

RESEARCH ARTICLE

Treatment of Challenging Behavior Maintained by Caregiver Accommodation Using Cumulative Schedules of Reinforcement

Matthew L. Edelstein^{1,2}  | Amanda M. Taboas^{1,2} | Megan L. Krantz^{1,2} | Joshua A. Mellott¹

¹Department of Behavioral Psychology, Kennedy Krieger Institute, Baltimore, Maryland, USA | ²Johns Hopkins University School of Medicine, Baltimore, Maryland, USA

Correspondence: Matthew L. Edelstein (Edelstein@kennedykrieger.org)

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ABSTRACT

As a strategy to prevent reoccurrence of challenging behavior, some caregivers report frequent or excessive reinforcement of their child's requesting behavior. The current study describes the assessment and treatment of 14 children, ages 3–12 ($M = 6.4$, $SD = 2.7$), who engaged in challenging behavior that was reinforced by adult cooperation with manding. Following a differentiated mand analysis, treatment structure involved a 20-h caregiver training program, delivered across either 2 or 5 consecutive weeks. Caregivers were trained to conduct all procedures, which incorporated the use of a cumulative duration schedule along with reinforcement schedule-thinning in a changing criterion design. Results averaged a 94% reduction across cases and statistically significant reductions in challenging behavior both within and between appointments (Cohen's d s = 0.88 and 1.1, respectively). The current study extends the literature on the treatment of percurrent challenging behavior by incorporating caregivers as therapists and using cumulative reinforcement schedules.

1 | Introduction

The development of the functional analysis (FA; Iwata et al. 1982/1994) provided a means for evaluating isolated environmental variables that evoke and maintain challenging behavior. Causal relationships identified by FAs are invaluable for informing function-based interventions and promoting adaptive behavior. However, as the application of FA procedures can at times produce inconclusive results (e.g., Hagopian et al. 2013), modifications have been warranted to analyze additional types (e.g., access to tangible items; Wacker et al. 1990) or categories of reinforcement (e.g., automatic; Querim et al. 2013). To address the potential for these Type 1 errors, test conditions may be used to identify functional relationships between percurrent behavior and the reinforcement

that follows (e.g., Bowman et al. 1997). Percurrent behavior involves any response that serves to increase the effectiveness of a subsequent (or temporally current) response, such as a mand, at obtaining reinforcement (i.e., Skinner 1968).

Challenging behavior in children can sometimes serve as percurrent behavior and may increase the effectiveness of manding directed toward their caregivers. Manding is a type of verbal operant i.e. functionally controlled by the establishing operation relevant to the consequence of a specific response form (e.g., Michael 1988; Skinner 1957). So, an illustrative example may involve a child's use of disruptive behavior (percurrent response) following the deprivation of food (establishing operation) resulting in a decreased latency in receiving a snack from a caregiver. What then may follow is the same pattern of

caregiver responding following a child mand for a snack as a means of preventing disruptive behavior (mand cooperation). This pattern of responding can create a cyclical pattern; for the child, it can create an expectation that all manding will and should be honored, and for the caregiver, it may create high levels of distress at the prospect of being unable to accommodate increasingly unreasonable manding.

Following anecdotal observations that denied idiosyncratic manding resulted in challenging behavior, coupled with inconclusive FA results, Bowman et al. (1997) tested a contingency arrangement in which test and control conditions were alternated in a multielement design (i.e., “mand analysis”). In test conditions, the therapist placed a participant’s manding on extinction following a brief pre-session period of cooperation with manding. Contingent on child challenging behavior, the therapist resumed complying with the child’s manding for a period of 30 s. In the control condition, therapists complied with all child manding and there were no consequences in place for challenging behavior. Mand analyses were shown to differentially identify relevant reinforcement contingencies, and subsequent treatment evaluations effectively reduced challenging behavior using functional communication training (FCT; Carr and Durand 1985) and extinction procedures.

The analysis procedures described in Bowman et al. (1997) have been replicated numerous times (e.g., Kurtz et al. 2015; Schmidt et al. 2017; Torres-Viso et al. 2018) and bolstered by a variety of procedural variations (e.g., directing the child to engage in competing activities, rearranging the environment; Rajaraman and Hanley 2021). Function-based interventions following differentiated mand analyses typically involved FCT plus extinction paradigms. In some studies, differential reinforcement was used to teach adaptive communicative responses, such as “it’s my way” (e.g., Eluri et al. 2016). In addition, nearly all studies included schedule thinning procedures via multiple (e.g., Schmidt et al. 2017) or chained (e.g., O’Connor et al. 2003) schedules of reinforcement to facilitate generalization. In their multiple schedule arrangement, Schmidt and colleagues used verbal prompts and digital timers to signal when reinforcement of manding was available [that is, discriminative stimuli (S^D), “Daryl’s way”), and when it was unavailable [that is, stimulus delta (S^Δ), “we are going to play (therapist’s) way”) for participants.

Several studies included specific task demands that participants were required to cooperate with during an S^Δ interval, which were communicated via a token system. For instance, O’Connor et al. (2003) and Eluri et al. (2016) both incorporated a token system and discriminative stimuli to signal when a child was able to control their environment (i.e., child directing adults and tasks; “Child’s Way”) and when parents/adults had control over the environment (i.e., adults directing tasks; “Adult’s Way”). O’Connor and colleagues used a “play my way” card to signal the availability of reinforcement, which was made unavailable during academic periods to teach tolerance for adult-directed activities (i.e., the S^Δ interval). A token board was incorporated simultaneously to provide

information regarding the number of demands that would be in place during the S^Δ interval. Similarly, Eluri and colleagues communicated adult expectations via a token board, which required cooperation with 15 adult directives. The token board signaled the S^Δ interval, which involved the therapist interrupting their child’s preferred interactions with activities (e.g., manipulating play in a way that was different from the child’s preferences). Contingent on successfully earning all their tokens, the participant earned access to the S^D interval, which involved the therapist complying with reasonable child manding and was signaled via a card that said, “my [child’s] way.” The authors noted that the duration of the S^D interval was highly variable, ranging from 0 to 7.5 min. Results of both studies suggested that the use of the token systems was effective at reducing rates of challenging behavior from baseline, albeit only within the context of response-based schedules of reinforcement.

Given the imperative to include caregiver treatment objectives into the development of function-based procedures (e.g., Becraft et al. 2024), it may be useful to consider alternative reinforcement schedules that may be acceptable to caregivers based on their individual goals for their child. One such alternative is the use of duration schedules of reinforcement (e.g., Mellott and Ardoin 2023; Peck and Byrne 2016; Williams and Johnston 1992), which reinforce a single instance of continuous behavior after a set duration of time. A cumulative duration schedule is one where reinforcement is delivered following a total accumulated duration of responding, rather than following a set duration of a single response (i.e., duration schedules; Gulotta and Byrne 2015) or the first response following a specified interval of time (i.e., interval schedules; Zuriff 1970). e.g., a coach might reinforce players’ running behavior by ending practice after they have run for 5 min. Regardless of how many times they started and stopped, practice would only conclude after they had accumulated 5 min of running behavior. Cumulative duration schedules may be useful for caregivers to implement across settings and contexts, as naturally occurring reinforcement contingencies are often based on continuous dimensions of behavior (e.g., during playtime with siblings). The purpose of the current study is to extend research on the treatment of challenging behavior maintained by mand cooperation in two ways: first, by modifying treatment procedures to include the use of cumulative duration schedules, and second, to demonstrate generalizability by including caregivers as therapists in both the assessment and treatment evaluation components of service provision.

2 | Method

2.1 | Participants and Setting

Participants were 14 children between the ages of 3 and 12 ($M = 6.4$, $SD = 2.7$) and their caregivers. All participants met the following criteria for inclusion: (1) children whose challenging behavior was evoked by denied mands that were

analyzed between July 2022 and August 2023, (2) only participants whose challenging behavior was assessed via a mand analysis were included, and (3) all participants were prospectively assigned to receive the same treatment procedures. Consistent with Hagopian (2020), the current study met all the criteria for a prospective controlled consecutive case series, in that all participants who received a mand analysis within the given 13-month timeframe were assigned to undergo the same treatment procedure a priori. No participants meeting those criteria were excluded from the current report for any reason. Caregivers provided information regarding the conditions under which they would accommodate their child's manding to prevent challenging behavior, which then informed both the test conditions of the mand analysis and subsequent treatment. Caregiver report at the initial interview indicated that 57% of participants engaged in manding for caregivers to provide idiosyncratic access to preferred items/activities (e.g., access to specific features of an item), 29% engaged in manding for caregivers to engage with tangibles (e.g., ordering or arranging specific items), and 14% engaged in manding to direct caregivers' interactions (e.g., specific conversations or preferred topics). Additional information regarding participant characteristics are listed in Table 1.

The outpatient treatment program is part of a hospital-based psychology department which receives referrals from community physicians, schools, and internal providers. The program required at least 1 caregiver to attend every appointment to receive caregiver training. Trained therapists, supervised by licensed psychologists with doctoral-level behavior analyst certifications, provided oversight of all caregiver-implemented assessment and treatment procedures.

All functional analysis, mand analysis, and treatment sessions were conducted in a therapy room (4 m by 3 m) with one-way

observation windows and a cloud-based audio-video system, which allowed for secondary review of dependent variables and procedural fidelity. All therapy rooms contained 1 couch, 2 adult-sized chairs, 1 table, and 2 child-sized chairs. Materials used during the appointments included participants' preferred items/activities, typically consisting of a tablet/iPad for older children or clinic toys (e.g., toy trains, Magnatiles, Legos, action figures, etc.), identified each day prior to the start of the appointment via a brief free-operant preference assessment (e.g., Sautter et al. 2008). Each treatment admission was planned to allow families time to accommodate their daily work and school schedules, and appointments were typically scheduled for 9:00 a.m.–11:00 a.m. Families residing 50 miles or more from the clinic and in need of accommodation to receive services were provided complementary lodging to facilitate participation in the program. Missed appointments were not rescheduled due to the condensed nature of the treatment programming, however, families were permitted to miss up to 2 appointments.

The Intensive Treatment Program (ITP; Edelstein et al. 2022) involved a 2-week, 20-h treatment course during which families attended treatment in person, every weekday for 2 h per day. The Day Treatment Program involved a 5-week, 20-h treatment course consisting of 2-h treatment appointments occurring twice per week.

2.2 | Direct Observation, Data Collection, and Response Definitions

The primary dependent variables were child challenging behavior, demonstration of appropriate behavior, and cooperation with adult directives. Challenging behavior (e.g., tantrums, aggression, etc.) was measured via frequency counts

TABLE 1 | Participant information.

P	Diagnosis	Age	Sex	Race	Tx type	Tx target	Caregiver	Mand history	% reduction
1	ODD	4	F	W	ITP	T	M	Idiosyncratic access	100
2	ADHD	9	F	MR	Day	T	M	Attention	100
3	ADHD	7	M	A	ITP	T	F	Idiosyncratic access	100
4	ODD	10	F	W	Day	A,T	M	Idiosyncratic access	100
5	ODD	6	M	W	ITP	T	M	Tangible	25
6	ODD	3	F	A	ITP	T	M	Attention	100
7	ADHD	5	M	W	ITP	A	M	Idiosyncratic access	100
8	ADHD	12	F	W	Day	A,T	M	Tangible	100
9	ADHD	4	M	B	Day	T	M	Idiosyncratic access	100
10	ADHD	4	M	W	Day	A,T	F	Idiosyncratic access	88
11	ADHD	5	M	W	ITP	A,T	M	Tangible	81
12	ODD	9	F	MR	ITP	T	M	Idiosyncratic access	100
13	ODD	7	F	W	ITP	T	M	Idiosyncratic access	97
14	ODD	4	M	MR	Day	A,T	M	Tangible	97

Abbreviations: A = aggression; A = Asian; ADHD = attention-deficit/hyperactivity disorder; B = black; Day = day treatment program; F = father; F = female; ITP = intensive treatment program; M = male; M = mother; Mand History = maintaining conditions for challenging behavior; MR = multiracial; ODD = oppositional defiant disorder; P = participant identifier; T = tantrum; Tx = treatment; W = white.

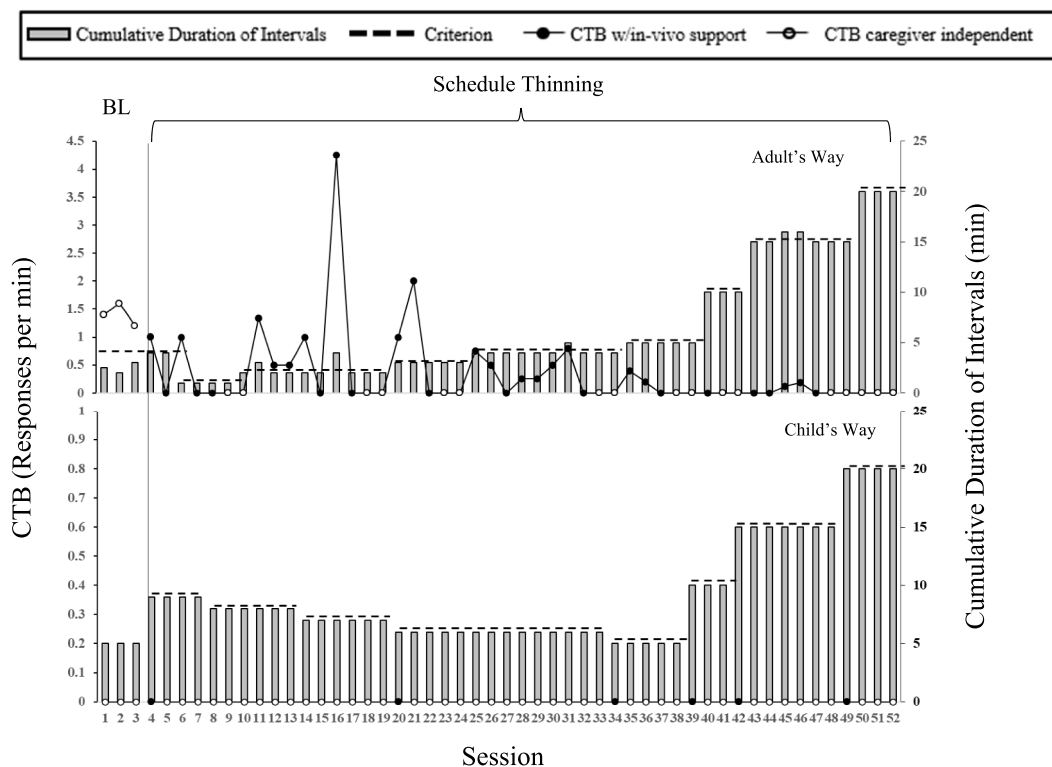


FIGURE 1 | Assessment and Treatment Graph (P1). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

and later converted to a rate by dividing the total number of responses by the duration of a given session. Child appropriate behavior (i.e., "behavior rules") was broadly defined as engaging in (1) a safe, calm body (i.e., engaging with appropriate material in the absence of challenging behavior) and (2) using a quiet voice (i.e., use of adaptive language at conversational level). While appropriate requesting was acknowledged across all phases of the intervention, repeated requesting of unavailable activities would not meet the criteria outlined in the behavior rules. Cooperation with adult directives was defined as initiating or complying with a directive within 5 s of the adult utterance. Both the behavior rules and child cooperation served as incompatible replacement responses to challenging behavior. Cumulative duration variables (i.e., behavior rules and cooperation) were measured on a continuous basis. In baseline, all direct measures were collected in 5 min sessions. In the treatment evaluation, data were collected on a session-by-session basis, with the total number of sessions varying each visit ($M = 7.2$; Range: 5–20). session duration varied based on the stage of treatment (described in further detail in procedure).

Data were collected on within-session challenging behavior by the clinician. The definition of challenging behavior was individualized to each participant; however, all participants engaged in either tantrums, aggression, or both as a primary target behavior. *Tantrums* were broadly defined as being a combination

of disruptive behavior and/or vocal aggression (e.g., profanity, verbal threats, vocal refusal, etc.). *Aggression* was broadly defined as being any instance of hitting, kicking, biting, or shoving other people. Broad categories of primary targets are included in Table 1.

2.3 | Indirect Measures

Daily Behavior Rating Scale (BRS; Edelstein et al. 2022) is a one-item question measured on a 0–10 Likert scale (0–3 = mild issues, 4–7 = moderate issues, 8–10 = severe issues). This indirect, subjective rating scale allowed caregivers to rate the functional impairment caused by their child's challenging behavior since the previous appointment. While the scale has not been formally validated, it is used as a collateral measure of the external validity of the treatment procedure.

Text Message Behavior Rating is a one-item question sent to caregivers via text message every day at a time of their choosing. The tool automatically prompts caregivers to provide data regarding the frequency of occurrence of each patient's target behavior. Caregivers respond by texting the total number of target behaviors that occurred during the 24-h period since the previous prompt. These responses are automatically recorded and made available to clinicians for review. Caregivers who opted out of the text-message system were given the option to

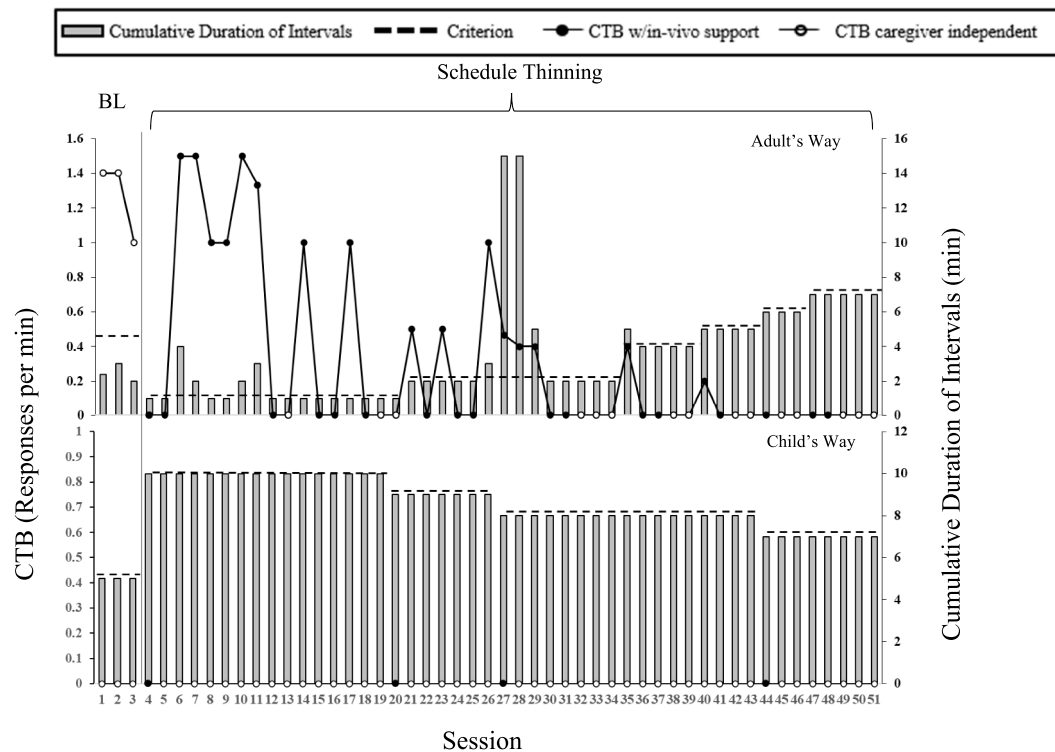


FIGURE 2 | Assessment and Treatment Graph (P2). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

complete a paper-and-pencil data sheet. The text system was used to indirectly measure the generality of the treatment procedure.

Eyberg Child Behavior Inventory (ECBI; Eyberg and Pincus 1999) is a validated, normed 36-item caregiver rating scale used to measure child challenging behavior. The Intensity Subscale measures caregivers' perception of the frequency of behavior problems, and the Problem Subscale measures caregivers' perception of the magnitude of the problem. The test-retest reliability on both scales has been found to be acceptable ($\alpha = 0.86$ for Intensity Subscale; 0.88 for Problem Subscale), and the discriminative validity has been shown to identify significant differences between non-referred, and conduct-disordered children (Eyberg and Ross 1978).

The Parenting Stress Inventory—fourth Edition, Short Form (PSI-4-SF; Abidin 2012) is given to caregivers querying the perceived levels of stress due to caregiver-child interactions on a 4-point Likert Scale. Subscales include Parent Distress, Parent-Child Dysfunctional Interaction, and Difficult Child. Reliability coefficients across domains were found to contain a high degree of internal consistency (i.e., Chronbach's $\alpha = 0.9$ – 0.91 ; Abidin 2012).

Therapy Attitude Inventory (TAI; Eyberg and Johnson 1974). The TAI is a 10-item treatment acceptability measure completed

by caregivers after they have received a course of therapy. Specific questions inquire about the impact of the treatment procedures, skills acquired during the treatment process, and the magnitude of child behavior change. Items are rated on a Likert Scale, ranging from 1 (indicating dissatisfaction with treatment or worsening of problems) to 5 (indicating maximum satisfaction or improvement of problems). Cronbach's α was determined to be 0.91 , and the stability coefficient across a 4-month period was 0.85 .

2.4 | Interobserver Agreement and Procedural Integrity

A second, independent coder scored recorded behavior data to allow for the calculation of inter-observer agreement (IOA). In both the mand analysis and the treatment evaluation, data from each session were divided into 30-s intervals and compared on an interval-by-interval basis. An agreement occurred in each interval when both the primary and secondary observer agreed on either the occurrence or non-occurrence of a response, and agreement percentages were calculated by dividing the number of sessions with agreement over the total number of sessions. For cumulative duration measures, child appropriate behavior and cooperation were coded using whole interval recording [that is, observers scored a (+) if appropriate behavior and

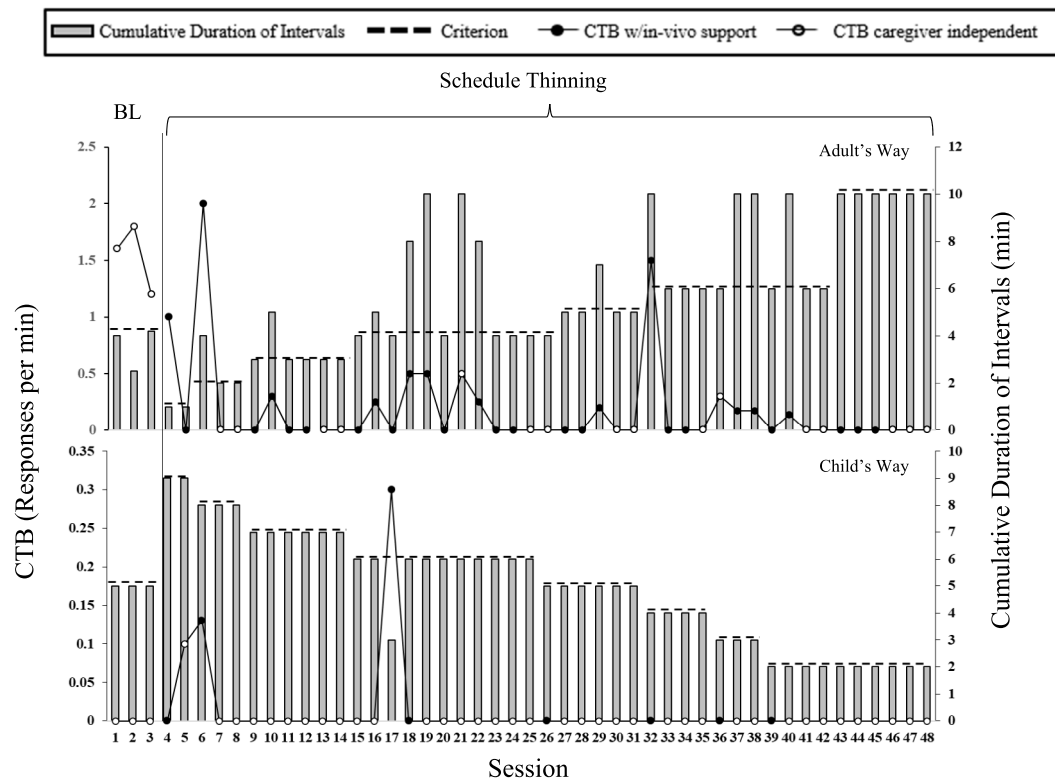


FIGURE 3 | Assessment and Treatment Graph (P3). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

cooperation were observed for the entirety of the interval; otherwise, the observers scored a (–)]. IOA was calculated for 45% of all FA sessions (range, 40%–60%) and 34.4% of treatment sessions (range, 30%–50%). Across all participants, agreement for challenging behavior averaged 93.4% (range, 86%–100%), cooperation averaged 99.6% (range, 96%–100%), and appropriate behavior averaged 98.8% (range, 90%–100%).

A procedural fidelity checklist (see Appendix A) was used to independently score whether caregivers correctly and independently implemented the assessment and treatment protocols. Specific items from the checklist included the appropriate use of the discriminative stimuli and digital timers, as well as appropriate delivery of reinforcement and extinction procedures. A second observer scored a (+) for items on the checklist that were correctly implemented and a (–) for those that were implemented incorrectly. Average percentages of treatment integrity were calculated by dividing the number of items with a (+) by the total number of possible items and multiplying by 100. Procedural fidelity of independent caregiver implementation of procedures averaged 95% across participants (range, 88%–100%) and was scored across 34% of all sessions (range, 30%–50%).

2.5 | Procedure

Prior to beginning treatment, families were given the option of self-selecting between either the Intensive or Day Treatment

Program options (described above). Of the 14 families identified, 8 (57%) elected to complete the Intensive Treatment Program, while 6 families (43%) elected to complete the Day Treatment Program. Treatment courses involved an individualized, in-person format. Families began treatment by receiving a semi-structured functional interview (Edelstein et al. 2023) designed to identify target behaviors and develop initial functional hypotheses regarding functions of the child's target behavior before assessing for causal relationships via functional analyses and/or mand analyses. Within both treatment program structures, the first 20–30 min of treatment appointments were reserved for families to provide updates and for therapists to review between-appointment data collected from home-based skills practice. The remaining appointment time was reserved for skills practice.

All clinicians were formally trained in de-escalation and assaultive behavior management techniques to minimize the risk of injury for participants, their caregivers, and staff. Caregivers received individualized coaching in preventative and blocking procedures as needed via modeling and role play; in addition, clinicians were present to coach caregivers in the implementation of these procedures during episodes of challenging behavior in clinic. As a precaution for some participants, furniture was proactively removed from treatment rooms to minimize the potential for property destruction or injury. Specific safety plans were generated with families to ensure that skills could effectively be practiced outside of the clinic setting without causing additional risk.

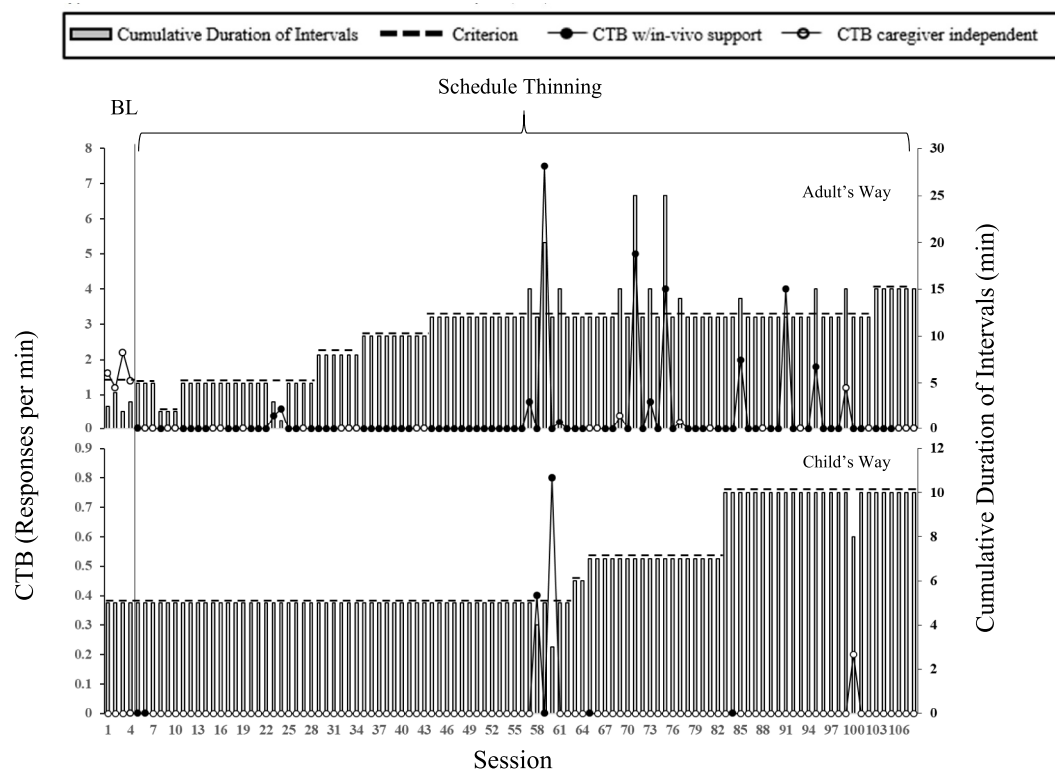


FIGURE 4 | Assessment and Treatment Graph (P4). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

2.5.1 | Mand Analysis

Following the interview, caregivers were trained to conduct an analysis to test the hypothesis that participants engaged in challenging behavior to get adults to comply with their manding (Bowman et al. 1997). The use of this analysis procedure was indicated due to either (1) both caregiver report suggesting that their child's manding may be serving a percurrent relation to challenging behavior and undifferentiated functional analysis results [that is, no clear results indicating function of behavior after the completion of a traditional analysis targeting attention, tangible, and/or escape functions; participant identifier (P's) 1, 2, 3, 4, 6, 10], or (2) pre-treatment clinician observations of the child-caregiver interaction (e.g., child requesting for caregivers' cooperation in completing activities within their personal preferences and engaging in challenging behaviors when adults did not comply with their way; P's 5, 7, 8, 9, 11, 12, 13, 14). Functional analysis results were interpreted by a doctoral-level behavior analyst to verify whether differentiation occurred between test and control conditions.

Similar to Bowman et al. (1997), the mand analysis included test and control conditions that were presented in a multi-element design. Three test and three control conditions were conducted for all participants except P5, for whom four of each

condition were conducted. Materials used during the analysis were selected by the child using a free operant preference assessment (i.e., Sautter et al. 2008) and were identical in both test and control conditions. During the control condition, the child was permitted to play with toys and make requests of caregivers as desired; these requests were honored provided they were feasible. There were no programmed consequences contingent on challenging behavior. Test conditions included free access to preferred items and activities; however, caregivers modified their participation to involve adult-directed play ("Adult's Way"), which was in contrast to the child's preference (e.g., changing the color while drawing/coloring, playing a game according to new rules, or building blocks differently than directed by the child). Appropriate requests were not honored during the Adult's Way periods of test conditions, and instead caregivers were trained to respond to these requests by saying "it's my way now, we can play your way later." Contingent on participant challenging behaviors, caregivers were instructed to reinforce target behavior by allowing the play to return the child's preferences ("Child's Way"), thereby complying with manding, for a duration of 30 s. Following 30 s of Child's Way, caregivers then returned to continue playing according to their preferences until either additional target behaviors occurred or until 5 min elapsed. Each condition was 5 min in duration, and data were collected on instances of child target behavior across conditions.

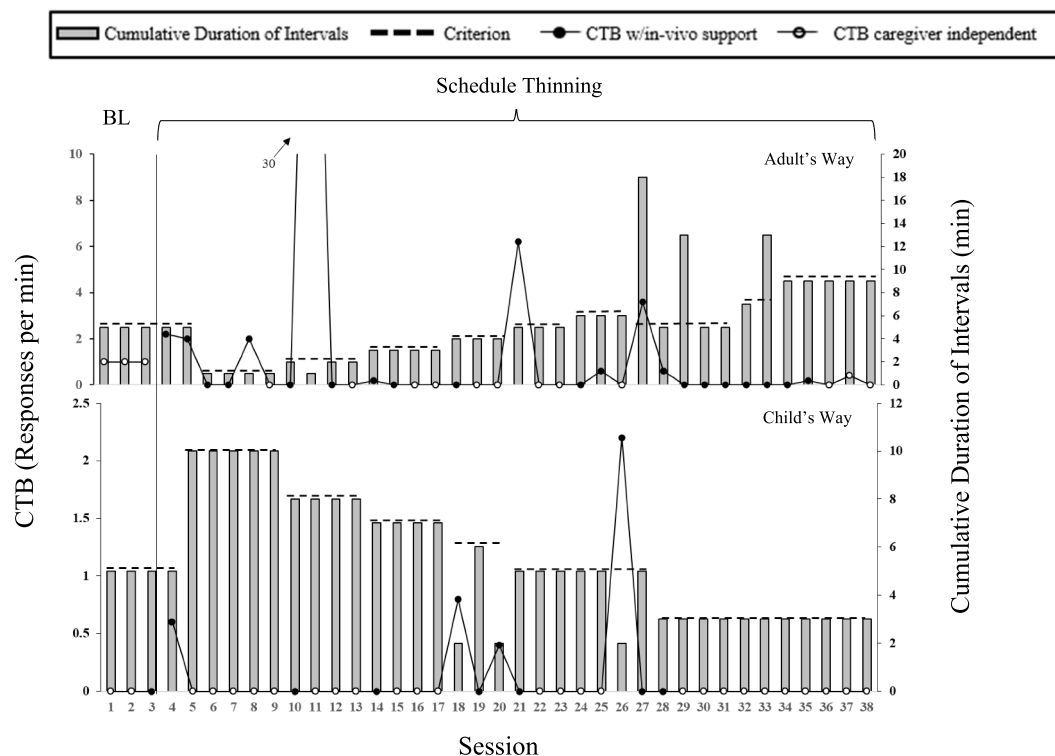


FIGURE 5 | Assessment and Treatment Graph (P5). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

2.5.2 | Experimental Design

The treatment analyses used a changing criterion design over the cumulative duration of child cooperation and appropriate behavior (i.e., behavior rules) during the S^A intervals (Adult's Way) to evaluate the effects of progressively increased response requirements. Functional control was demonstrated by showing that the cumulative duration of cooperation and appropriate behavior in Adult's Way increased following successive changes in reinforcement contingencies. Importantly, participants were permitted to engage with tasks and activities according to expectations articulated in Adult's Way after the interval ended (e.g., if the participant was asked to complete a work task for 5 cumulative minutes, they could choose to continue engaging in the work task in Child's Way). Alternatively, participants could refuse to cooperate with Adult's Way expectations, though non-cooperation would extend the total duration of the Adult's Way interval consistent with a cumulative duration schedule. Adult's Way was terminated once participants' responding met the cumulative duration criterion at a given subphase and was signaled by a digital timer. The initial criterion for the S^A interval duration was set a priori based on caregiver input and varied from 1 to 5 min. Shorter S^A intervals were used for participants with high rates of challenging behavior in baseline (e.g., P2). After this initial phase, the criterion was altered in each subphase to control the progression of behavior change. To evaluate the pre-post

effects of the intervention at the group level, paired sample t -tests were conducted in Microsoft Excel 2016. Cohen's d effect size estimates were also provided for all treatment analyses. All data and materials can be made available by the first author upon request.

2.5.3 | Caregiver Training

Clinicians used behavioral skills training (e.g., Sarokoff and Sturmey 2004) to model treatment procedures and provide in vivo corrective feedback to caregivers immediately following a procedural error. First, caregivers were provided with instructions on the procedures and rationale prior to implementing each phase of the assessment or intervention. For assessment procedures, clinicians provided modeling by role playing with the caregiver rather than demonstrating with the child. During the treatment evaluation, clinicians modeled the implementation of the procedure with the child, narrating each essential component. Then, caregivers were invited to take the role of the therapist and implement procedures with direct coaching and feedback from the clinician. Once caregivers were implementing procedures independently, caregiver fidelity data were coded by the clinician from outside of the treatment room in an adjacent observation room with one-way mirror. Performance feedback was then provided to caregivers after each session.

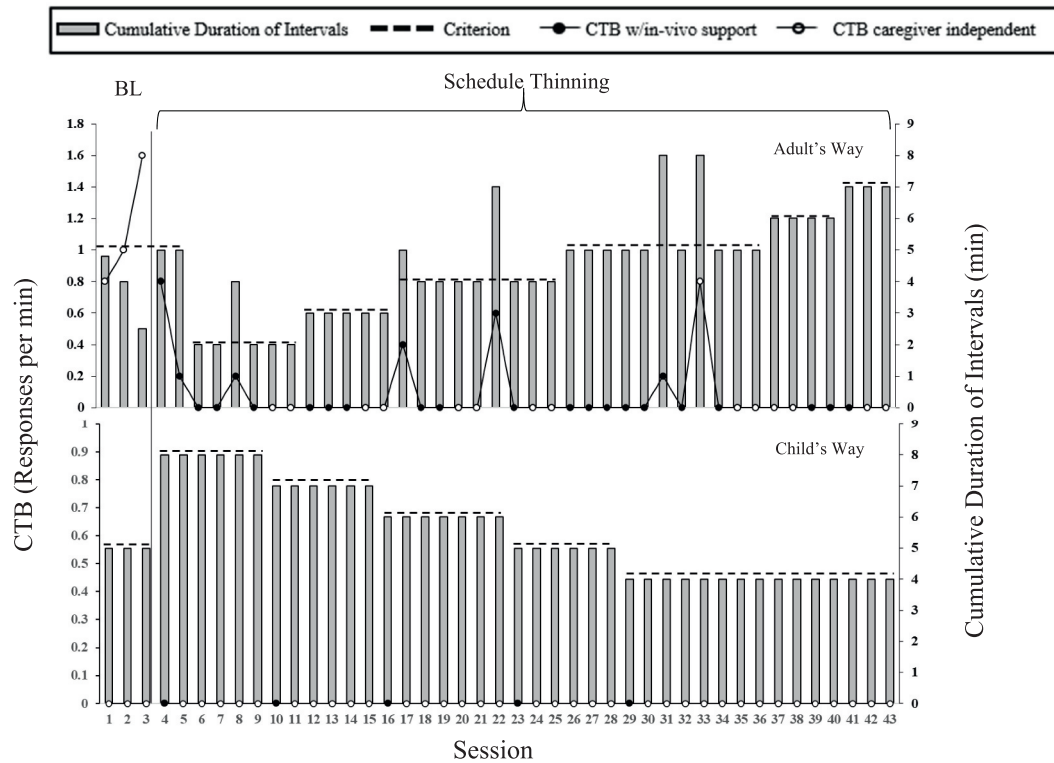


FIGURE 6 | Assessment and Treatment Graph (P6). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

2.5.4 | Baseline

Rates of challenging behavior and cumulative durations of cooperation and appropriate behavior from the test condition of the mand analysis were used as the baseline condition for the treatment evaluation.

2.5.5 | Treatment Evaluation

The treatment package included the use of fixed cumulative duration schedules (e.g., Mellott and Ardoin 2023) signaled by either a green "Child's Way" card (i.e., the S^D component) or a red "Adult's Way" card (i.e., the S^A component). Periods of cooperation with the participant manding (i.e., Child's Way) were alternated with periods during which participants were required to cooperate with adult directives and where their manding contacted extinction (i.e., Adult's Way). At the start of each S^A component (e.g., 5 min of Adult's Way), caregivers were trained to deviate from the participant's preferred activity while saying, "Now it is Adult's Way." During the S^A interval, participants were required to both continuously engage in appropriate behavior and to cooperate with adult manipulation of their interaction (e.g., either through a change to the nature of the play or by complying with an expectation for continuous on-task behavior). Contingent on

participant challenging behavior or nonadherence with adult directives, caregivers were instructed to re-state the current interval (i.e., "remember, it's Adult's Way") and re-prompt the expectation (e.g., "we are building Legos my way"). In addition, failure to cooperate with Adult's Way caused the interval timer to be paused and only resumed once participants re-engaged in appropriate behavior for 5 consecutive seconds. Thus, the Adult's Way interval reflected a cumulative duration schedule of reinforcement such that learners were required to accrue a total pre-determined duration of responding before accessing reinforcement (e.g., Mellott and Ardoin 2023). Following completion of the S^A interval (signaled via a digital timer), caregivers stated, "Good job following Adult's Way, now it is your way." Generally, response requirements in the S^A interval were increased once participants and their caregivers met both of the following criteria: (1) when participants' cumulative duration of demonstrating behavior rules and cooperation met criterion for a given subphase for three consecutive sessions, and (2) when all caregivers involved in training demonstrated procedural fidelity of 90% or greater across 2 or more sessions.

At the start of each S^D interval, (e.g., 5 min of Child's Way) caregivers were trained to provide access to highly preferred activities and to engage in interaction as directed by the participant. All reasonable participant manding was honored during this S^D interval, provided that the participant refrained from engaging in

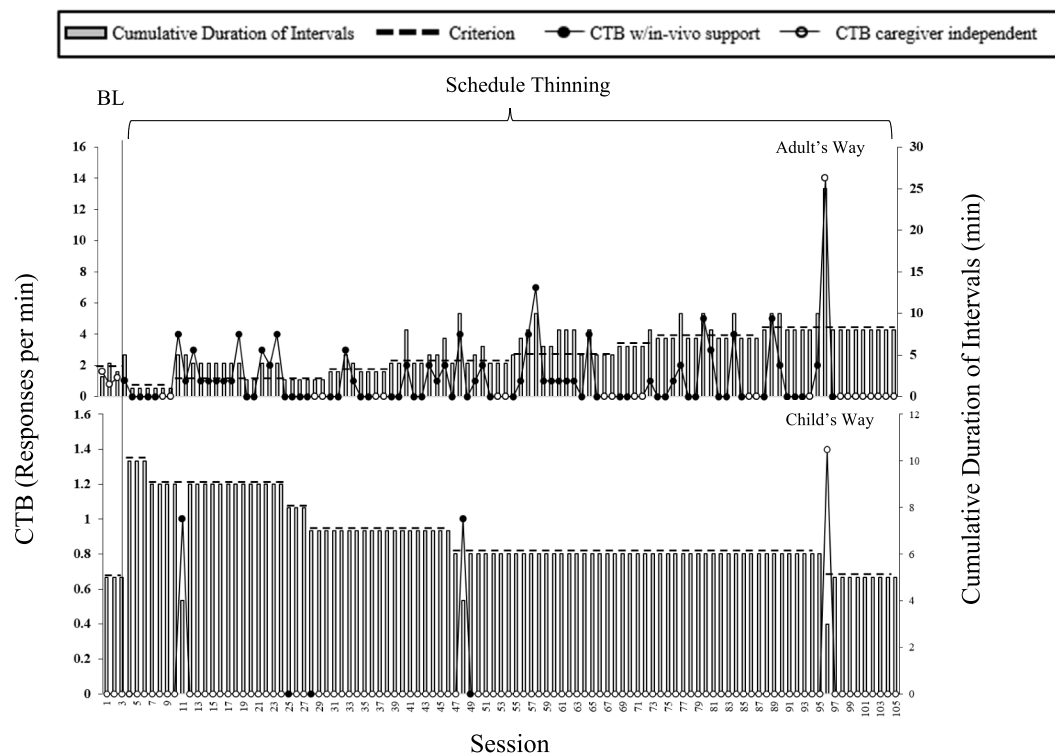


FIGURE 7 | Assessment and Treatment Graph (P7). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

challenging behavior (i.e., followed the appropriate behavior rules). Examples of child manding included ways to interact with preferred items or preferred topics of conversation. Contingent on the first instance of a participant mand above conversational level (e.g., yelling), caregivers provided a reminder to the child that failure to follow the appropriate behavior rules would result in a return to Adult's Way (e.g., "remember, you need to stay safe and calm to keep playing your way"). Following either a second instance of yelling or contingent on target challenging behavior (e.g., aggression) within the S^D interval, the interval was terminated and the S^A interval immediately began. The warning statement was used to provide an opportunity for participants to alter their responding prior to temporarily losing access to reinforcement; this procedure was used infrequently, as participants generally tolerated the programmed reinforcement interval. For all but two participants (i.e., P1 and P4), S^D intervals were systematically decreased based on corresponding increases to the subphases in the S^A interval. Caregivers for P1 and P4 expressed their preferences to achieve relatively high terminal S^A intervals (i.e., 20 and 15 min, respectively), which led to the clinical decision to deviate from the schedule thinning procedure used from other participants and increase durations of Child's Way to match the S^A interval.

3 | Results

The results of the treatment evaluation are depicted in Figures 1–14. Rates of challenging behavior from the mand

analyses were used as baseline for all participants and averaged 2.41 responses per min (range, 1.0–12.9 responses per min). The overall clinical endpoint was calculated by averaging the last 5 sessions of the S^A condition in each treatment evaluation, which occurred on the last day (day 10) of each treatment course. Across participants, rates of challenging behavior at the endpoint averaged 0.15 responses per min (range, 0–0.4 responses per min), reflecting a 94% reduction from baseline. Percent reductions of challenging behavior from baseline across individual participants are also included in Table 1. Eight out of 14 participants (57% of participants; Ps 4, 6, 8, 9–12, & 14) were quick responders to the treatment evaluation. That is, the introduction of the independent variable resulted in reductions of 80% or greater from baseline within the first two subphases. Despite some variability during schedule thinning in the S^A interval in all but two participants (P11 & P12) in this group, all participants' target behavior ultimately came under stimulus control and reduced to zero.

Six of the 14 participants (43% of participants; Ps 1–3, 5, 7, & 13) were slower responders to the treatment evaluation, which we defined as variable responding following the introduction of the independent variable, requiring greater than 20 sessions to bring target behavior under stimulus control. Four out of six participants (Ps 3, 5, 7, & 13) in the slower responder group also demonstrated some variable responding during the S^D interval, requiring that the reinforcement period be terminated prior to reaching the designated criterion.

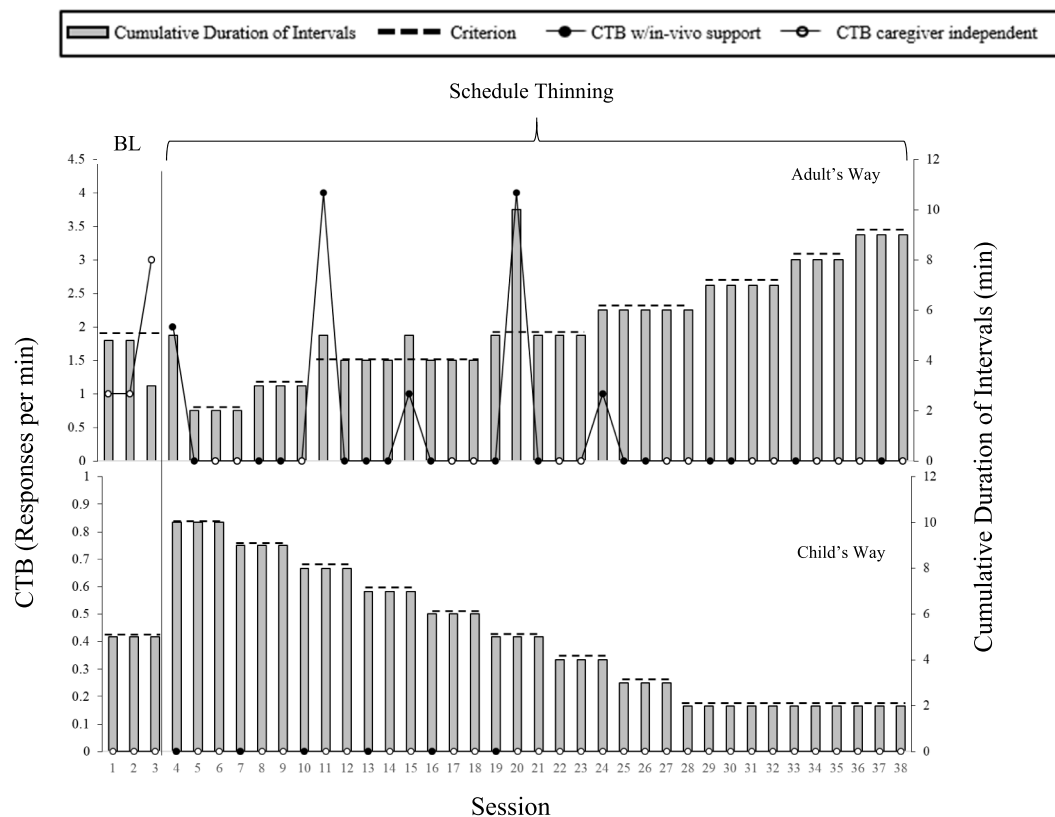


FIGURE 8 | Assessment and Treatment Graph (P8). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

Paired sample *t*-tests were computed to evaluate the impact of the intervention on the group level across dependent variables (see Table 2). In addition, Cohen's *d* (Cohen 1988) effect sizes were calculated to determine the sizes of any effects. As indicated in Table 2, results suggest significant decreases in challenging behavior as measured by trained observers within-the treatment context ($d = 0.8$) and as measured by caregivers between appointments ($d = 1.1$). Decreases in the BRS, which was used as a caregiver-reported indirect measure of functional impairment, were also statistically significant ($p < 0.001$; $d = 1.7$).

Regarding standardized measures (i.e., ECBI and PSI) provided at baseline and discharge, results revealed significant changes in pre-to post-treatment caregiver responses for the ECBI. Specifically, both ECBI Problem and Intensity Subscale scores were significantly reduced after treatment with large effect sizes (1.1 and 1.3, respectively). Results from the PSI suggest that the subjective impact of child challenging behavior on caregiver stress was improved in only one domain (PSI—Difficult Child Subscale; $d = 0.8$); however, none of the other subscales reflected significant pre-post reductions from baseline.

3.1 | Procedural Fidelity

The use of behavioral skills training, in-session coaching, and opportunities for demonstrating independence appeared useful

for preparing caregivers to correctly implement complex treatment procedures. Clinicians most consistently provided coaching during sessions with high rates of challenging behavior in either Adult's or Child's Way to provide support and instill confidence for caregivers. All caregivers met criteria for independence by the end of their treatment course, though there was some variability in the total number of independent sessions conducted across participants. Generally, caregivers achieved independence fastest during the baseline and Child's Way conditions, which had the fewest intervention components.

3.2 | Follow Up and Maintenance

Participants were followed for six months following the 20-h treatment course to ensure generality of the treatment procedures and long-term maintenance of reductions in target behavior. To calculate the frequency of target behavior at home and in the community, frequencies reported via the text-messaging system were averaged across 5 consecutive days prior to the follow up appointment. Results suggest that continued implementation of treatment procedures post-discharge produced an overall decreasing trend in challenging behavior during following; see Figure 15 for maintenance data. Specifically, at 1-month post discharge, participants demonstrated a 63% reduction in daily frequency of challenging behavior from baseline (as compared to 57.4% reduction at the

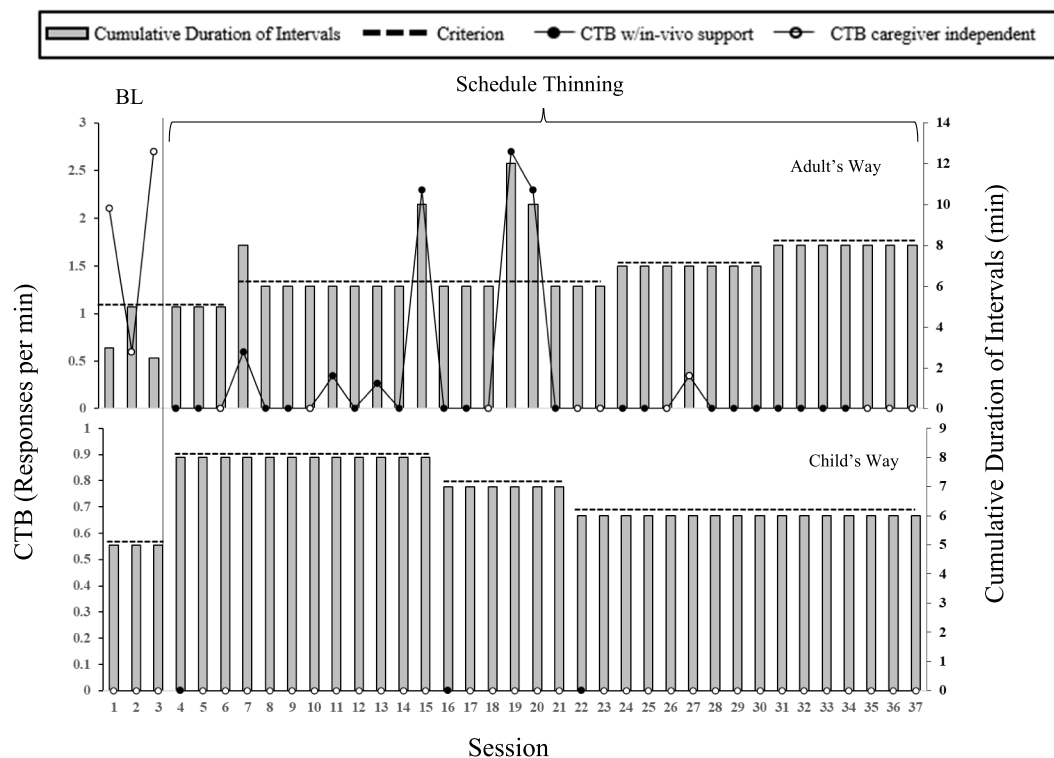


FIGURE 9 | Assessment and Treatment Graph (P9). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

end of the 20-h treatment course). Frequencies of challenging behavior reported by caregivers continued to decrease, with mean reductions reaching 80% at 3-month and 82% at 6-month post-discharge.

During follow-up appointments, caregivers were also asked to report on the level of functional impairment resulting from their child's challenging behavior using the Behavior Rating Scale (BRS). Results from this indirect measure (Figure 16) suggest that self-reported levels of impairment remained stable in the 4 weeks following the completion of the treatment course, and then continued to improve. Specifically, at 1-month post-discharge, mean BRS scores were 3.9 (range, 2–7), which reflected no change from ratings at discharge. At 3-month follow up, mean BRS scores were 3.14 (range, 1–5), and at 6-month, mean scores were 2.57 (range, 1–3).

3.3 | Treatment Acceptability

At the end of the 20-h treatment course, caregivers completed the Therapy Attitude Inventory as a measure of treatment acceptability and social validity (Eyberg and Johnson 1974; see Table 3). Overall, caregivers reported that they learned the most related to teaching procedures (Item 2) and responding to challenging behavior (Item 1), $M_s = 4.21$ and 4.07 , respectively. Additional items that garnered high acceptability scores were

Items 9, which queries caregivers regarding the utility of the program and 10, which solicits overall acceptability rating ($M_s = 4.7$ and 4.86 , respectively).

4 | Discussion

While the relationship between mand cooperation and child challenging behavior has been demonstrated across dozens of publications and participants (see Rajaraman and Hanley 2021 for a comprehensive review), none to our knowledge have discussed treatment evaluation in the context of caregiver delivery using cumulative duration schedules of reinforcement. The current study sought to train caregivers as the primary interventionists throughout the assessment and treatment evaluation, as well as to evaluate the trainability of a cumulative schedule of reinforcement. As highlighted in Table 1, participants' challenging behavior identified in the current study functioned to gain access to the ability to control interactions with their caregiver in the environment. Manding observed during the analysis often involved the specific way that the environment was manipulated, rather than for specific items or activities themselves. During the initial clinical interview, caregivers reported that their children had rapidly shifting preferences and that it was often hard to predict what they would want and when they would want it.

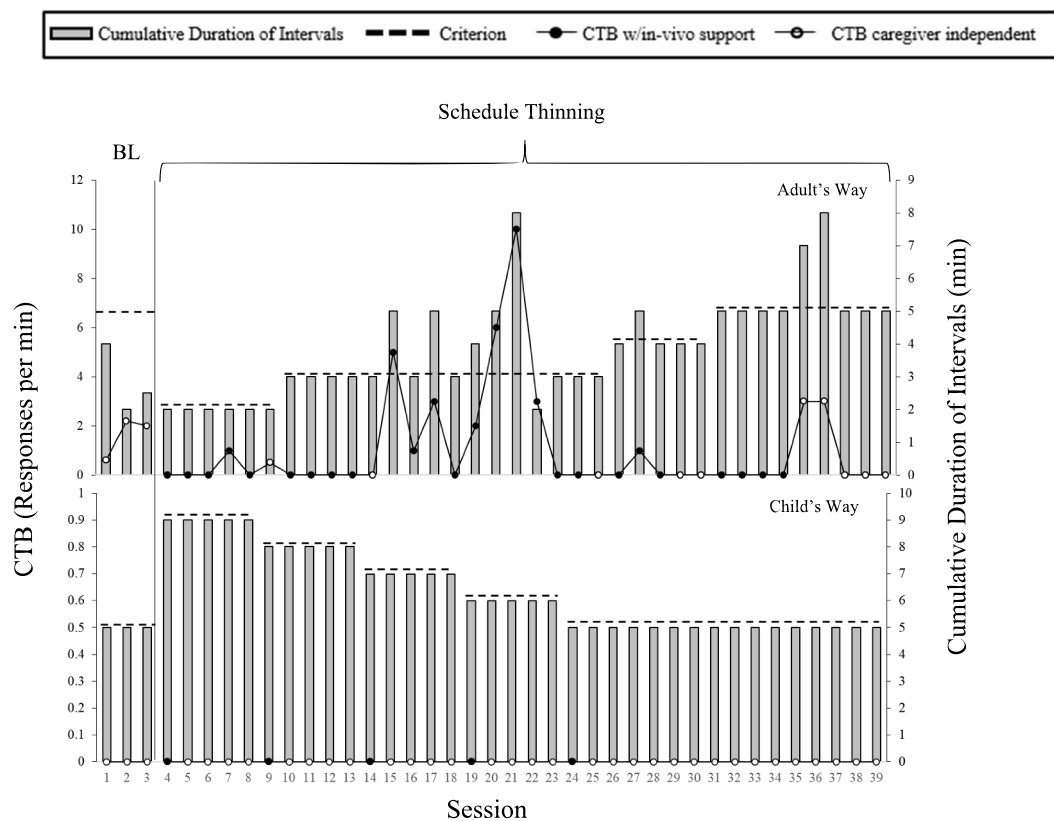


FIGURE 10 | Assessment and Treatment Graph (P10). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

The extant research literature has identified other procedures for thinning mand denials, such as using multiple or chained schedules of reinforcement (i.e., Owen et al. 2020). While these procedures have been demonstrated to both be efficacious and effective, there may be some contexts where the use of continuous schedules of reinforcement may be beneficial. For instance, caregivers may have more interest in reinforcing the accumulated duration of a behavior (i.e., leisure reading time) rather than responding during a fixed interval of time. Importantly, the use of the cumulative duration schedule does not require individuals follow a specific sequence of responding, which may offer flexibility to caregivers who are navigating competing demands.

The aims of the current study were (1) to evaluate whether caregivers could be trained to independently conduct complex intervention procedures, and (2) to evaluate the generality of cumulative duration schedules. Regarding the first aim, our results suggest that caregivers can achieve independence implementing treatment procedures in relatively short periods of time, resulting in significant reductions in challenging behavior both within and outside of clinic ($M_s = 92\%$ and 57% , respectively). Additionally, after a 20-h intensive intervention program, caregivers were able to apply treatment procedures at home and in the community with only three follow-up visits across 6 months. Toward our second aim, results suggest that the use of cumulative duration schedules of reinforcement

appeared useful to caregivers, who demonstrated their ability to successfully generalize the procedure outside of the training environment. Families anecdotally shared that they would use "Adult's Way" to communicate expectations related to homework (e.g., requiring cumulative durations of reading time), promoting tolerance of both nonpreferred settings (e.g., grocery shopping) and nonpreferred interactions (e.g., sharing toys with a sibling). Results from follow-up appointments and treatment acceptability measures suggest that cumulative duration reinforcement schedules may allow caregivers to flexibly use stimulus control procedures throughout the day and across contexts.

Interestingly, there were no statistically significant improvements in overall caregiver stress levels (PSI—Parental Distress Subscale) following the intervention, nor did caregivers report improved interactions with their child (PSI—Parent-Child Dysfunctional Interaction Subscale). These results might suggest that, despite objective reductions in rates of challenging behavior, these caregivers may continue to feel clinically significant levels of stress. One contributing factor to these results may be the length of the treatment program itself; given the brief and intensive nature of treatment, clinicians may have been unable to address factors beyond challenging behavior that may contribute to parenting stress (e.g., financial stressors, health-related stressors, and family-related stressors). While speculative, these limitations should be taken seriously and

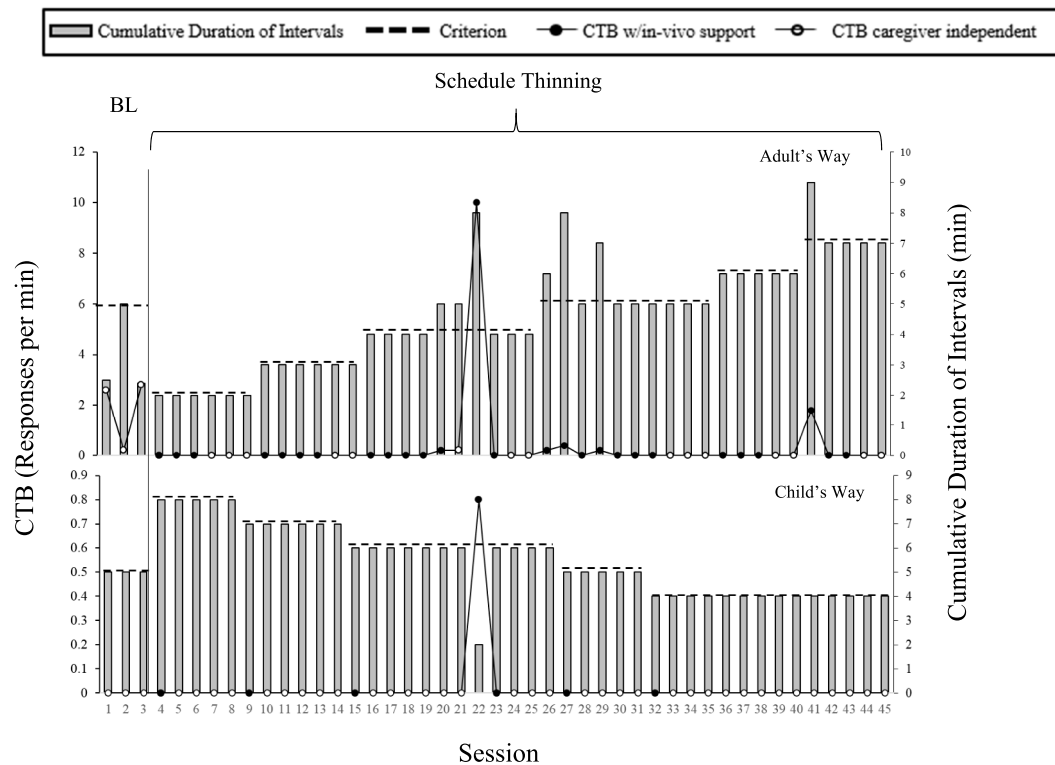


FIGURE 11 | Assessment and Treatment Graph (P11). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

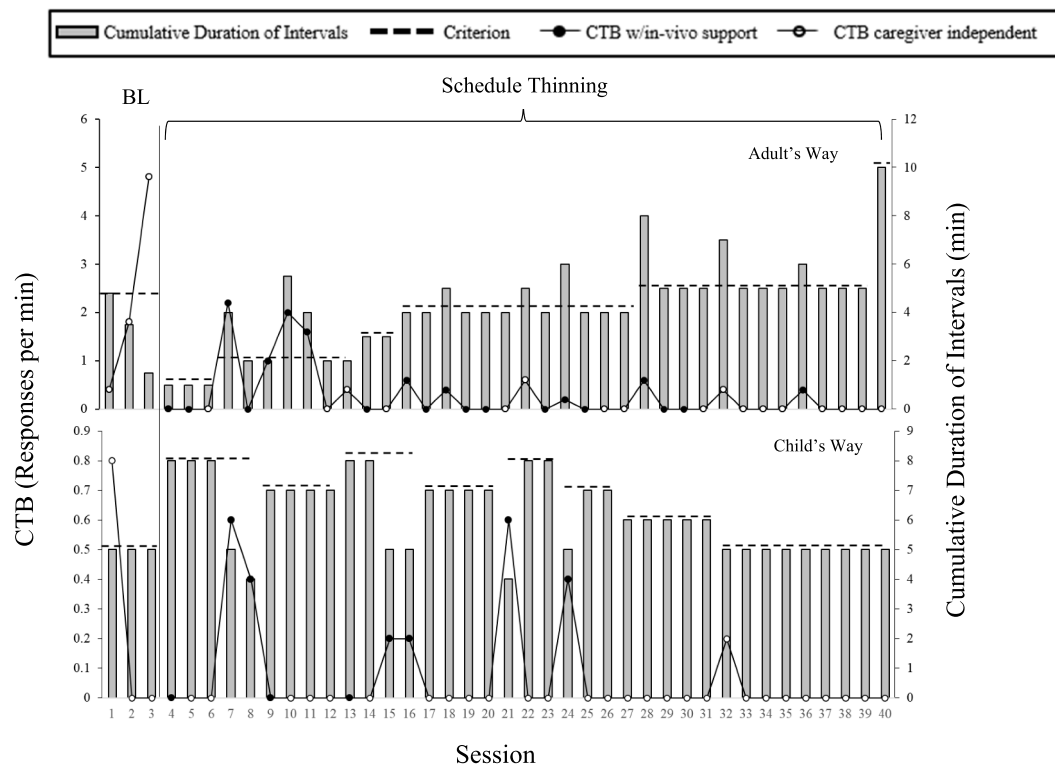


FIGURE 12 | Assessment and Treatment Graph (P12). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

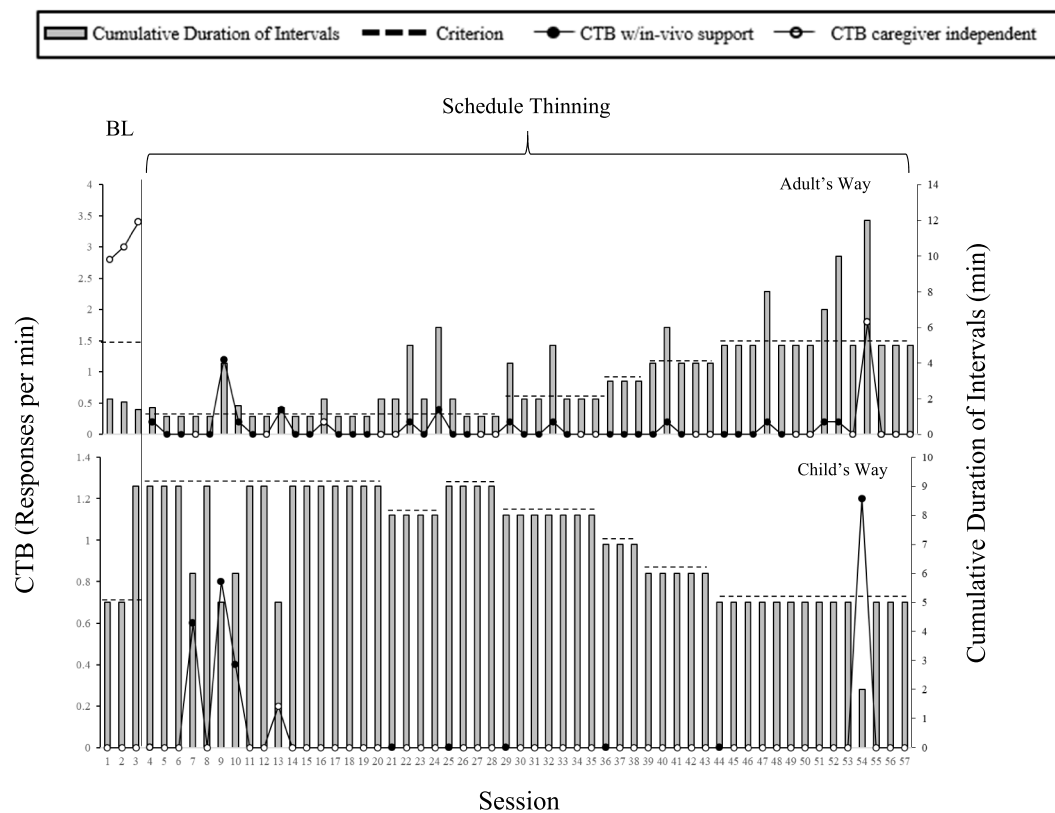


FIGURE 13 | Assessment and Treatment Graph (P13). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

addressed using both psychoeducation and relapse prevention, as overwhelmed caregivers may be less likely to adhere to treatment procedures over time (e.g., Gilroy and Kaplan 2020).

The assessment methods employed in the current study are consistent with those which have shaped the mand cooperation literature thus far, and we have extended those findings by reporting how often each occurred within a well-defined cohort. Most were identified following either undifferentiated functional analysis results or informal observations of caregiver-child interactions. Future studies should seek to prospectively identify children who engage in percurrent challenging behavior, as such a process would likely lead to more efficient treatment procedures. In addition, similar to comments from Owen et al. (2020), we did not evaluate the specificity of the current treatment procedures to percurrent challenging behavior. i.e., we were not able to establish whether our procedures reflect a tailored intervention for percurrent relations between manding and challenging behavior. Future research should evaluate comparative outcomes with other evidence-based behavior analytic procedures.

While the procedures described in the current study serve to extend the current literature, the results should be tempered by its limitations. Specifically, our methods diverged from others' procedures (e.g., Eluri et al. 2016) in that we did not teach or require a functional communication response (i.e., "my way")

for participants to access activities or caregivers according to their own preferences. Instead, participant access to the S^D interval was signaled via a card and a digital timer and provided contingent on a specified interval of cooperation with adult directives. Our rationale for this modification was due to the learning history of both the participants and their caregivers; specifically, caregivers already had a robust learning history of responding to and reinforcing their children's repertoire of manding behavior. In addition, all participants in the current sample had full vocal-verbal repertoires that included developmentally appropriate manding. However, given the precedent for conducting functional communication training prior to schedule thinning (e.g., Rajaraman and Hanley 2021), our decision to exclude this component reflects a potential limitation. While anecdotally, we found that our intervention had no punishing effect on participants' manding behavior (i.e., they continued to request throughout all components of the procedure, and those requests were acknowledged but not honored during the S^D interval), future applications should collect data on appropriate manding to ensure that participants' ability to self-advocate is unencumbered.

The variable degree of experimental control across participants was also a limitation of the current study. Specifically, some participants (i.e., P2), required extended amounts of treatment time prior to reductions of challenging behavior meeting clinically significant levels; others, (i.e., P14) only reached cumulative

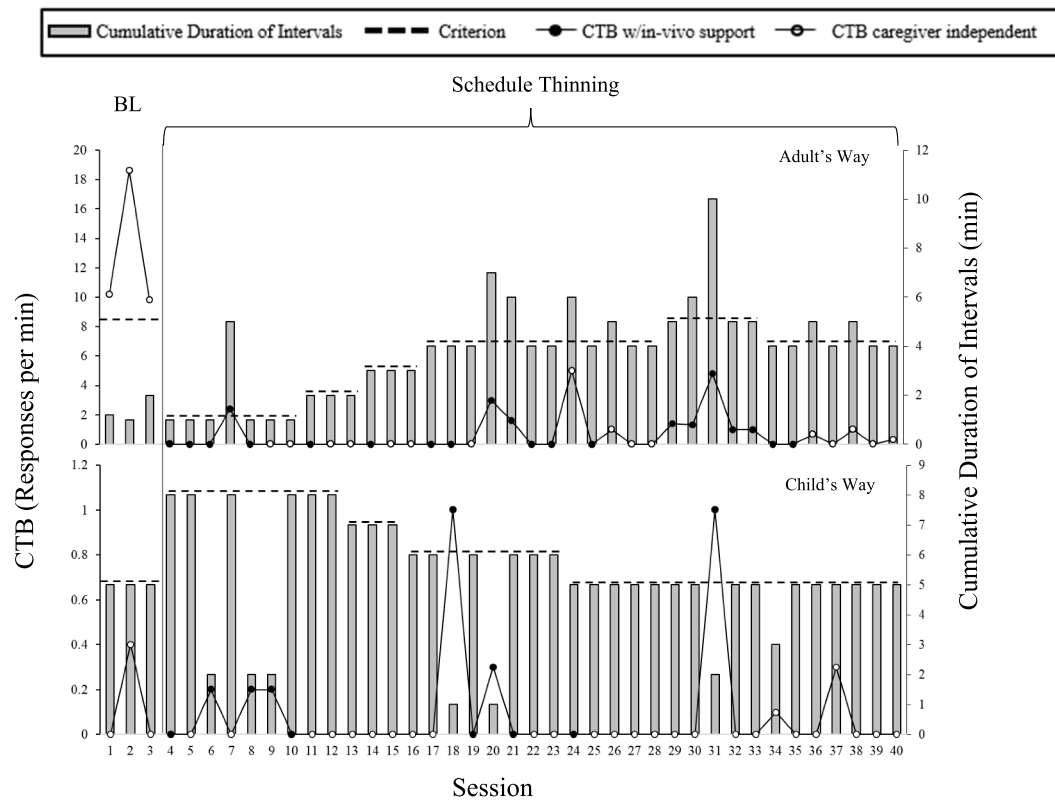


FIGURE 14 | Assessment and Treatment Graph (P14). BL refers to data gathered from the test condition of the mand analysis; CTB refers to combined target behavior; in vivo coaching refers to sessions where clinicians actively coached caregivers on implementation in the treatment room; caregiver independent refers to sessions where clinicians stepped out of the room to observe caregiver implementation via one-way mirror; Duration of intervals is reflected by the bar graph and refers to the cumulative number of minutes of appropriate behavior in Child's Way and minutes of appropriate plus target behavior in Adult's Way.

TABLE 2 | Results of paired samples *t*-test analyses.

	Pre <i>M</i> (SD)	Post <i>M</i> (SD)	Paired samples <i>t</i> -test	<i>d</i>
PB in treatment context	2.41 (3.04)	0.15 (0.33)	<i>t</i> (13) = 0.01**	0.8
PB between-appointment	3.57 (3.05)	1.52 (1.14)	<i>t</i> (13) = 0.02**	1.1
BRS	7.57 (1.65)	3.92 (1.4)	<i>t</i> (13) = 0.001***	1.7
ECBI-I	69.4 (8.68)	59.9 (6.3)	<i>t</i> (13) = 0.004***	1.3
ECBI-P	67.9 (10.8)	56.2 (10.4)	<i>t</i> (13) = 0.009***	1.1
PSI-PD	73.8 (19.2)	63.9 (16.3)	<i>t</i> (13) = 0.168	—
PSI-PCDI	72.9 (24.2)	73.8 (16.7)	<i>t</i> (13) = 0.092	—
PSI-DC	93.2 (8.74)	83.8 (14.1)	<i>t</i> (13) = 0.053**	0.8
PSI-total	82.9 (11.5)	75.6 (10.7)	<i>t</i> (13) = 0.11	—

Abbreviations: BRS = behavior rating scale; ECBI-I = eyberg child behavior inventory, intensity subscale; ECBI-P = eyberg child behavior inventory, problem subscale; PB = problem behavior; PSI-DC = parenting stress index, difficult child subscale; PSI-PCDI = parenting stress index, parent-child difficult interaction subscale; PSI-PD = parenting stress index, parent distress subscale; PSI-Total = parenting stress index, total score.

***p* < 0.05.

****p* < 0.01.

durations of several minutes in Adult's Way. As a further challenge to experimental control, given the real-world setting in which this study was conducted, it occasionally became challenging to balance caregiver input and our goal of systematically schedule thinning both the S^D and S^A intervals. For instance, when rates/intensity of challenging behavior created concern for safe caregiver implementation (e.g., P1), we chose to increase

rather than decrease the S^D interval to maximize the amount of available reinforcement provided contingent on successful completion of Adult's Way. While these clinical decisions impacted the logical progression of our procedure, they served to increase caregivers' ability to safely implement the intervention. Future studies could improve upon the demonstration of experimental effect by incorporating programmed high-density

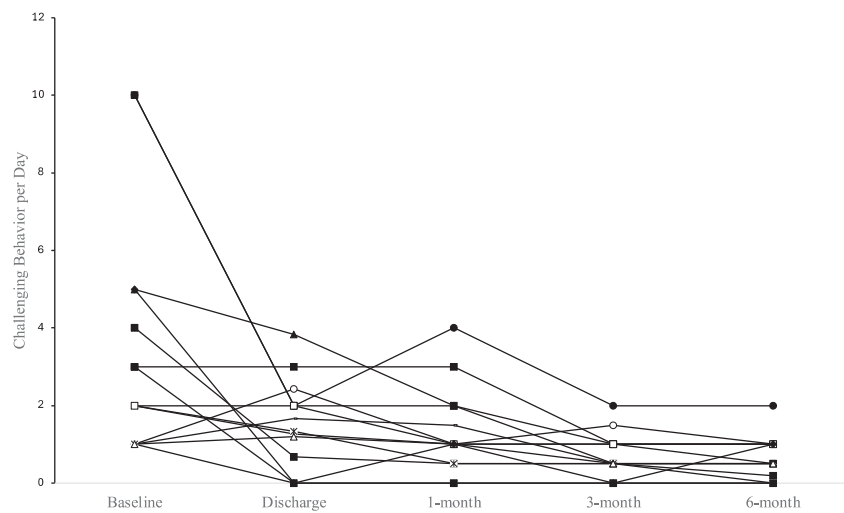


FIGURE 15 | Maintenance Data. Challenging behavior per day refers to instances of challenging behavior reported by caregivers via the text message delivery system. Baseline data point reflects the mean rate across 5 days, subsequent timepoints reflect caregiver reported averages immediately following discharge, and at 1-, 3-, and 6-month follow-ups.

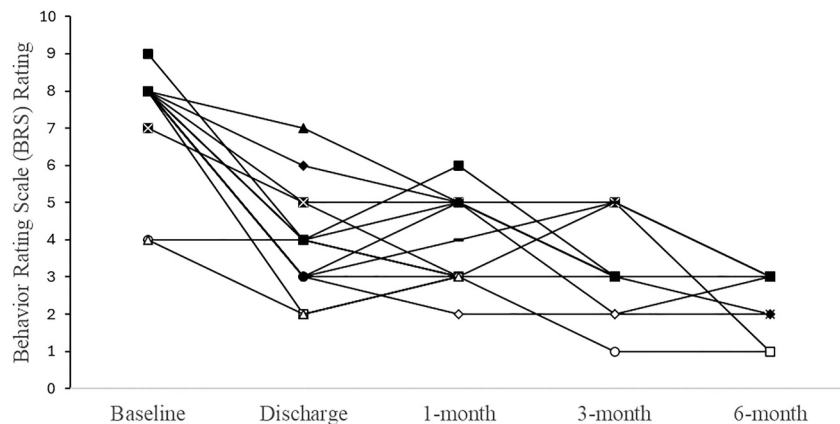


FIGURE 16 | Behavior Rating Scale (BRS) Maintenance Data. Behavior Rating Scale (BRS) rating refers to caregiver report regarding the overall functional impairment caused by challenging behavior. Ratings of 8 and above reflect Severe impact, ratings from 4 to 7 reflect Moderate impact, and ratings of 3 and below reflect Mild impact. Each data point reflects caregiver reported functional impairment score during baseline, immediately following discharge, and at 1-, 3-, and 6-month follow-ups.

TABLE 3 | Results of therapy attitude inventory.

Item #	Item description	M (SD)	Range
1	Responding to challenging behavior	4.07 (0.7)	3–5
2	Teaching new skills	4.21 (0.43)	4–5
3	Relationship with child	3.50 (0.65)	3–5
4	Confidence to implement procedures	4.42 (0.51)	4–5
5	Problems at home	3.86 (0.53)	3–5
6	Following directions	4.14 (0.53)	3–5
7	Overall progress	4.14 (0.36)	4–5
8	Generalized improvement	3.07 (0.62)	2–5
9	Program relevance	4.70 (0.47)	4–5
10	Program impression	4.86 (0.36)	4–5

reinforcement at the onset of Adult's Way (i.e., reinforce child appropriate manding for access to their way on a fixed ratio 1 schedule prior to schedule thinning).

Ultimately, the current study provides continued support for the inclusion of caregivers in all phases of the assessment and treatment process. Caregivers' behavior may be negatively reinforced by their child's history of challenging behavior once manding is denied, thus maintaining a cycle of responding that impacts family functioning. As the percurrent relation between challenging behavior and cooperation with manding may seem complex and even counter-intuitive for those providing care, integrating stakeholders into the treatment process from the beginning may be a useful way to enhance generalization programming. Importantly, creating a sense of predictability around the contexts and triggers for challenging behavior is likely a powerful tool in empowering caregivers to meet and manage the needs of their children.

Ethics Statement

The procedures in this study were approved by Institutional Review Board (IRB) and conforms to the provisions of the Declaration of Helsinki.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Appendix A: Procedural Fidelity Checklist

Skill component	Score		
Adult's way			
Visual cards and other signals (i.e., timer) are visible to participant	+	–	N/A
Adult tacts “adult's way”	+	–	N/A
Adult tacts expectations for adult's way	+	–	N/A
Adult tacts expectations about how to access child's way	+	–	N/A
Adult responds contingent on participant's demonstration of appropriate behavior and task completion	+	–	N/A
Response to CTB			
Disruptive behavior: pause timer	+	–	N/A
Target behavior: restart contingent on appropriate behavior	+	–	N/A
Child's way			
Visual cards and other signals (i.e., timer) are appropriately placed	+	–	N/A
Adult tacts “child's way”	+	–	N/A
Known preferences immediately provided or honored within 5–10s	+	–	N/A
Child's manding is reinforced	+	–	N/A
No demands are placed besides safety	+	–	N/A
Response to CTB			
Immediately begin adult's way	+	–	N/A
Fidelity total (+/possible opportunities)		= %	