Published in final edited form as:

Child Health Care. 2015 ; 44(3): 205–220. doi:10.1080/02739615.2014.948164.

Assessing Environmental Consequences of Ticking in Youth with Chronic Tic Disorders: The Tic Accommodation and Reactions Scale

Matthew R. Capriotti¹, John C. Piacentini², Michael B. Himle³, Emily J. Ricketts^{1,4}, Flint M. Espil¹, Han Joo Lee¹, Jennifer E. Turkel¹, and Douglas W. Woods⁵

¹University of Wisconsin-Milwaukee

²University of California Los Angeles

³University of Utah

⁴Western Psychiatric Institute and Clinic/University of Pittsburgh Medical Center

⁵Texas A&M University

Abstract

Tics associated with Tourette syndrome and other chronic tic disorders (CTDs) often draw social reactions and disrupt ongoing behavior. In some cases, such tic-related consequences may function to alter moment-to-moment and future tic severity. These observations have been incorporated into contemporary biopsychosocial models of CTD phenomenology, but systematic research detailing the nature of the relationship between environmental consequences and ticking remains scarce. This study describes the development of the Tic Accommodation and Reactions Scale (TARS), a measure of the number and frequency of immediate consequences for ticking experienced by youth with CTDs. Thirty eight youth with CTDs and their parents completed the TARS as part of a broader assessment of CTD symptoms and psychosocial functioning. The TARS demonstrated good psychometric properties (i.e., internal consistency, parent-child agreement, convergent validity, discriminant validity). Differences between parent-reported and child-reported data indicated that children may provide more valid reports of tic-contingent consequences than parents. Although preliminary, results of this study suggest that the TARS is a psychometrically sound measure of tic-related consequences suited for future research in youth with CTDs.

Chronic tic disorders (CTDs) such as Tourette syndrome are impairing biobehavioral conditions marked by the recurrent presence of motor and/or phonic tics. Tics are thought to result from structural and functional irregularities within brain-based cortico-striato-thalamo-cortical circuitry, which is responsible for motor planning, gaiting, and execution (Mink, 2003; Peterson et al., 2003; Wang et al., 2011). Substantial evidence suggests that behavioral factors also impact the expression of tic symptoms. Research has implicated both antecedent events (i.e., those which are in effect prior to the occurrence of a tic) and consequence events (i.e., those which occur after the tic, as a result of its occurrence) as

behavioral factors associated with variation in tic symptoms. In line with this research, widely-used interventions for CTDs (e.g., Comprehensive Behavioral Intervention for Tics, CBIT, Woods et al., 2008) include therapeutic components aimed at identifying and constructively addressing relationships between behavioral factors and tic severity.

Both descriptive and experimental studies have shown that antecedent variables can be associated with either the attenuation or exacerbation of tics for a given individual (for a review, see Conelea & Woods, 2008a). Frequently-reported tic-exacerbating antecedents include talking with others, watching television, discussing tics, specific activities or settings, and stress and anxiety (Silva, Munoz, Barickman, & Friedhoff, 1995). It is important to note that associations between specific antecedents and tics are idiographic in nature; what exacerbates tics for one individual may attenuate tics for another. For instance, in one study (O'Connor, Brisebois, Brault, Robillard, & Loiselle, 2003), 50% of participants reported that social activities were associated with tic exacerbation, while another 39% reported that such social engagements reduced tics. Consistent with operant learning theory (e.g., Skinner, 1938), another type of behavioral factor, tic-related consequences, can also increase or decrease tic strength. For example, if a patient, "Joey" has several classmates who often ask, "Are you OK" after he has a head-jerking tic, then Joey may become more likely to exhibit this head-jerking tic in the future when around these classmates. In such a case, the well-intentioned comments reinforce or "strengthen" the tic. In this context, the term "consequence" refers to any change in the child's external or internal (i.e., bodily) environment that occurs as the result of the behavior. This differs somewhat from lay usage of the word, which sometimes implies the delivery of a punishment for misbehavior.

These relationships have clear clinical implications. If consequences that strengthen tics could be identified and minimized, and those that weaken tics could be identified and strategically implemented, then patients might experience an overall reduction in tic severity. Only one study has evaluated perceived associations between tic exacerbation and environmental consequences among individuals with CTDs. Himle and colleagues (in press) analyzed data from clinical interviews with 51 youth receiving behavior therapy for CTDs and their parents. Children and their parents were asked about a number of social consequences that may occur during periods of tic exacerbation, and the clinician dichotomously recorded whether or not each consequence had been endorsed. A majority of respondents endorsed attention-based consequences (e.g., being told to stop ticcing, 73%; receiving comfort, 59%; being laughed at, looked at, or asked about tics, 35%). Additionally, a substantial proportion of patients endorsed escape-based consequences (i.e., being provided a break or asked to leave an area, 18%; being unable to complete a required chore or task, 26%). The number of functional consequences endorsed was positively correlated with some aspects of tic severity. However, this analysis was limited by the fact that the frequency with which said consequences occurred was not measured.

Several studies have experimentally demonstrated functional relationships between tic frequency and environmental consequences. For instance, Watson and Sterling (1998) compared rates of a child's coughing tic under two different experimental conditions. In the "attention" condition, the child's parent provided brief verbal attention after a tic occurred (e.g., commented on the tic). In the "tangible" condition, the parent made no comments on

the tic, but instead provided the child a preferred item when the tic occurred. Tic rates were reliably higher in attention conditions than in tangible conditions, suggesting that this attention was reinforcing ticcing for the child. Based on this, the authors designed an ultimately-successful intervention based on differential attention, in which the child's parents stopped attending to the tic and instead provided attention following tic-free periods.

Similarly, Carr, Taylor, Wallander, and Reiss (1996) conducted a functional analysis of an 11-year-old boy's vocal tics. This analysis included two conditions wherein differential consequences were provided for ticcing: one was an attention condition similar to that used by Watson and Sterling (1998). The other was an "escape" condition in which the child was presented with a moderately difficult academic task (a math worksheet), and, when a tic occurred, the experimenter instructed the boy to "take a break" and withdrew the worksheet for 30s. That is, ticcing resulted in a temporary escape from the work requirement. Tic rates were elevated in both the attention and escape conditions compared to a control condition, suggesting that the boy's tics were exacerbated by both attention and escape from demands. Finally, Scotti, Schulman, and Hojnacki (1994) conducted a similar assessment with a young man with tics and intellectual disability. They concluded that his tics were maintained, in part, by escape (i.e., social negative reinforcement), as indicated by elevated rates of ticcing during the escape condition).

Environmental consequences can also function to weaken tics (e.g., by reducing their frequency). Numerous laboratory-based studies have demonstrated this by delivering small rewards following brief tic-free intervals (i.e., according to a differential reinforcement of other behavior, or "DRO," schedule). Across studies, strong reductions (~80%, on average) are seen when rewards are provided contingent on tic suppression (Capriotti, Brandt, Espil, Ricketts, & Woods, 2012; Capriotti, Brandt, Turkel, Lee, & Woods, in press; Conelea, Brandt, & Woods, 2011; Conelea & Woods, 2008b; Himle & Woods, 2005; Himle, Woods, Conelea, Bauer, & Rice, 2007; Lyon et al., 2011; Specht et al., 2013). Notably, merely asking subjects to suppress tics in the absence of reinforcement for doing so has been found to yield only slight decreases in tic frequency (~10%, Woods & Himle, 2004).

Results of other studies suggest that consequences for ticcing can also influence premonitory urges, which are uncomfortable sensations that precede tics and are temporarily alleviated by their performance. In one such study, the number of aversive tic-related experiences children endorsed (e.g., "Do other kids pick on you... because of your tics?") was directly related to premonitory urge severity, even when controlling for tic severity (Capriotti, Espil, Conelea, & Woods, 2013). Despite limitations surrounding the cross-sectional nature of this study, these results lend support to the model of urge progression described by Woods, Piacentini, Himle, and Chang (2005). In this model, urges begin as benign, transient pre-tic sensations; but, as individuals age and experience a history of consequences for ticcing, these sensory experiences become important "warning signs" that signal the upcoming consequences of ticcing and, therefore, they become more salient and acquire an aversive valence.

At present, it is clear that: (a) environmental consequences for ticcing can be related to both increases and decreases in tic frequency, (b) a majority of youth with CTDs and their families perceive that environmental consequences are associated with tic exacerbation and,

c) existing behavioral interventions rely on consequence manipulation as part of treatment packages for tics (Piacentini et al., 2010; Wilhelm et al., 2012; Woods et al., 2008). However, the literature on environmental consequences and ticcing has several notable limitations. First, no standardized measures for assessing the frequency of tic-related consequences exist. Previous studies have relied on dichotomous items assessing whether or not certain consequences ever occur, without measuring their frequency. However, according to operant theory, the frequency with which a reinforcing consequence follows a behavior is a critical determinant of whether and how the behavior will change in the future (Ferster & Skinner, 1967). Likewise, there have been no empirical evaluations of whether interview- and parent-training-based approaches to the functional (i.e., consequence-based) assessment and treatment of tics actually lead to changes in the child's natural environment and, in turn, promote symptom reduction. Given that the surveys and interviews used in existing studies have not had well-defined time windows (i.e., have not specifically asked about consequences experienced in the past week, month, etc.), they may not be sensitive to treatment-induced changes. Thus, an instrument for assessing consequences within a brief, well-defined timeframe is needed to test these questions.

Based on the multitude of questions surrounding the effects of environmental consequences for ticcing, and the lack of empirically-supported tools for assessing them in customary outpatient settings, we developed the Tic Accommodation and Reactions Scale (TARS), a paper-and-pencil measure of the frequency with which environmental consequences for ticcing occur. The present study aimed to provide a preliminary evaluation of the reliability and validity of this measure.

Method

Participants

Participants were youth and their parents who participated in one of two trials of behavior therapy for CTDs. Both trials were previously approved by the University of Wisconsin-Milwaukee Institutional Review Board. Inclusion criteria common to both trials were: age 8–17 years, positive diagnosis of a CTD, YGTSS total tic score > 13 and < 30 if diagnosed with Tourette syndrome or > 9 and < 20 if diagnosed with chronic motor or vocal tic disorder, and low-average or above intellectual functioning. Youth were excluded from either trial if they presented with another psychiatric condition requiring immediate treatment, had previously received behavior therapy for tics, or met criteria for psychosis, autism-spectrum, mania, conduct, and/or substance abuse disorders. For one trial (F31MH096375; Ricketts, PI), in which therapy was delivered via telehealth, participants were also required to have a computer with reliable high-speed internet access at home. For the other trial (NCT01440023; Lee, PI), which involved testing a computerized response inhibition training program as an adjunct to behavior therapy, participants were excluded if they presented with unmanaged attention deficit hyperactivity disorder symptoms (Conners' t-score > 70). Children on psychotropic medications were included in both trials as long as their regimen had been stable for a criterion period (six weeks for the telehealth study, four weeks for the response inhibition study).

Thirty eight youth and their parent(s)/guardian(s) participated in the present study. If multiple parents/guardians presented to the assessment with the child, each participated in interview-based assessments of tic severity and comorbid psychopathology (see below), but only one completed the TARS and was instructed to do so independent of other informants. Child participants had a mean age of 11.7 years ($SD=2.2$) and were predominantly male (79%) and Caucasian (92%). The mean YGTSS tic severity score was 22.1 ($SD=7.2$), indicative of moderate tic severity. Thirty seven percent of participants met diagnostic criteria for at least one Axis-I psychiatric condition aside from CTD, including attention deficit hyperactivity disorder (21%), obsessive-compulsive disorder (10%), and other anxiety disorders (21%). Thirty two percent were taking a psychotropic medication for CTD at the time of the study.

Instrument Development

TARS items ($n=35$) were developed based on consequence items on the Functional Assessment Interview Form used in Comprehensive Behavioral Intervention for Tics treatment protocol (Woods et al., 2008). This treatment package was designed by members of the Tourette Syndrome Association Behavioral Sciences Consortium, a multidisciplinary team of experts in the behavioral assessment and treatment of tic disorders. Subscales were determined a priori. Three setting-based subscales were defined as the sum of all item scores for items within the Home ($n=14$ items), School ($n=9$), and Public ($n=12$) domains, respectively. Three function-based subscales (Attention, $n=20$; Escape, $n=10$; and Aversive, $n=17$) were designated based on the putative behavioral function(s) of the consequence described (i.e., social positive reinforcement, social negative reinforcement, or social punishment, respectively). Appendix A contains representative items from each subscale.

Procedure

Participation in this study occurred within pre-intervention assessment sessions of treatment studies for pediatric CTDs. In these sessions, youth and their parents completed various interviews and questionnaires assessing tic and comorbid psychiatric diagnoses, psychosocial functioning, intellectual functioning and tic-specific symptom severity. A Masters-level clinician with extensive training in the behavioral assessment and treatment of tic disorders conducted all interviews and answered respondents' questions about questionnaires when they arose. Diagnostic status and intellectual functioning were assessed at an initial screening appointment. All other measures described herein were administered in a baseline assessment appointment that occurred 1–2 weeks later.

Measures

Yale Global Tic Severity Scale (YGTSS)—The YGTSS is an interview-based, clinician-rated measure of tic severity and tic-related impairment. Based on a structured interview with the patient and his/her parent(s)/guardian(s), the clinician separately rates the severity of motor and vocal tics along a number of dimensions (number, frequency, intensity, complexity, and interference; range: 0–5 each). These are used to create separate motor and vocal tic severity scores (range: 0–25 each), which can then be summed to create a total tic severity score (range: 0–50). Additionally, the interview includes questions about tic-related

distress and impairment, which contribute to a global rating of tic-related impairment (range: 0–50). The YGTSS has excellent internal consistency and inter-rater reliability (Leckman et al., 1989) and is considered the gold-standard measure of tic severity in clinical research.

Mini Neuropsychiatric Interview for Children (MINI-KID)—The MINI-KID is a respondent-based structured interview that assesses for the current presence/absence of common Axis-I psychiatric conditions. It has demonstrated sound psychometric properties and good convergent validity with other well-validated and widely-used diagnostic interviews (Sheehan et al., 2010).

Premonitory Urge for Tics Scale (PUTS)—The PUTS is a paper-and-pencil questionnaire on which patients with CTDs rate the extent to which they experience various forms of tic-related premonitory urges. Responses are provided on a four-point scale ranging from “not at all true” to “very true.” The PUTS has demonstrated good internal consistency ($\alpha=.81$), reliability, and validity in children, adolescents, and adults with CTDs (Crossley et al., 2014; Reese et al., 2014; Woods et al., 2005). In the initial PUTS development study, the mean score was 18.5 ($SD=6.1$).

Family Assessment Measure III-Brief Form (FAM III-Brief)—The FAM III-Brief is a 14-item measure that assesses general family functioning (Skinner, Steinhauer, & Santa-Barbara, 1995). It can be completed by the child and parent separately or together. Higher FAM III-Brief scores are indicative of more problematic family functioning. All versions of the FAM-III have demonstrated strong reliability and validity with child, parent, and joint-informant approaches (Skinner, Steinhauer, & Sitarenios, 2000). In the present study, the child-report version was used as the primary measure of overall family functioning.

Results

Mean, Standard Deviation, and Distribution of Scores

Inspection of total TARS scores indicated an adequate spread of scores for both parent-report (range: 0–32) and child-report (range: 0–42) versions. The mean total scores were significantly lower ($t_{37}=4.25$, $p<.01$) for parents ($M=8.26$, $SD=.38$) than for youth ($M=14.58$, $SD=.38$). For both respondent types, the distribution of total scores was positively skewed. However, more skew was observed in parent-reported scores (moment of skewness coefficient= +1.27) than for child-report scores (+0.81). Additionally, parents endorsed the occurrence of fewer distinct consequences (defined by the number of items with scores >0) than did children ($t_{37}=3.53$, $p<.01$, Parents: $M=6.94$, $SD=5.64$; Children: $M=10.1$, $SD=5.51$).

Internal Consistency

Cronbach's alpha was calculated to evaluate the internal consistency of the TARS. Results were interpreted according to George and Mallery's (2003) guidelines. Good internal consistency was seen for the total scores on both parent-report ($\alpha=.89$) and child-report ($\alpha=.83$) versions. For the parent-report version, internal consistency was good for the Home subscale ($\alpha=.80$) and for the Public subscale ($\alpha=.82$), and acceptable for the School subscale

($\alpha=.66$). For the child-report version, similar patterns were seen, with good internal consistency for Home ($\alpha=.70$) and Public subscales ($\alpha=.72$), and acceptable internal consistency for the School subscale ($\alpha=.65$). We completed identical analyses for the function-based subscales. When examining parent-reported scores, internal consistency was good for the Attention ($\alpha=.88$) and Aversive ($\alpha=.77$) subscales and acceptable for the Escape subscale ($\alpha=.63$). Similarly, for child report data, internal consistency was good for the Attention ($\alpha=.82$) and Aversive ($\alpha=.82$) subscales, and poor for the Escape subscale ($\alpha=.57$).

Table 1 shows intercorrelations among TARS subscales. Significant positive relationships were seen among setting-based subscales. That is, for each informant, Home, School, and Public subscale scores were related to each other (R range: .39–.65). In general, the same pattern was seen for parallel analyses on function-based subscales (R range: .34–.81)

Parent-Child Agreement

We computed Spearman's rank-order correlation coefficients for the relationships between parent and child reports on total scores and each subscale. Fair correspondence was seen for total scores ($\rho=.52$). For setting-based subscales, agreement was strong for the Home subscale ($\rho=.70$), but relatively low for the School ($\rho=.36$) and Public ($\rho=.25$) subscales. Among function-based subscales, agreement was roughly comparable for the Attention ($\rho=.53$), Aversive ($\rho=.47$), and Escape ($\rho=.39$) subscales.

Convergent and Discriminant Validity

We sought to evaluate the convergent and discriminant validity of the TARS by examining the relationship of total TARS scores to measures of tic severity, tic-related impairment, and premonitory urge severity (convergent)¹, as well as to measures of general family functioning (divergent). General family functioning was used as a comparator for divergent validity to test if the TARS was picking up on more global styles of familial reaction to child behavior (i.e., not specific reactions to tics, but to challenging behaviors in general). Tables 2 and 3 display the results of these analyses.

In general, convergent validity was supported by the correlation of total child- and parent-report TARS scores with multiple dimensions of CTD symptom severity and disorder-related impairment. Discriminant validity was supported by the lack of significant correlation between TARS total scores and FAM III-Brief scores.

Parent-report total TARS scores were positively correlated with degree of vocal tic severity and tic-related impairment (Table 2). For child-report total TARS scores, significant positive correlations were seen with vocal tic severity, total tic severity, premonitory urge severity, and tic-related impairment. For Home and Public subscales, similar patterns of correlation were seen. For the School subscale, parent-report total scores correlated only marginally with PUTS scores, and child-report scores correlated significantly with vocal tic severity and tic-related impairment. No setting-based subscale score for either informant was significantly correlated with family functioning.

¹YGTSS total tic severity scores and PUTS scores were not significantly correlated in this sample (R=.04, $p=.84$).

We conducted comparable analyses using function-based subscales (Table 3). Escape subscale scores were positively correlated with a majority of CTD symptom and impairment dimensions, using both parent- and child-report versions of the TARS. Child-report Escape scores were strongly correlated with premonitory urge severity ($\rho = .56$, $p < .01$). For the Aversive subscale, child-report scores correlated directly with vocal tic severity, total tic severity, and tic-related impairment. In contrast, parent-report scores correlated only with tic-related impairment. Attention subscale scores were related to relatively few dimensions of CTD severity for both parent- and child-report TARS forms. Child-report scores were significantly related to vocal tic severity ($\rho = .38$, $p < .05$) and marginally correlated with tic-related impairment, whereas parent-report scores were significantly correlated only with tic-related impairment. Function-based subscale scores by either informant were generally not correlated with overall family functioning; however, a significant correlation ($\rho = .38$, $p = .02$) was observed between child-reported escape-based consequences and family functioning.

Finally, we explored the relationship between total TARS scores and specific dimensions of tic severity. We created combined dimensional scores by summing the motor and vocal scores each dimension of tic severity assessed by the YGTSS (i.e., number, frequency, intensity, complexity, and interference). Parent-reported TARS scores were related only to tic intensity ($\rho = .37$, $p = .03$; $p > .35$ for all other analyses). Child-report scores were significantly related to tic frequency ($\rho = .41$, $p = .02$) and intensity ($\rho = .45$, $p < .01$), and marginally related to number of tics ($\rho = .32$, $p = .07$) and tic-related interference ($\rho = .30$, $p = .08$).

Discussion

We developed and tested the psychometric properties of a paper-and-pencil measure (the TARS) for assessing environmental consequences for ticcing in youth with CTDs. Overall, the TARS demonstrated acceptable psychometric properties, indicating that it is suitable for use in future clinical research studies examining environmental consequences of ticcing. Although not necessarily intended as a unitary measure, the TARS demonstrated relatively high internal consistency across parent and child informants. Internal consistency was also high for setting-based and function-based subscales. In addition to describing the psychometric properties of this measure, these findings may also elucidate the nature in which tic-related consequences occur in naturalistic environments. High internal consistency was observed within each setting-based subscale; for instance, children who endorsed frequently experiencing one type of consequence for ticcing at home were more likely to experience other types as well. This may suggest that different systems in a child's life (e.g., family, school, extracurricular groups) develop characteristic levels of responding to tics. The positive correlations observed in consequences between settings indicate that some personal characteristics (e.g., the nature of the child's tics, other behavioral patterns, physical traits of the child) or generalized social patterns of responding to tics may yield similar levels of consequences across settings.

Consistent with previous research (Carr et al., 1996; Himle et al., in press; Scotti et al., 1994; Watson & Sterling, 1998), this study found that the vast majority of youth with CTDs report experiencing consequences for ticcing (cf. Himle et al., in press), and that these

consequences (as measured by TARS scores) are positively correlated with tic severity. This is consistent with the notion that tic-contingent consequences commonly function as reinforcers (i.e., increase tic severity). However, the results of this study do not speak to the directionality of causation in the observed relationship between tic severity and tic-contingent consequences. Longitudinal research is needed to determine direction of causality in this relationship. Regardless of these issues, our findings, particularly related to the Aversive subscale data, argue strongly that contingently telling the child to stop ticcing would be unlikely to decrease the severity of his/her tics in the future. This suggests that natural environments are unlikely to arrange social consequences that successfully decrease tic severity in the manner observed in some laboratory studies (e.g., Conelea et al., 2011; Himle et al., 2007; Woods & Himle 2004).

We also saw interesting differences based on informant (i.e., between parent- and child-report versions of the TARS). For TARS total scores and both sets of subscale scores, child-reported accounts of tic-related consequences tended to be more strongly associated with aspects of tic and premonitory urge severity than were parent-reported TARS scores. Additionally, parent-child agreement was variable across subscales, and parents reported lower total scores than children. Taken together, these data suggest that parents may tend to under-report the extent to which they or other individuals respond to their child's tics. Overall, child-reported TARS scores demonstrated higher convergent validity with CTD severity than did parent-reported scores. Interestingly, parent-reported TARS scores were more strongly associated with YGTSS tic-related impairment scores. Reasons for this are unclear, but perhaps parental perceptions of tic-related impairment influence clinician ratings of impairment more so than children's reports. As a result, parent-completed measures associated with impairment may correlate more highly than do child-completed measures. Whether this is due to differential levels participation in the interview (e.g., children letting their parents "do the talking for them") or clinician bias is an empirical question suited for future research.

The present findings also have notable implications for developmental models of CTDs that incorporate both tics and premonitory urges. Partially supported is the hypothesis that repeatedly experiencing consequences for ticcing leads to increased premonitory urges salience/severity (Capriotti et al., 2013; Woods et al., 2005). The notion that aversive consequences for ticcing promote the development of premonitory urges was not supported, but there was a relationship between escape-related consequences for ticcing and urge severity. Thus, it could be that a history of experiencing social negative reinforcement for ticcing (i.e., escape from or avoidance of unpleasant situations or activities) modulates the salience and/or severity of premonitory urges. Again, longitudinal research is needed to more completely test this hypothesis and earlier ones (e.g., Woods et al., 2005).

Limitations

This study was subject to several limitations. Data were collected at only one timepoint, and therefore we could not evaluate the temporal stability of the TARS. This cross-sectional design also prevented causal inferences from being drawn from our results. Future research involving assessment at multiple timepoints is needed to investigate whether tic-related

consequences at Time A are a significant predictor of tic severity at a later Time B, consistent with the behavioral model of CTDs. Additionally, our sample was relatively small. This precluded a factor analysis, which could have shed additional information on the structure of the TARS. Further investigation of the TARS using a large sample may elucidate the measure's factor structure and allow for more well-powered psychometric analyses. The limited parent-child agreement observed for some subscales in the present study may also be seen as a limitation, although it is possible that these discrepancies reflect differences in what is actually observed by the different reporters, as opposed to a weakness of the measure itself.

Implications for Practice

Aside from setting the stage for future research, results of this study have immediate implications for clinicians providing behavior therapy to youth with CTDs. For one, these data are consistent with the notion that tic-related consequences may be important determinants of tic severity and, as such, important treatment targets. They also suggest that parents are likely to under-report tic-contingent consequences that their child experiences. Given this, clinicians may use a number of strategies to ensure the validity of their function-based assessments. For instance, it may be advisable to collect information independently (e.g., by having both parent and child complete respective versions of the TARS), rather than relying entirely on a joint interview. Clinicians should also keep in mind that parents may be unaware of consequences for ticcing that occur outside of the home. Presenting educational information about the commonality of social consequences for ticcing to parents may increase their comfort with accurately reporting their own reactions to their child's ticcing. Parents may also be reassured to know that tic-related consequences are not indicative of family dysfunction or poor parenting (this study).

Future research elucidating the nature of relations between environmental consequences and CTD symptoms also has great potential to inform an integrated biobehavioral model of CTDs, which, in turn, could serve as a framework within which to approach clinical practice and case conceptualization. Understanding interactional processes related to tic symptoms and potential social reinforcement appears relevant to a variety of issues surrounding the developmental psychopathology of CTDs. The measure described in herein constitutes one tool to aid scientific inquiry toward answering these important questions.

Acknowledgments

This project was supported by grants from the National Institutes of Health to Emily Ricketts (F31MH096375) and from the Tourette Syndrome Association to Han Joo Lee.

References

- Capriotti MR, Brandt BC, Ricketts EJ, Espil FM, Woods DW. Comparing the effects of differential reinforcement of other behavior and response-cost contingencies on tics in youth with Tourette syndrome. *Journal of Applied Behavior Analysis*. 2012; 45:251–263. [PubMed: 22844135]
- Capriotti MR, Brandt BC, Turkel JE, Lee HJ, Woods DW. Negative reinforcement and premonitory urges in youth with Tourette syndrome: An experimental evaluation. *Behavior Modification*. (in press).

- Capriotti MR, Espil FM, Conelea CA, Woods DW. Environmental factors as potential determinants of premonitory urge severity in youth with Tourette syndrome. *Journal of Obsessive-Compulsive and Related Disorders*. 2013; 2:37–42.
- Carr JE, Taylor CC, Wallander RJ, Reiss ML. A functional-analytic approach to the diagnosis of a transient tic disorder. *Journal of Behavior Therapy & Experimental Psychiatry*. 1996; 27:291–297. [PubMed: 8959431]
- Conelea CA, Brandt BC, Woods DW. The impact of a stress induction task on tic frequencies in youth with Tourette syndrome. *Behaviour Research and Therapy*. 2011; 49:492–497. [PubMed: 21658680]
- Conelea CA, Woods DW. The influence of contextual factors on tic expression in Tourette's syndrome: A review. *Journal of Psychosomatic Research*. 2008a; 65:487–496. [PubMed: 18940379]
- Conelea CA, Woods DW. Examining the impact of distraction on tic suppression in children and adolescents with Tourette syndrome. *Behaviour Research and Therapy*. 2008b; 46:1193–1200. [PubMed: 18774126]
- Crossley E, Seri S, Stern JS, Robertson MM, Cavanna AE. Premonitory urges for tics in adult patients with Tourette syndrome. *Brain Development*. 2014; 36:45–50. [PubMed: 23369830]
- Ferster, CB.; Skinner, BF. *Schedules of reinforcement*. New York: Appleton-Century-Crofts; 1957.
- George, D.; Mallery, P. *SPSS for Windows step by step: A simple guide and reference*. 4th ed.. Boston: Allyn & Bacon; 2003. 11.0 update.
- Himle MB, Capriotti MR, Hayes LP, Josyula K, Woods DW, Scahill L, Piacentini J. Functional variables associated with tic exacerbation in children with chronic tic disorders. *Behavior Modification*. (in press).
- Himle MB, Woods DW. An experimental evaluation of tic suppression and the tic rebound effect. *Behaviour Research and Therapy*. 2005; 43:1443–1451. [PubMed: 16159587]
- Himle MB, Woods DW, Conelea CA, Bauer CC, Rice KA. Investigating the effects of tic suppression on premonitory urge ratings in children and adolescents with Tourette's syndrome. *Behaviour and Research Therapy*. 2007; 45:2964–2976.
- Leckman JF, Riddle MA, Hardin MT, Ort SI, Swartz KL, Stevenson J, Cohen DJ. The Yale Global Tic Severity Scale: Initial testing of a clinician-rated scale of tic severity. *Journal of the American Academy of Child and Adolescent Psychiatry*. 1989; 28:566–573. [PubMed: 2768151]
- Lyon GJ, Samar SM, Conelea CA, Trujillo MR, Lipinski CM, Bauer CC, Coffey BJ. Testing tic suppression: Comparing the effects of dexamethylphenidate to no medication in children and adolescents with attention-deficit/hyperactivity disorder and Tourette's disorder. *Journal of Child and Adolescent Psychopharmacology*. 2010; 20:283–289. [PubMed: 20807066]
- Mink JW. The basal ganglia and involuntary movements: Impaired inhibition of competing motor patterns. *Archives of Neurology*. 2003; 60:1365–1368. [PubMed: 14568805]
- O'Connor K, Brisebois H, Brault M, Robillard S, Loiselle J. Behavioral activity associated with onset in chronic tic and habit disorder. *Behaviour Research and Therapy*. 2003; 41:241–249. [PubMed: 12547383]
- Peterson BS, Thomas P, Kane MJ, Scahill L, Zhang H, Bronen R, Staib L. Basal ganglia volumes in patients with Gilles de la Tourette syndrome. *Archives of General Psychiatry*. 2003; 60:415–424. [PubMed: 12695320]
- Piacentini J, Woods DW, Scahill L, Wilhelm S, Peterson AL, Chang S, Walkup JT. Behavior therapy for children with Tourette disorder: A randomized controlled trial. *Journal of American Medical Association*. 2010; 303:1929–1937.
- Reese HE, Scahill L, Peterson AL, Crowe K, Woods DW, Piacentini JC, Wilhelm S. The premonitory urge to tic: measurement, characteristics, and correlates in older adolescents and adults. *Behavior Therapy*. 2014; 45:177–186. [PubMed: 24491193]
- Scotti JR, Schulman DE, Hojnacki RM. Functional analysis and unsuccessful treatment of Tourette's syndrome in a man with profound mental retardation. *Behavior Therapy*. 1994; 25:721–738.
- Sheehan DV, Sheehan KH, Shytle RD, Janavs J, Bannon Y, Rogers JE, Wilkinson B. Reliability and validity of the Mini International Neuropsychiatric Interview for children and adolescents (MINI-KID). *Journal of Clinical Psychiatry*. 2010; 71:313–326. [PubMed: 20331933]

- Silva RR, Munoz DM, Barickman J, Friedhoff AJ. Environmental factors and related fluctuation of symptoms in children and adolescents with Tourette's disorder. *Journal of Child Psychology and Psychiatry*. 1995; 36:305–312. [PubMed: 7759592]
- Skinner, BF. *The behavior of organisms*. New York: Appleton-Century-Crofts; 1938.
- Skinner, HA.; Steinhauer, PD.; Santa-Barbara, J. *FAM-III manual*. Toronto, ON: Multi-Health Systems Inc.; 1995.
- Skinner HA, Steinhauer PD, Sitarenios G. Family Assessment Measure (FAM) and process model of family functioning. *Journal of Family Therapy*. 2000; 22:190–210.
- Specht MW, Woods DW, Nicotra CM, Kelly LM, Ricketts EJ, Conelea CA, Walkup JT. Effects of tic suppression: Ability to suppress, rebound, negative reinforcement, and habituation to the premonitory urge. *Behavior Research and Therapy*. 2013; 51:24–30.
- Wang Z, Maia TV, Marsh R, Colibazzi T, Gerber A, Peterson BS. The neural circuits that generate tics in Tourette syndrome. *American Journal of Psychiatry*. 2011; 168:1326–1337. [PubMed: 21955933]
- Watson TS, Sterling HE. Brief functional analysis and treatment of a vocal tic. *Journal of Applied Behavior Analysis*. 1998; 31:471–474. [PubMed: 9757584]
- Wilhelm S, Peterson AL, Piacentini J, Woods DW, Deckersbach T, Sukhodolsky DG, Scahill L. Randomized trial of behavior therapy for adults with Tourette's disorder. *Archives of General Psychiatry*. 2012; 69:795–803. [PubMed: 22868933]
- Woods DW, Himle MB. Creating tic suppression. Comparing the effects of verbal instruction to differential reinforcement. *Journal of Applied Behavior Analysis*. 2004; 37:417–420. [PubMed: 15529900]
- Woods, DW.; Piacentini, J.; Chang, SW.; Deckersbach, T.; Ginsberg, GS.; Peterson, AL.; Wilhelm, S. *Managing Tourette syndrome: A behavioral intervention for children and adult (therapist guide)*. New York, NY: Oxford University Press; 2008.
- Woods DW, Piacentini J, Himle MB, Chang SW. Premonitory Urge for Tics Scale (PUTS): initial psychometric results and examination of the premonitory urge phenomenon in youths with tic disorders. *Journal of Developmental and Behavioral Pediatrics*. 2005; 26:97–403.

Appendix A

Domain	Attention	Escape	Aversive
Home	My mom and/or dad tells me to stop ticcing	My mom and/or dad or brother(s) and/or sister(s) does a chore or task for me	I have to stop playing a videogame or watching TV
School	Another kid tells me it's okay or encourages me	I cannot finish my schoolwork	Another kid(s) teases me
Public	Another kid asks me questions about tics	I have to leave or take a break from an activity	I have to stop playing a sport or outdoor game

Representative TARS Items

Table 1

Correlations among TARS subscale scores and total scores

	Parent			Child		
	Home	School	Public	Home	School	Public
School	.47**	-	-	.39*	-	-
Public	.56**	.62**	-	.65**	.62**	-
Attn	Escape	Avers	Avers	Attn	Escape	Avers
Escape	.63**	-	-	.34*	-	-
Avers	.81**	.54**	-	.80**	.41**	-

* p<.05
** p<.01

Spearman's rank-order correlation coefficients for relationships among TARS subscales.

Attn=attention; Avers=Aversive

Table 2

Correlation of total and setting-based subscale scores with tic and family functioning measures

	Total		Home		School		Public	
	Parent	Child	Parent	Child	Parent	Child	Parent	Child
YGTS Motor	-.14	.10	-.02	.25	-.26	-.12	-.13	-.01
YGTS Vocal	.31 [^]	.46 ^{**}	.36 [*]	.33 [^]	.05	.34 [*]	.22	.59 ^{**}
YGTS Total	.20	.41 [*]	.25	.41 [*]	.00	.23	.18	.42 ^{**}
PUTS Total	.15	.29 [^]	.19	.30 [^]	.30 [^]	.13	.05	.31 [^]
YGTS Impair.	.52 ^{**}	.33 [*]	.60 ^{**}	.31 [^]	.22	.38 [*]	.25	.36 [*]
FAM Total	-.17	.24	-.13	.07	.02	.14	-.25	.19

[^]
p<.10*
p<.05**
p<.01

Spearman's rank-order correlation coefficients for relationships between TARS setting-based subscale and total scores and measures of CTD severity and family functioning.

FAM Total= Fam-III Brief total score (child-report).

Table 3

Correlation of function-based subscale scores with tic and family functioning measures

	Escape		Attention		Aversive	
	Parent	Child	Parent	Child	Parent	Child
YGTSS Motor	.03	.34*	-.19	-.06	-.22	.09
YGTSS Vocal	.44**	.30 [^]	.25	.38*	.26	.54**
YGTSS Total	.32 [^]	.40*	.15	.26	.14	.44**
YGTSS Impair	.50**	.21	.42**	.30 [^]	.54**	.57**
PUTS Total	.32 [^]	.56**	.15	.21	.04	.07
FAM Total	.12	.38*	-.17	.11	-.23	.17

[^]
p<.10

*
p<.05

**
p<.01

Spearman's rank-order correlation coefficients for relationships between TARS function-based subscales and measures of CTD severity and family functioning.

FAM Total= FAM-III Brief total score (child-report).