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Technology-Enhanced BPT for Early-Onset Behavior Disorders: Improved Outcomes for Children With Co-Occurring Internalizing Symptoms

Justin Parent[a,b], April Highlander[c], Raelyn Loiselle[c], Yexinyu Yang[c], Laura G. McKee[d], Rex Forehand[e], and Deborah J. Jones[c]

[a]Warren Alpert Medical School, Brown University; [b]Bradley/Hasbro Children's Research Center, E. P. Bradley Hospital; [c]Department of Psychology and Neuroscience, University of North Carolina at Chapel Hill; [d]Department of Psychology, Georgia State University; [e]University of Vermont

ABSTRACT

Objective: Early-onset behavior disorders (BDs) are common and costly. The evidence-base for Behavioral Parent Training (BPT), the standard of care for early intervention for BDs in young children, is well-established; yet, common comorbidities such as internalizing symptoms are common and their impact, not well understood. The goal of the current study was to examine the potential for technology to improve BPT effects on observed parenting and child behavior outcomes for families of children recruited for clinically significant problem behavior who also presented with relatively higher internalizing symptoms.

Method: Families with low incomes ($N = 101$), who are overrepresented in statistics on early-onset BDs, were randomized to an evidence-based BPT program, Helping the Noncompliant Child (HNC), or Technology-Enhanced HNC (TE-HNC). Children were ages 3 to 8 years (55.4% were boys). Child race included White (64.0%), Black or African American (21.0%), more than one race (14.0%), and Hispanic/Latinx (13.9%).

Results: Families in both groups evidenced improvement in internalizing symptoms at posttreatment; however, TE-HNC yielded the greatest improvement in positive parenting and child compliance at posttreatment and follow-up for children with the highest internalizing symptoms at baseline.

Conclusions: TE-HNC resulted in improved parenting and child behavior outcomes for children with elevated levels of co-occurring internalizing symptoms at baseline relative to standard HNC. We posit that these added benefits may be a function of TE-HNC, creating the opportunity for therapists to personalize the treatment model boosting parent skill use with more complex presentations, although a formal test of mediation will be important in future work.

Over one hundred million children worldwide experience clinically elevated problem behavior consistent with conduct disorder, oppositional defiant disorder, and/or attention deficit hyperactivity disorder, making Behavior Disorders (BDs) one of the most common reasons for child mental health referrals (e.g., Ghandour et al., 2019; Merikangas et al., 2009; Polanczyk et al., 2015). Without adequate early-onset treatment (3 to 8 years old), BDs can increase the likelihood of later problems in adolescence and adulthood, including delinquency, school drop-out, and depression (e.g., Fergusson et al., 2013; Odgers et al., 2007; Piquero et al., 2016). Early identification and intervention is estimated to save up to $4.4 million in criminal justice, education and health care costs per high-risk child by young adulthood, alone highlighting the clinical and public health importance of early intervention (Cohen & Piquero, 2009; Petitclerc & Tremblay, 2009).

Behavioral Parent Training (BPT; also called Behavioral Parenting Interventions and Parent Management Training) is a family of evidence-based treatments that share a common history, underlying theory, and similar skills (see Kaehler et al., 2016; Reitman & McMahon, 2013; Southam-Gerow & Prinstein, 2014, for reviews). BPT is considered the standard of care treatment for early-onset problem behavior (Axelrod & Santagata, 2021; Leijten et al., 2013). Building on social learning theory, BPT considers positive parenting skills aimed at improving the quality of the parent-child relationship and effective discipline

CONTACT Justin Parent justin_parent@brown.edu Warren Alpert Medical School, Brown University, 1 Hoppin St #204, Providence, RI

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to be the mechanism of child behavior change (Forehand et al., 2014; Leijten et al., 2013; Reyno & McGrath, 2006). Decades of research suggest that BPT is efficacious; however, positive outcomes are not experienced equally by all families, leading to questions regarding *for whom* and *how* BPT might have the most significant impact (e.g., Forehand et al., 2014; Leijten et al., 2017; Lundahl et al., 2006). In part, such variability may be due to the fact that many young children presenting with clinically significant problem behavior also have comorbid internalizing symptoms (e.g., Ansar et al., 2022; Gonzalez & Jones, 2016; Wang & Liu, 2021; Weisz et al., 2017). Internalizing and externalizing symptoms commonly co-occur and particularly so in young children (Arslan et al., 2021; Fanti & Henrich, 2010; Oland & Shaw, 2005). Internalizing symptoms may reflect what is currently or will be diagnosed as a distinct internalizing disorder and/or reflective of an underlying affective component to problem behavior (see Zachary & Jones, 2019 for a review).

Notably, some data suggest that comorbid internalizing symptoms may indeed worsen later outcomes for youth with BDs (Zarakoviti et al., 2021); yet we still know relatively little about how internalizing symptoms affect the course of BPT treatment or outcomes for early-onset BDs (see Zarakoviti et al., 2021 for a review). On the one hand, BPT interventions tailored for internalizing youth have been shown to be effective in reducing young children's anxiety (Cartwright-Hatton et al., 2011; Lebowitz et al., 2020) and depression (Eckshtain et al., 2017; Luby et al., 2018), as well as improving child emotion regulation (Chronis-Tuscano et al., 2016; Rothenberg et al., 2019). However, of the 12 RCTs with children with clinical levels of BDs reviewed by Zarakoviti et al. (2021), only three (25%) found significant effects on child internalizing symptoms, and only one study demonstrated uniform effects across informants. The contrasting findings suggest the importance of additional work to understand how to bolster the effects of BPT for children with early-onset BDs also presenting with the full range of internalizing symptoms and how to maintain those improvements over time.

From an experimental therapeutics perspective, BPT improving co-occurring child internalizing problems makes conceptual sense given that aspects of the coercive cycle of parent-child interactions have also been linked to child internalizing symptoms, including parenting characterized by low levels of warmth and high levels of harshness (Gonzalez & Jones, 2016; Granic & Lougheed, 2016). BPT targets these same processes early in treatment and typically before child compliance is directly addressed, perhaps accounting at least in part for the secondary effects on internalizing symptoms as well (e.g., Chase & Eyberg, 2008; Pinquart, 2017; Rothenberg et al., 2019). Yet, given that few studies have focused on young children in particular or assess *both* internalizing and externalizing symptoms or their interaction (Gonzalez & Jones, 2016; Zarakoviti et al., 2021), we still know too little about how presenting with clinically significant BDs and relatively higher internalizing symptoms impacts positive parenting or child behavior outcomes.

Understanding BPT benefits for families of children with common comorbidities like internalizing symptomatology may be particularly critical for families with low income. Lower socioeconomic status has been linked to a higher prevalence of both internalizing and externalizing symptoms in youth and to an increase in symptoms as children age (e.g., Lansford et al., 2019; Miller et al., 2021; Slopen et al., 2010). Consistent with the Family Stress Model (Conger & Conger, 2008; Conger et al., 1992), families navigating financial strain are more susceptible to these coercive patterns of parent-child interactions (e.g., Lunkenheimer et al., 2016; Patterson, 2002; Shaw & Shelleby, 2014). Financial strain and associated stressors also can make it more difficult for families to effectively engage in and benefit from BPT (e.g., Lansford et al., 2019; Miller et al., 2021; Slopen et al., 2010). Thus, innovative strategies to maximize treatment gain for families with a low income is critical (e.g., Jones et al., 2013; Lundahl et al., 2006; Shaw, 2013), including for those families presenting with comorbid internalizing symptoms.

Building upon these gaps, the current study explores the potential for technology to enhance BPT outcomes for low-income families of children with BDs who also had relatively high levels of internalizing symptoms. A digital approach to BPT affords the potential to further personalize this evidence-based treatment model (e.g., Baumel et al., 2016; Breitenstein et al., 2014; Jones et al., 2013, for a review), perhaps regardless of whether the child's overt problem behaviors for which families are seeking treatment are a function of underlying internalizing or externalizing symptoms or both. In the case of low-income families, who are more likely to own a mobile phone than a desktop or another mobile device (e.g., Tsetsi & Rains, 2017), a technology-enhanced treatment model (i.e., parent smartphone application and therapist web-portal) has the potential to offer parents between-session connection to the BPT program, as well as opportunities for tailored coaching and support in and out of session (e.g., daily surveys, video recording of home practice) toward increased parental autonomy and generalization of skills.

Indeed, technology-enhancements (TE-) to an evidence-based BPT program, *Helping the Noncompliant*

Child (HNC; McMahon & Forehand, 2003) improved cost effectiveness (i.e., fewer weeks to complete treatment) for some aspects of family engagement (e.g., homework completion; Jones et al., 2021) and treatment outcomes (e.g., parenting and child externalizing behavior; Parent et al., 2022) for families with low income without compromising parent satisfaction with treatment or therapist alliance (Anton & Jones, 2019; Anton et al., 2016). Moreover, TE-HNC families who used the technology-enhancements more consistently had a better treatment response for child behavior outcomes (Anton et al., 2016). This study extends these findings by assessing whether HNC and TE-HNC result in reductions in child internalizing symptoms in low-income families presenting for treatment for child problem behavior. In addition, we examine whether TE-HNC yields the greatest impact (e.g., lowest symptoms, highest levels of positive parenting) at posttreatment or follow-up for children with the highest levels of internalizing symptoms at baseline.

Method

Overview

This study includes secondary analyses of data from 101 families who participated in a randomized control trial comparing a standard BPT program, Helping the Noncompliant Child (HNC; McMahon & Forehand, 2003), to Technology-Enhanced HNC (TE-HNC; Jones et al., 2014, 2021) on parent engagement and treatment outcomes. Families with children ages 3 to 8 years were included if family income was less than 250% of the federal poverty level. Further, inclusion criteria included clinically significant child externalizing problem behavior as defined by the Eyberg Child Behavior Inventory (Problem >15 or Intensity >131; Eyberg & Pincus, 1999), but child could not have a significant developmental and/or physical impairment that required substantive adaptations to standard HNC (e.g., unable to respond to parent skill use, do Time-Out). Families were also excluded if caregivers had a *current* mood, psychotic, and/or substance use disorder assessed via the Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1998) or a pending and/or prior substantiated child abuse/neglect case. Exclusion criteria were selected based on considerations regarding precedence of other presenting issues (e.g., caregiver mental health) and to avoid the substantive adaptations that may be necessary to allow families to effectively engage in standard BPT given the potential to introduce between and within group variability in the context of a randomized control trial. Participants were recruited via advertisements and flyers distributed at nonprofit organizations, local schools, agencies serving families with low income, and by word-of-mouth (Khavjou et al., 2018, 2020).

Participants

Most (98%) caregivers identified as female; more than half (61.4%) were married or living with a partner and identified as White (68.3%), Black or African American (21.8%), American Indian/Alaska Native (1.0%), or multiple races (7.9%). Some preferred not to answer (1%). Further, 6.9% of caregivers identified as Hispanic/Latinx. Parents indicated that approximately half (55.4%) of children were boys; child race included White (64.0%), Black or African American (21.0%), more than one race (14.0%), or American Indian/Alaska Native (1%). Approximately twice as many children as parents were Hispanic/Latinx (13.9%), reflecting the racial and ethnic diversity between and within participating families. Given variability in marital/relationship status of caregivers and the greater time and resource constraints on low-income families that make two parent participation challenging for all families, we limited session participation to one caregiver.

Regarding clinical symptoms, ratings across multiples scales and a clinical interview were used to characterize the clinical presentations of the sample. *T*-scores were calculated using the complete scores from the preschool or school-aged forms of the CBCL (see Measures section for complete details). As noted earlier, children were required to demonstrate clinically elevated levels of externalizing problems on the ECBI (75% above the cutoff on the intensity scale and 96% for the problem scale). Additionally, the majority of parents (67.3%) reported that their child had borderline or clinically elevated levels of externalizing and nearly half (48%) reported elevated internalizing problems at baseline (*T*-score ≥60); 18% reported clinical levels (*T*-score ≥65) on the CBCL. Though dimensional scores were used in analyses, the Mini International Interview for Children and Adolescents (MINI-KID) (Sheehan et al., 2010) was used to further characterize the sample. At baseline, 20% of children met criteria for an anxiety disorder: 4%, for OCD; 2%, for a tic disorder; and 6%, for a mood disorder. Regarding problem behavior, 46.9% met criteria for ODD, 13.3%, for CD, 48%, for ADHD (any type); and 72%, for any behavior disorder.

Procedure

Families completed a phone screen and baseline assessment at a community-based clinic to confirm eligibility

and provide consent for their family's participation. Eligible families were then randomized to either HNC or TE-HNC. Assessments included caregiver self-report, interview, and observational data collection. Families were compensated $50 per assessment for completing the baseline, posttreatment, 3-month follow-up, and 6-month follow-up assessments. TE-HNC families received an additional $100 when they returned the program phone. While the majority (94%) of families owned a smartphone, project-supplied phones aimed to increase the likelihood of consistent service. All procedures were approved by the university's institutional review board.

Intervention

All families received HNC, which is a therapist-delivered, criteria-based (i.e., therapists conduct weekly observation and coding of skill use to determine progression through skills and program completion) BPT intervention validated for young (ages 3 to 8 years) children with behavior disorders. HNC includes weekly face-to-face therapy sessions and brief midweek coaching calls to assess, problem solve, and reinforce caregiver use of new skills. HNC consists of two phases: Differential Attention (e.g., Attends, Rewards, Ignoring) and Compliance Training (e.g., Clear Instructions, Time-Out). When parents progress to Phase II (i.e., Compliance Training), they continue to practice Phase I skills both in and out of session to maintain skill proficiency (see McMahon & Forehand, 2003, for more detail).

Families randomized to TE-HNC received all of the components of standard HNC, as well as enhancements via an interconnected HIPAA-compliant smartphone application (app) for the caregiver (Tantrum Tamers ©) and web portal for the therapist. The prototype was developed by an interdisciplinary team, including researchers with expertise in BPT programs for underserved families, an advisory panel of five BPT clinicians (20% men; 20% racial and/or ethnic minority), an industry partner with experience developing health-related apps, and health economists with expertise in health care evaluation and cost effectiveness (Jones et al., 2010, 2014). Building on the functionality and content tested in the pilot study and efforts to minimize the additional time that parents spent using the app, the Tantrum Tamers app tested in this study included skills videos to review the rationale for and model each new skill and the integration of skills; surveys to assess parent skill use, successes, and challenges; video recording of parent skill use at home for therapist coaching and feedback; a midweek video call; reminders regarding skills practice and sessions; and a weekly checklist of home practice assignments. Together with the web portal, which allowed the therapist to monitor parent skill use at home (e.g., responses to daily surveys, video recorded home practice), clinicians could tailor midweek calls and weekly sessions based on specific presenting issues, progress, and challenges (Jones et al., 2021; Webb et al., 2010). As reported in Jones et al., the mean number of sessions was 11.63 for TE-HNC and 14.15 for HNC; drop-out was 32% for TE-HNC and 28% for HNC (Jones et al., 2021).

Therapist Training and Fidelity

Master's-level therapists treated families in both groups. Training included reviewing treatment manuals, establishing reliability with the HNC coding system, role-play and session observations and discussion, weekly observation, and supervision and feedback by two licensed clinical psychologists. Almost a third (30%) of sessions were coded by a master's- or doctoral-level coder for fidelity; 61% of those were coded a second time, yielding an average fidelity rating of 98% for both the HNC and TE-HNC groups.

Measures

Demographics

Caregivers reported their own and their child's demographic information at baseline, including, age, race/ethnicity, marital status, education level, and income.

Observed Parenting and Child Compliance

Parent-child observations and coding were conducted at all assessments by raters masked to treatment condition. Coders received training in the Behavioral Observation Coding System (McMahon & Forehand, 2003), which is a standard part of the HNC program used to determine parent skill mastery and progress in and completion of the program. Each coder had approximately 50 hours of training and were required to reach at least 80% agreement on one or more of the coded behaviors with expert coders on a series of training videos. Half of the videos were double coded for fidelity. When two coders failed to reach 80% agreement, they jointly coded the observation to resolve discrepancies. Behaviors were coded for 5 minutes and reported at a rate per minute to account for variability in interaction length. Intraclass correlation coefficients for agreement across raters ranged from .945 to .957 across behavioral codes.

Two parent behaviors were coded in the context of child directed play or Child's Game, which is the primary context in which HNC Phase I (Differential Attention) skills are taught and practiced in session and at home (see McMahon & Forehand, 2003).

Attends was defined as positive attention in which the parent provides an ongoing verbal description of what the child is doing, and **Rewards** was defined as positive attention that is provided following the child's appropriate behavior. These two behaviors were combined for a single average score of positive parenting behavior, which is posited in the literature to be a primary therapeutic mechanism of change for both internalizing and externalizing problems. Child **Compliance**, the targeted therapeutic outcome in BPT programs like HNC, was assessed in the context of the clean-up task (Parent's Game) that is the context in which Phase II skills are learned and practiced (see McMahon & Forehand, 2003). Compliance was measured as the percentage of all clear instructions to which the child complied within 5 seconds after an instruction was issued.

Internalizing Symptoms

The Child Behavior Checklist (CBCL; Achenbach, 2001) preschool or school-aged form, depending on the child's age at study entry, was used to measure internalizing. CBCL items are rated on a 3-point scale of 0 (not true), 1 (somewhat/sometimes true), and 2 (very/often true). For measuring broadband internalizing problems, we used the subscale scoring from the preschool form (86.1% of the sample completed the preschool version) and only used the 19 items that were common across the two CBCL versions. Broadband internalizing problems was a sum score that included four narrowband subscales: Emotionally Reactive (e.g., whines, worries, sulks), Anxious/Depressed (e.g., nervous, fearful, sad), Somatic Complaints (e.g., headaches, stomachaches), and Withdrawn (e.g., withdrawn, acts young). Omega reliability (Hayes & Coutts, 2020) was .80–.81 across all waves.

Supplemental Measures—Irritability

Given that irritability is a common affective dimension shared across both internalizing and externalizing problems (Evans et al., 2017; Zachary & Jones, 2019), we sought to examine whether findings were unique to internalizing or could alternatively be explained by an irritable dimension of oppositionality. For supplemental analyses we examined irritability levels via a subscale from the CBCL (Achenbach, 2001) that consists of three items assessing common studies aspects of irritability (temper, mood, stubborn). Strong support has been found for the reliability and validity of the CBCL Irritability subscale (Evans, Bonadio, et al., 2020; Galano et al., 2022) and support for sensitivity to detecting intervention effects (Evans, Weisz, et al., 2020). The average across the three items was 1.09 (range 0–2), and 69% of parents reported their child at least sometimes struggles with irritability. Omega reliability was .69 [.58, .90] for the three-item irritability subscale.

Data Analytic Plan

First, as preliminary analyses we examined whether trajectories of internalizing symptoms significantly improved and whether trajectories differed across treatment conditions. We examined linear mixed effect models with maximum likelihood estimation to use all available measurements (baseline, post, and 6-month follow-up) and account for nonindependence of repeated measurements within individuals. We estimated a random intercept and slope, and results interpretation focused on the fixed effects of time, including a quadratic time effect, and a time-by-treatment interaction. Analyses were conducted using the Jamovi (The jamovi project, 2021) GAMlj mixed module in R (Gallucci, 2019).

Following analyses examining change in internalizing symptoms, we then conducted our primary analyses to examine whether baseline internalizing symptoms moderated treatment outcomes on observed parenting, observed compliance, and internalizing symptoms at post and 6-month follow-up. Path analyses were run with observed positive parenting, observed child compliance, and the internalizing outcome estimated as simultaneous outcomes with treatment condition, baseline internalizing symptoms, and a treatment-by-internalizing interaction as the primary predictors. Separate models were run for posttreatment and 6-month follow-up. Path analyses were conducted using Mplus 8.4 using maximum likelihood estimation with robust standard errors. All analyses used intent-to-treat methods and included child age as a covariate given that it was positively associated with child internalizing symptoms at all time points.

Results

Preliminary Results

Two-level mixed effects model results for the internalizing symptoms trajectory are summarized in Table 1. Fit indices supported a quadratic growth model that estimated a flattening slope from posttreatment to the 6-month follow-up. The effect of time, $b = -4.73$, [−6.13, −3.34], $p < .001$, and quadratic time, $b = 1.60$, [.91, 2.29], $p < .001$, were significant such that internalizing symptoms decreased from baseline to posttreatment and then flattened from posttreatment to the 6-month follow-up. The treatment-by-time and

Table 1. Fixed effect estimates for internalizing trajectory model.

			95% CI		
Variables	*b*	*SE*	Lower	Upper	*p*
(Intercept)	7.915	0.447	7.038	8.792	<.001
Child Age	1.373	0.318	0.750	1.997	<.001
Treatment	−0.933	0.896	−2.689	0.822	.300
Time	−4.734	0.710	−6.126	−3.342	<.001
Time^2	1.600	0.352	0.910	2.291	<.001
Treatment ✻ Time	1.879	1.421	−0.906	4.664	.19
Treatment ✻ Time^2	−0.790	0.705	−2.172	0.591	.266

Notes. Treatment coded 1 = HNC and 2 = TE-HNC.

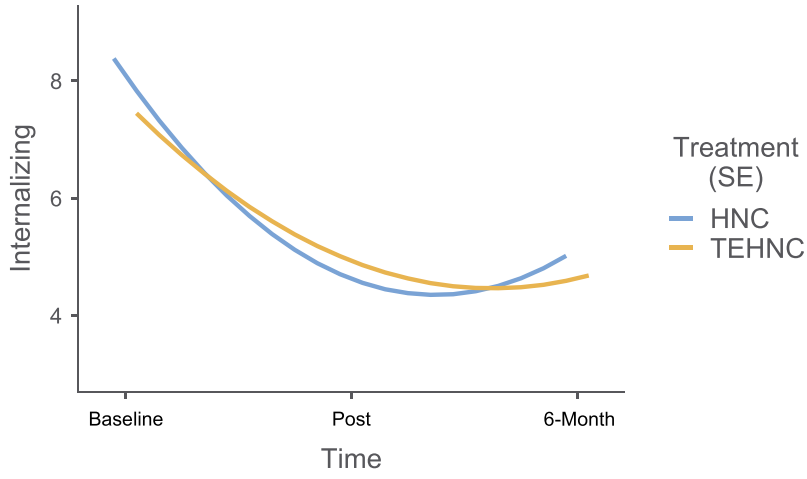

Figure 1. Internalizing symptom trajectories for treatment groups.

treatment-by-time^2 interactions were both nonsignificant, *p*s > .10, suggesting that improvements and long-term waning of treatment effects were similar across groups. Figure 1 depicts model results. Overall, the *reduction* in internalizing problems from baseline to the posttreatment was medium (Cohen's $d = 0.657$) and was maintained at the 6-month follow-up (Baseline–6-month Cohen's $d = 0.675$).

Primary Results

Complete results are depicted in Table 2. For outcomes at posttreatment with baseline internalizing symptoms as the moderator, model fit was excellent, $\chi 2\ (12) = 8.97$, $p = .705$, RMSEA = .000, CFI = 1.0, SRMR = .058. The treatment-by-internalizing symptoms interaction was significant for observed positive parenting such that TE-HNC outperformed HNC when baseline internalizing symptoms were high, $b = 3.18$ [95% CI 1.27, 5.09], but not when internalizing symptoms were average, $b = 1.08$ [−.20, 2.24], or low, $b = -1.13$ [−2.56, .288]. Similarly, child internalizing symptoms moderated posttreatment outcomes for observed child compliance such that TE-HNC outperformed HNC when baseline internalizing symptoms were high, $b = .196$ [.083, .31], but not when internalizing symptoms were average, $b = .082$ [−.01, .20], or low, $b = -.012$ [−.17, .14]. The interaction predicting child internalizing symptoms was not significant, suggesting change in internalizing was similar across treatment groups regardless of baseline levels.

For outcomes at the 6-month follow-up with baseline internalizing symptoms as the moderator, model fit was excellent, $\chi 2\ (12) = 9.69$, $p = .643$, RMSEA = .000, CFI = 1.0, SRMR = .065. The treatment-by-internalizing symptoms interaction was marginally significant for observed positive parenting. The form of the marginal interaction was similar to the significant interaction for posttreatment: TE-HNC outperformed HNC when baseline internalizing symptoms were high, $b = 3.79$ [.83, 6.75], but not when internalizing symptoms were low, $b = .475$ [−1.69, 2.64]. The interaction for 6-month observed child compliance was significant and the simple slopes support similar interpretation: TE-HNC outperformed HNC when baseline internalizing symptoms were high, $b = .364$ [.23, .50], but not when internalizing symptoms were low, $b = .053$ [−.11, .22].

Table 2. Path analysis model results for internalizing problems.

	Posttreatment			6-Month Follow-up		
Variables	ß	95% CI	*p*	ß	95% CI	*p*
DV: Observed Positive Parenting						
DV Baseline	.335	.10, .57	.012	.285	.06, .51	.013
Child Age	−.273	−.52, −.03	.031	−.069	−.34, .20	.610
Treatment	.177	−.02, .38	.080	.366	.16, .58	.001
Baseline Internalizing	−.818	−1.3, −.29	.002	−.779	−1.4, −.08	.030
Treatment ✻ Internalizing	1.11	.56, 1.6	.000	.836	−.12, 1.8	.086
DV: Observed Compliance						
DV Baseline	.126	−.15, .40	.363	.259	.05, .47	.014
Child Age	.000	−.22, .22	.998	.077	−.14, .33	.546
Treatment	.219	−.02, .46	.069	.440	.20, .68	.000
Baseline Internalizing	−.583	−1.2, .10	.094	−.731	−1.5, −.12	.018
Treatment ✻ Internalizing	.732	.07, 1.4	.029	.964	.19, 1.55	.001
DV: Internalizing						
Child Age	.212	−.02, .44	.070	.172	−.11, .46	.239
Treatment	.066	−.12, .25	.489	.037	−.18, .25	.741
Baseline Internalizing	.494	−.30, 1.2	.223	.696	−.04, 1.4	.064
Treatment ✻ Internalizing	.021	−.86, .90	.963	−.111	−.95, .72	.794

Notes. Treatment coded 1 = HNC and 2 = TE-HNC. Residual covariances between outcomes and covariance estimated but not depicted.

Similar to the posttreatment model, the interaction predicting child internalizing symptoms at the 6-month follow-up was not significant, suggesting change in internalizing symptoms was similar across treatment groups regardless of baseline levels. See Figure 2 for the form of all four moderation effects. Overall, when children had co-occurring internalizing symptoms at baseline, families randomized to TE-HNC had ~ 20% higher to 36% higher levels of observed child compliance, and parents were observed to use ~ 3 to 4 more positive parenting behaviors per minute compared to standard HNC. In contrast, both groups improved on

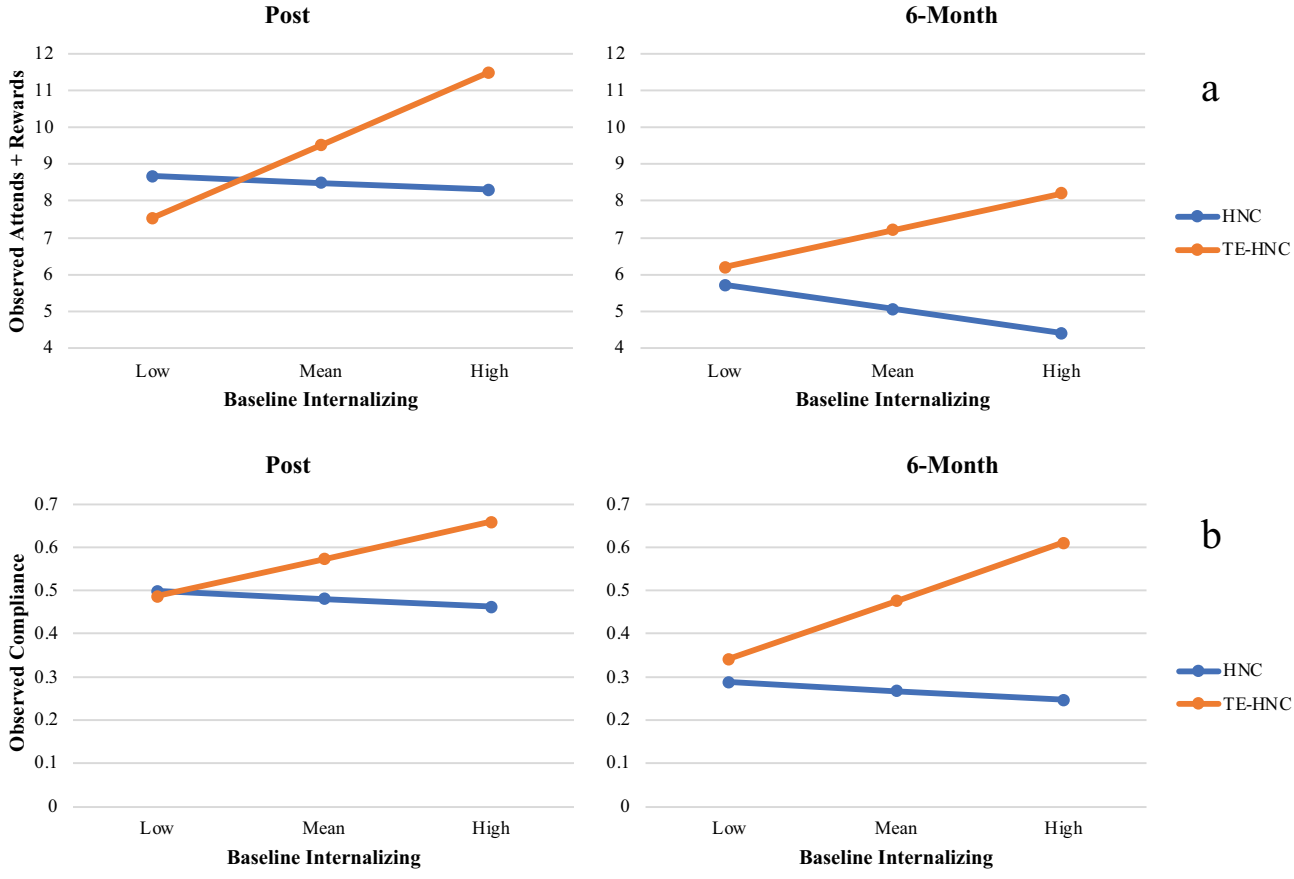

Figure 2. The moderating effect of baseline child internalizing problems on (a) positive parenting behaviors and (b) compliance.

internalizing symptoms at similar rates regardless of internalizing severity.

Supplemental Analyses

Given that irritability is a transdiagnostic factor spanning both internalizing and externalizing spectra (Evans et al., 2017; Zachary & Jones, 2019), we examined results obtained to see whether internalizing problems were similar or distinct from those found for irritability. First, regarding patterns of longitudinal change in irritability, the effect of time, $b = -2.59$, [−3.19, −1.99], $p < .001$, and quadratic time, $b = .89$, [.58, 1.19], $p < .001$, were significant such that irritability improved from baseline to posttreatment and then flattened from posttreatment to 6-month follow-up. The treatment-by-time and treatment-by-time^2 were both nonsignificant, ps > .10, suggesting that improvements and long-term maintenance of treatment effects were similar across groups. Overall, the *reduction* in irritability from baseline to posttreatment was large (Cohen's $d = 1.16$) and was maintained at the 6-month follow-up (Baseline–6-month Cohen's $d = 1.08$).

Regarding irritability as a moderator, the treatment-by-irritability interaction was significant for observed positive parenting at posttreatment such that TE-HNC outperformed HNC when baseline irritability was high, $b = 2.82$ [1.24, 4.39], but not when irritability was low, $b = -1.66$ [−3.54, .217], or average, $b = .578$[−.63, 1.78]. The interactions predicting observed child compliance and irritability were not significant, suggesting posttreatment compliance and irritability was similar across treatment group regardless of baseline levels. At the 6-month follow-up, the treatment-by-irritability interaction effects were not significant for observed positive parenting or child compliance. Further, contrary to results for other models, the treatment-by-baseline irritability interaction significantly predicted 6-month irritability levels such that TE-HNC was inferior to HNC when irritability was low, $b = 1.18$ [.16, 2.2], but not when irritability was average, $b = .248$[−.49, .98], or high, $b = -.69$ [−1.65, .28]. Across models, model fit indices were good to excellent. In a final set of sensitivity models, we included both internalizing and irritability moderators together in the same model and interpretation of results was consistent with single-moderator models, suggesting that findings for each moderator may be unique moderating effects. Finally, we controlled for baseline externalizing severity (ECBI severity score). We found that results for the internalizing moderator models that controlled for baseline externalizing severity were consistent in interpretation with the primary results and suggest that results are not better explained by overall child behavior severity. Complete results are available in supplemental appendix Tables S1 and S2.

Discussion

Increased focus in research and applied intervention contexts has begun to be placed on treating co-occurring internalizing symptoms among young children with BDs, especially given the worse prognosis and treatment outcomes (Ansar et al., 2022; Gonzalez & Jones, 2016; Weisz et al., 2017). The current study's secondary analyses examined the potential for a technology-enhanced treatment model to improve BPT parenting and internalizing symptoms for low-income families of young children with BDs. Consistent with prior work (Forehand et al., 2013; Rothenberg et al., 2019; Zarakoviti et al., 2021), children in HNC and TE-HNC evidenced significant improvements in internalizing symptoms that were maintained at the 6-month follow-up. Supplemental analyses also showed large improvements in level of child irritability that was maintained at follow-up. Theory suggests that the focus on positive parenting and enhancing warmth in the parent-child relationship that is a foundation of BPT programs may at least indirectly improve children's internalizing symptomatology by increasing children's sense of security in the parent-child relationship, which can be compromised in the context of more insensitive or unresponsive parenting (Gonzalez & Jones, 2016).

While changes in the patterns of child internalizing symptoms were similar across groups, families of children with higher internalizing symptoms at baseline benefitted more at posttreatment *and* follow-up if they were randomized to TE-HNC. As we will highlight in our discussion of limitations, the technology developed and tested in the parent study was *not* designed to target and our inclusion criteria did not include internalizing symptoms. Yet, we posit that the technology enhancements tested in this study may have conferred benefits for co-occurring internalizing and externalizing problems in several ways. Importantly, prior results from this study, and from our pilot work, suggest that TE-HNC families complete treatment in fewer weeks than HNC families, suggesting that findings are not simply a function of TE-HNC families getting more total time (Jones et al., 2014, 2021). Instead, we posit that TE-HNC may afford the opportunity for therapists to refine their feedback and coaching to families, including as it relates to symptoms that are or parents perceive to be a function of internalizing symptoms.

Clinically, for example, we have observed that parents can have more challenges using BPT skills when

they perceive problem behavior such as tantrums to be a function of a child's anxiety or sadness versus when they believe that the same behavior is the result of the child being "bad" or "manipulative" or "trying to push my buttons." Indeed, conceptualizing a behavior as a function of anxiety or sadness may result in a parent doing things that are contrary to the theory and skills taught in BPT, including giving attention to behaviors parents want to decrease (e.g., whining, tantrums, noncompliance) by attempting to verbally or physically calm, soothe, or negotiate with a child. In turn, parents of children with comorbid internalizing and externalizing symptoms may be at greater risk for not using the BPT skills at all or using them incorrectly or inconsistently, potentially alleviating parent and child distress in the short-term but leading to worse outcomes in the long-term.

With this example in mind, technology-enhanced treatment models like TE-HNC may provide clinicians a "window" into the family's daily life, offering a better understanding of the interrelationship of the child's internalizing symptoms with the problem behavior that is the focus of treatment and of how parenting and parent-child interactions shape and maintain those associations. Therapists in technology-enhanced treatment models then have the opportunity to tailor their feedback and coaching for more-complex families like those with comorbid symptoms potentially resulting in greater generalization of those Phase I skills posited to be linked to co-occurring internalizing symptoms (as well as sustainment of Phase I skills into Phase II of treatment). For example, parents wishing to a soothe a child's distress in the context of a Time-Out for noncompliance may be better coached to complete the Time-Out first, achieve compliance, then talk with the child about their thoughts and feelings to avoid inadvertently increasing (rather than decreasing) the risk of noncompliance in the future.

As with all research, results should be interpreted in light of study limitations. First, as noted earlier, the results presented here are secondary analyses and the technology enhancements tested in the parent study were not developed to explicitly target internalizing symptoms. Rather, TE-HNC was designed to more generally increase parent connection to and support from the HNC program toward improved engagement and treatment outcomes. In addition, although approximately half of children had elevated levels of internalizing symptoms, children were not recruited for this study based on their baseline levels of internalizing symptomatology; therefore, results may look different if all children met diagnostic criteria for both internalizing and externalizing disorders, for example. Third, most participating caregivers were female. This contributes to the underrepresentation of fathers and other male caregivers in the child, family, and intervention literature (Fabiano & Caserta, 2018; Parent et al., 2017).

Fourth, while others have tested adaptations to standard BPT to directly target comorbid internalizing symptoms or emotion- or affect-related targets (e.g., Freeman et al., 2008; Lebowitz et al., 2020; Luby et al., 2018), we did not include such a comparison group in this study. Thus, we do not know how TE-HNC would have compared to such an approach. However, these treatments emphasize similar parenting skills (e.g., differential attention) and apply them to internalizing behaviors (e.g., reducing accommodation and rewarding brave behavior) for which technology enhancements may similarly benefit outcomes through similar hypothesized mechanisms. Fifth, to decrease variability between families we limited participation to one caregiver regardless of marital or relationship status. BPT tends to work better when all caregivers involved in the child's life are learning and using the skills, so outcomes may be different if multiple caregivers participate. Indeed, this is one potential advantage of TE-HNC relative to HNC; that is, all parents received standard HNC handouts that they could share with other caregivers, TE-HNC caregivers could also share things like the skills videos that likely better conveyed the rationale for and modeled the new skills for even nonparticipating caregivers.

This study also has strengths. First, this study focused on families with low-income who are more likely to have a child with a behavior disorder yet less likely to engage in and thus benefit from BPT (Shaw & Shelleby, 2014). Investigating strategies (technology) to address potential challenges (comorbid internalizing symptoms) to optimize treatment outcomes is thus critical with this underserved group. Second, this study examined *both* internalizing and externalizing symptoms. While there is a growing literature demonstrating BPT's potential to reduce internalizing symptoms, it is far less common for basic or applied research on children in this age range to examine patterns in families of children with both relatively higher internalizing *and* externalizing symptoms or to explore whether and how that comorbidity affects parenting and child behavioral outcomes (e.g., Arslan et al., 2021). Third, this study used observational measures of parenting and child compliance, which are a hallmark of mastery-based BPT programs like HNC and used to determine parent progress from one skill to the next, Phase I to II, and program completion (McMahon & Forehand, 2003). Fourth, this study examines changes pre- to posttreatment and also replicates the pattern of findings at 6-month follow-up,

increasing our confidence in the findings. Fifth, this study contributes to a growing literature in BPT and children's mental health, highlighting the promise of digital mental health for increasing access to, engagement in, and outcomes of evidence-based treatment approaches like BPT (e.g., Brager et al., 2021; Georgeson et al., 2020). Finally, since HNC is one example of a family of evidence-based BPT programs, findings should generalize to other programs as well, perhaps particularly to those that also use mastery criteria (e.g., Parent Child Interaction Therapy, PCIT Funderburk & Eyberg, 2011).

In summary, TE-HNC resulted in improved parenting and child behavior outcomes for children with elevated levels of co-occurring internalizing symptoms at baseline relative to standard HNC. We posit that these added benefits may be a function of allowing for a personalized and efficient treatment model to boost parent skill use with more-complex presentations, although a formal test of mediation will be important in future work. It will also be important for future work to consider the other ways in which the combination of internalizing and externalizing symptoms shape treatment outcomes in standard and technology-enhanced BPT. For example, we examined the interaction of BDs and internalizing symptoms, but it is also plausible that changes in internalizing symptoms may mediate improvement in BDs or vice versa. That said, current findings contribute to a growing literature suggesting the potential cost-effectiveness of BPT as at least a first line of intervention for children with early-onset BDs and increasingly for comorbid internalizing and behavioral symptoms. Since parents are less likely to seek treatment for children's internalizing symptoms (e.g., Alegría et al., 2004; Thurston et al., 2015), starting with a course of BPT may allow parents and children to make important changes in the dynamics of their parent-child interactions toward improvements in both behavior and co-occurring internalizing symptoms. Ongoing assessment of posttreatment gains and maintenance of those gains after treatment ends may allow clinicians to determine whether and for whom additional services for internalizing and/or behavioral services are warranted. The COVID-19 pandemic and associated policy and practice changes expedited the incorporation of digital tools into clinical practice, including in BPT (Sullivan et al., 2021). Yet, while this study explores one technology-enhanced BPT approach, there remains much to consider before such a model could likely be implemented in the settings where families with low income are most likely to seek care. Much like the research-to-practice gap in the evidence-based treatment literature more generally, a disconnect has grown between what is happening in academic research versus industry that affects the likelihood that such approaches can be "prescribed" by mental health providers and covered by health insurance including programs like Medicaid (Carl et al., 2022). Thus, the feasibility of this model for front-line service settings remains to be seen.

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No potential conflict of interest was reported by the authors.

ORCID

Justin Parent http://orcid.org/0000-0002-1659-8188

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