.91, CFI=0.94, GFI=0.87, and AGFI=0.84. Standardized path coefficients ranged from .28 (item 12) to .76 (item 14) and are presented in Table 3.

Two additional confirmatory factor analyses were conducted to verify that the two-factor model fit better than alternative models. First, we tested whether the current two-factor model fit the data better than the original four-factor model of RCPR (Lewinsohn, 1974). Fit indices for the four-factor model were relatively strong: RMSEA=.08, NNFI=0.93, NFI=0.91, CFI=0.93, GFI=0.87, and AGFI=0.83. Nevertheless, a post-hoc chi-square analysis indicated that the current two-factor model provided a better fit to the data [ $\chi^2(5)=7.26$ ,  $p<.01$ ]. Second, we tested whether the current two-factor model fit the data better than a higher-order unifactorial model. Fit indices for the unifactorial model were rather modest: RMSEA=.11, NNFI=0.88, NFI=0.86, CFI=0.89, GFI=0.78, AGFI=0.73. Further, a subsequent chi-square analysis supported the superiority of the two-factor model [ $\chi^2(1)=218.13$ ,  $p<.001$ ].

## Study 3

### METHOD

#### Participants and Procedure

Study 3 was conducted to assess the predictive validity of the RPI, specifically examining the incremental validity of the RPI in predicting daily diary reports of rewarding behaviors and activities above variance associated with depression. Participants included 33 undergraduates, females:  $n=23$  (69.7%), males:  $n=10$  (30.3%), and the sample consisted of 30 Caucasians (90.9%), 1 African American (3.0%), 1 Asian (3.0%), and 1 individual who self-classified as "Other" (3.0%). The mean age of participants was 19.5 years ( $SD=1.8$  years).

Each participant met individually with an experimenter on two occasions. During the first meeting, participants completed a demographic form, the 20-item RPI, the EROS, and the BDI-II. Following the questionnaires, participants were given seven daily diary activity-monitoring forms that had them monitor overt behaviors from 8 a.m. until 2 a.m.

Accordingly, behavior was monitored for 18 hours per day or a total of 126 hours for each participant (Hopko, Armento et al., 2003). The following instructions were provided:

I'd like you to keep this record for one week, making an effort to behave in as "normal" a manner as possible. What I'd like you to do is to record your behaviors during these half-hour intervals—you don't have to put everything you did in each half hour, only how MOST of your time during that half hour was spent. Remember to record only your behaviors, that is, what you do and how you spend your time. It is not necessary to write down specific thoughts or feelings that you might be having. Also, don't worry about having to write down everything as it happens—that might be too overwhelming. Instead, try to keep track of your behaviors every 3–4 hours, remembering how you spent your time. When you write down your behaviors, rate each of them using this scale, from 1 (*least rewarding or pleasurable*) to 4 (*most rewarding or pleasurable*). Of course you also may rate behaviors as having a reward value of "2" or "3." You have one form for each day of the week till we next meet. Try to be as accurate and as thorough as you can.

Participants returned approximately 1 week later and completed the postassessment RPI, EROS, and BDI-II. Throughout the assessment process, experimenters were blind to assessment results. For purposes of data analyses, given our objective of assessing the predictive validity of the RPI as it pertained to daily activities and associated reward, the pre- and post-RPI scores were used to formulate a mean score ( $M=60.6$ ,  $SD=8.9$ ) that would best represent self-assessed environmental reward during the week-long daily diary procedure (i.e., as opposed to using only the pre- or post-assessment score). This same procedure was used for each of the two RPI subscales (Factor 1:  $M=34.7$ ,  $SD=4.9$ ; Factor 2:  $M=25.9$ ,  $SD=4.7$ ), as well as the EROS ( $M=29.1$ ,  $SD=6.5$ ) and BDI-II ( $M=9.8$ ,  $SD=6.5$ ).

### RESULTS

#### Normative Data

Consistent with the first two studies, the symmetry (skewness=−.55,  $SE=.41$ ) and the flatness (kurtosis=.27,  $SE=.80$ ) of the distribution were within acceptable limits, and a visual analysis of observed values revealed a normal Q–Q plot with a uniform distribution. Based on independent sample  $t$  tests, neither an ethnicity (Caucasian vs. non-Caucasian) nor a gender effect was identified on



either the RPI total score (females:  $M=59.5$ ,  $SD=8.7$ ; males:  $M=62.0$ ,  $SD=11.0$ ) or RPI subscales.

### Reliability Analyses

Internal consistency of the RPI was strong at both the initial ( $\alpha=.90$ ) and second (test-retest) administration ( $\alpha=.90$ ). All corrected item-total correlations were statistically significant ( $p<.01$ ) for both Administration 1 (range=.18 to .82) and Administration 2 (range=.22 to .73). One-week test-retest reliability was excellent for the RPI total score ( $r=.88$ ) as well as Factors I ( $r=.83$ ) and II ( $r=.86$ ).

### Convergent Validity

In further support of the convergent validity of RPI and consistent with Study 2 results, moderate-to-strong correlations were observed between the RPI total score and a measure of environmental reward (EROS:  $r=.80$ ) and depression (BDI-II:  $r=-.74$ ).

### Predictive (Incremental) Validity

In total, participant behaviors were monitored for 126 hours. For the entire sample, average duration of time at each level of reward/pleasure was as follows: Level 1 ( $M=13.1$ ,  $SD=18.9$ ); Level 2 ( $M=29.3$ ,  $SD=15.3$ ); Level 3 ( $M=43.4$ ,  $SD=18.5$ ); and Level 4 ( $M=40.2$ ,  $SD=22.0$ ). Accordingly, for this sample, approximately 66% of behaviors were rated as highly rewarding or pleasurable (i.e., Level 3 or 4). To assess reward value of (daily diary) behaviors as a continuous variable, each participant received a total environmental reward score that was based on the following formula:

$$\begin{aligned} \text{Total Environmental Reward} = & \text{Time in Level 1} \\ & \text{behaviors (*1)} + \text{Time in Level 2} \\ & \text{behaviors (*2)} \\ & + \text{Time in Level 3} \\ & \text{behaviors (*3)} \\ & + \text{Time in Level 4} \\ & \text{behaviors (*4)}. \end{aligned}$$

A hierarchical multiple regression analysis was then conducted to determine the relative value of self-reported environmental reward (RPI) and depressive symptoms and behaviors (BDI-II) in

predicting total environmental reward as assessed via the daily diaries. Given study hypotheses and the finding of high bivariate relationships between the RPI (factors) and the BDI-II, we assessed the incremental value of the RPI factors in predicting rewarding behavior above that accounted for by the BDI-II. With Total Environmental Reward as the criterion variable, Step 1 of the regression model included BDI-II-assessed depressive symptoms and behaviors. In Step 2, we assessed the incremental value of the RPI factors (Reward Probability and Environmental Suppressors), anticipating that access to environmental reward as measured by daily diaries would be better accounted for by a direct measure of reward (RPI) as opposed to the related but less specific measure of depression (BDI-II). For the regression analysis, collinearity statistics were within the acceptable range, tolerance values=.32 to .47; variable inflation factor (VIF)=2.1 to 3.1 (Hair et al., 1995). Results of the regression analysis are presented in Table 4. For total environmental reward, the BDI accounted for 22% of the variance, with increased depression associated with less environmental reward. When the RPI factors were added in Step 2, the amount of variance increased to 51%, overall regression model:  $F(3, 29)=10.15$ ,  $p<.001$ , with higher self-reported reward probability significantly related to rewarding behaviors as indicated on the daily diaries. Change statistics indicated that the addition of the RPI to the prediction of total environmental reward was statistically significant,  $F$  change (2, 29)=8.69,  $p=.001$ .

Because we wanted to assess the incremental validity of the RPI in relation to that of the EROS, the current measure for assessing environmental reward, a second hierarchical multiple regression analysis was conducted with the BDI-II in Step 1 and the EROS entered in Step 2 instead of the RPI. Collinearity statistics were again within the acceptable range, tolerance value=.35; variable inflation factor (VIF)=2.8 (Hair et al., 1995). Results of the

Table 4  
Total Environmental Reward as a Function of RPI Factors and BDI-II Self-Report

Independent Variable	Standardized Coefficient ( $\beta$ )	SE	sr	t	p
<i>Step 1</i>					
BDI-II	-.47	1.3	-.47	-2.95	<.01
$R^2=.22$					
<i>Step 2</i>					
BDI-II	-.14	1.8	-.11	-.60	=.56
RPI (Reward Probability)	.79	1.9	.61	4.20	<.001
RPI (Env. Suppressors)	-.27	2.5	-.21	-1.16	=.26
$R^2=.51$					
$\Delta R^2=.29$					

Table 5  
Total Environmental Reward as a Function of EROS and BDI-II Self-Report

Independent Variable	Standardized Coefficient ( $\beta$ )	SE	sr	t	p
<i>Step 1</i>					
BDI-II	-.47	1.3	-.47	-2.95	<.01
$R^2 = .22$					
<i>Step 2</i>					
BDI-II	.06	1.9	.05	.25	=.80
EROS	.66	2.3	.44	2.70	=.01
$R^2 = .37$					
$\Delta R^2 = .15$					

regression analysis are presented in Table 5. For total environmental reward (and unchanged as expected), the BDI again accounted for 22% of the variance, with increased depression associated with less environmental reward. When the EROS was added in Step 2, the amount of variance increased to 37%, overall regression model:  $F(2, 30) = 8.89$ ,  $p = .001$ , with higher self-reported environmental reward significantly related to total environmental reward as assessed on the daily diaries. Change statistics indicated that the addition of the EROS to the prediction of total environmental reward was statistically significant,  $F$  change (1, 30) = 7.29,  $p = .01$ . Importantly, relative to the EROS, the RPI accounted for approximately twice the incremental variance (29% vs. 15%) in predicting total environmental reward as assessed via daily diaries.

### Discussion

These three studies were designed to establish the psychometric properties of the RPI, a brief self-report instrument assessing access to environmental reward as defined in theories of RCPR (i.e., the number of potential reinforcers, availability of reinforcers, the ability to obtain reinforcement, and exposure to aversive events; Lewinsohn, 1974; Lewinsohn et al., 1980). In other words, the RPI was a proxy measure of RCPR in which the contingencies of interest were the relation of behaviors and environmental conditions outlined on the RPI with depressive emotions and behaviors measured via the BDI-II. In Study 1, the RPI was established as a 20-item two-factor scale (Reward Probability and Environmental Suppressors), with strong internal consistency for the total scale and both subscales. The Reward Probability factor consisted of 11 items that involved integrating the number of potential reinforcers and an individual's ability to obtain reinforcement through instrumental behaviors. The Environmental Suppressors factor included 9 items that assessed availability of potential reinforcers and the presence of aversive stimuli in the environment. Confirmatory factor analysis on the replication

sample in Study 2 supported the two-factor structure through excellent goodness-of-fit indices and established its stronger model fit compared to both unifactorial and four-factor models. Convergent validity of the RPI and both subscales was established in Study 2 through strong positive correlations with other psychometrically sound self-report measures of activity and avoidance (BADs) and environmental reward (EROS), as well as moderate inverse relationships with commonly utilized measures of depression (BDI-II, CES-D). Supporting divergent validity, lower correlations were observed between the RPI and social support (MSPSS) and somatic anxiety (BAI). Additionally, internal consistency and 2-week test-retest reliability were excellent. Finally, Study 3 demonstrated support for the predictive validity of the RPI. After controlling for variance associated with depressive symptoms (BDI-II), an emotional condition highly and inversely associated with environmental reward, the RPI accounted for significant incremental validity in predicting total environmental reward. When the same analysis was repeated using the most common measure of environmental reward (EROS), the RPI accounted for nearly twice the variance (29% vs. 15%).

The relationships between the RPI and its factor scores with measures of depression symptomatology support behavioral models that identify diminished access to environmental reward and reduced RCPR as primary factors contributing to the development and maintenance of depression symptoms (Ferster, 1973; Lewinsohn, 1974). Importantly, the RPI accounted for nearly double the variance of the previously developed EROS in predicting total environmental reward. This finding is interpreted as a significant advancement that is primarily due to the RPI being developed with increased focus on the four primary components of RCPR as theorized by Lewinsohn and colleagues (Lewinsohn, 1974; Lewinsohn et al., 1980). Accordingly, the RPI and its factors represent a measure with increased construct validity relative

to the EROS. As acknowledged in the Introduction, a self-report instrument cannot directly assess RCPR, in that to do so, one would need to observe increased behavior over time as a function of specific environmental consequences. In assessing environmental contingencies and their relation to depression (Ferster, 1973), an ideal strategy would incorporate direct observational methods conducted within a longitudinal research design. Although such research may indeed be feasible, it is also scientifically prudent to develop multimethod assessment strategies to more comprehensively assess etiological and maintaining factors associated with depression. The RPI represents a pragmatic measure of critical factors proposed to determine an individual's exposure to environmental reward, and thus the measure approximates RCPR in the absence of direct behavioral observations of environmental contingencies over time. Establishing the reliability and validity of this measure as it relates to direct observations of the frequency and duration of rewarding behaviors and emotional consequences will be an important area of exploration.

Factor analyses on the RPI revealed two distinct factors of Reward Probability and Environmental Suppressors. The emergence of two factors was contrary to the expected four factors that were hypothesized to correspond to each of the four components of RCPR (Lewinsohn, 1974; Lewinsohn et al., 1980). This is a provocative finding, in that it may be an indication that RCPR can be understood in a more parsimonious way than previously theorized. Specifically, there may be minimal qualitative and conceptual distinctions between the number of potentially reinforcing events for an individual and that person's ability to elicit reinforcement. Instead, the probability of a behavior being rewarded (Factor 1) requires both adequate exposure to a broad range of situations and events and the necessary skills (social or otherwise) to engage or "perform" behaviors that will be rewarded and possibly reinforced in these contexts. Second, to the degree that environmental suppressors (Factor 2) are operative in that the availability of reinforcers in an individual's environment is limited and exposure to punishing or aversive experiences is increased, reinforcing contingencies will be less probable. Therefore, perhaps an individual's rate of RCPR is best understood more simply as a combination of factors that increase the likelihood of reinforcement (i.e., Reward Probability) weighed against variables that diminish the probability of reinforcement (i.e., Environmental Suppressors). Current data support such a conceptualization.

Although findings of these studies strongly support the psychometric properties of the RPI

and have important theoretical implications, this research program must be expanded to include more heterogeneous clinical and nonclinical samples. The current samples primarily involved younger, educated, and nondepressed Caucasian undergraduates. Given the observed relationships between the RPI and the depression symptomatology, it is expected that the findings of the current studies would generalize to clinical samples. A second potential limitation of the RPI is that it measures components of RCPR at a global and retrospective level, with a general time frame of "the past several months," and items such as "There are many activities that I find satisfying" and "My behaviors often have negative consequences." It could be argued that a more content- and time-specific assessment of reward domains (e.g., relationships, recreation, occupation), such as that provided by the PES (MacPhillamy & Lewinsohn, 1971), might provide idiographic data that is more relevant to psychological assessment and treatment and promotes a better understanding of an individual's unique reinforcement contingencies. As a counterargument, however, there are data that support the predictive utility and treatment sensitivity of measures of affect and behavior that are nonspecific in domain content (Armento & Hopko, 2007; Hopko et al., 2000; Stanley et al., 2003). Third, the RPI and similar self-report measures of reward and activity are limited in that some items may reflect the influence of common depression symptoms such as anhedonia and diminished energy. This possibility must be considered when interpreting the relationships between the RPI and the measures of depression symptoms. Importantly, however, as suggested in Study 3, the RPI accounted for an additional 29% of the variance in total environmental reward after controlling for depression, supporting the discriminant validity of the RPI.

In conclusion, the RPI represents a valid, reliable, and parsimonious measure of access to environmental reward that supports behavioral theories of depression. The RPI is the first measure that directly evaluates the four core components of RCPR, the guiding construct at the foundation of behavioral conceptualizations and treatments of depression. Accordingly, this measure fills a significant void in the assessment literature. As a means of assessing environmental reward and RCPR, the RPI may benefit behavioral and neurobiological research programs investigating associations between reinforcement and affect (Harmon-Jones et al., 2002; Hopko, Lejuez, Ruggiero et al., 2003; Jacobson et al., 1996; Lewinsohn & Graf, 1973; McBride, Murphy, & Ikemoto, 1999; Naranjo et al., 2001). By accounting for behavioral and environmental

factors that contribute to depression symptoms, the RPI has the potential to broaden and enhance the psychological assessment of negative mood states, while informing conceptualization and treatment efforts. Further, the scale's brevity makes it practical and accessible compared to more extensive measures like the PES (MacPhillamy & Lewinsohn, 1971), and therefore it may be more pragmatic for research and clinical endeavors, particularly in medical care environments where the need to focus on accountability as well as cost- and time-effectiveness have been highlighted (Schoenbaum, Unutzer, Sherbourne, & Duan, 2001; Wells, Schoenbaum, Unutzer, Lagomasino, & Rubenstein, 1999).

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