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FUNCTIONAL COMMUNICATION TRAINING WITH AND WITHOUT ALTERNATIVE REINFORCEMENT AND PUNISHMENT: AN ANALYSIS OF 58 APPLICATIONS

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Functional communication training (FCT) is an empirically supported treatment for problem behavior displayed by individuals with intellectual disabilities. Hagopian, Fisher, Sullivan, Acquisto, and LeBlanc (1998) analyzed 25 applications of FCT and showed that extinction was a necessary component of FCT, but sometimes punishment was needed to maintain low levels of problem behavior. The current consecutive case series summarized data from 58 applications of FCT in more recent cases. This analysis extended and updated Hagopian et al. by examining FCT when used in combination with alternative reinforcement (noncontingent and differential reinforcement) and multiple schedules during schedule thinning. Although it is difficult to make direct comparisons with the 1998 study, the results of the current case series analysis suggest that FCT can be enhanced when used in combination with alternative reinforcement and when multiple schedules are used during schedule thinning.

Key words: functional communication training, extinction, punishment, noncontingent reinforcement, severe problem behavior

Functional communication training (FCT; Carr & Durand, 1985) is a differential reinforcement procedure in which (a) the reinforcer provided is specific to the class of reinforcement responsible for maintaining the targeted problem behavior, and (b) the alternative response that produces that reinforcer is a socially acceptable form of communication. FCT is one of the most widely researched and commonly used interventions for problem behavior displayed by individuals with intellectual disabilities (for a review, see Tiger, Hanley, & Bruzek, 2008). FCT far exceeds the American Psychological Association's criteria for empirically supported treatments to be designated as a well-established treatment for problem behavior for children with intellectual and developmental disabilities, and for children with autism spectrum disorders (Kurtz, Boelter, Jarmolowicz, Chin, & Hagopian, 2011).

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Hagopian, Fisher, Sullivan, Acquisto, and LeBlanc (1998), one of the few studies on FCT reporting large numbers of subjects, examined a series of 25 applications of FCT across 21 cases. In that study, variations of FCT were progressively examined, including FCT without extinction, FCT with extinction, or FCT with punishment, until a successful outcome was achieved (defined as a 90% reduction in problem behavior). Results showed that FCT without extinction was largely ineffective, whereas FCT with extinction was effective in approximately half of the applications. However, FCT with extinction maintained its effectiveness in only half of the applications after schedule thinning for the communication response had been initiated. When FCT with extinction was ineffective (or failed under schedule thinning), a punishment component was added to FCT, which was effective in 90% of applications. Since the publication of Hagopian et al. (1998), research has led to several advances in the application of FCT. These include supplementing FCT with other reinforcement schedules (noncontingent reinforcement [NCR];

Fisher, Thompson, Bowman, Hagopian, & Krug, 2000; Hagopian, Contrucci Kuhn, Long, & Rush, 2005; differential reinforcement of alternative behavior [DRA]; Harding, Wacker, Cooper, Millard, & Jensen-Kovalan, 1994); and using multiple schedules to facilitate schedule thinning (Hanley, Iwata, & Thompson, 2001).

As a treatment procedure, NCR typically involves the fixed- or variable-time presentation of a stimulus that previously has been determined to be a reinforcer. This reinforcer may be functional (the stimulus that maintains problem behavior; Vollmer & Iwata, 1992) or arbitrary (a reinforcer that does not maintain problem behavior; Fischer, Iwata, & Mazaleski, 1997). Early research on the combination of NCR and FCT showed that NCR disrupted FCT, in that it reduced the rate of the appropriate communication response (Goh, Iwata, & DeLeon, 2000). However, this effect can be clinically advantageous if occurrences of the communication response are excessive and need to be reduced. For example, Hagopian et al. (2005) showed that FCT schedule thinning (resulting in fewer communicative responses) could proceed more quickly with the addition of an NCR component. Thus, when used in combination with FCT, the effects of NCR may reduce the motivation to emit both problem behavior and the communication response, enhancing treatment effects while decreasing the need for schedule thinning because the communication response does not occur excessively.

The addition of a DRA contingency to complement the effects of FCT also has been reported. Evidence suggests that DRA is effective in reducing problem behavior and increasing compliance using either functional (e.g., Piazza, Moes, & Fisher, 1996) or arbitrary (e.g., DeLeon, Neidert, Anders, & Rodriguez-Catter, 2001) reinforcers. Although FCT is a DRA procedure itself (differential reinforcement of communication), an additional DRA component can be implemented concurrently. In this case, an additional reinforcer is provided for some other appropriate response. The concurrent DRA schedule used most commonly with FCT involves reinforcement for compliance with demands. This might involve providing escape for both compliance and for appropriate communication, or it could it could involve providing dissimilar reinforcers (e.g., an edible item for compliance and escape for appropriate communication). For example, Harding et al. (1994) combined FCT (involving requests for assistance with a task) with DRA (for attempting the task) for two individuals who exhibited problem behavior. Adding reinforcement for compliance with demands may make the demand context more reinforcing, thereby attenuating the establishing operation for escape. In addition to decreasing problem behavior, this effect could extend to the communicative response, assuming it is under control of the same motivating operations as problem behavior. As noted above, decreasing the motivating operation for escape may enhance FCT by both decreasing problem behavior and the communication response to the extent that it may obviate schedule thinning.

Another area of notable advancement in the FCT literature is in the procedures for schedule thinning after successful implementation of FCT (for a review, see Hagopian, Boelter, & Jarmolowicz, 2011). The use of schedule thinning for appropriate communicative responses may be necessary if these responses occur too frequently (e.g., continuously asking for attention) or at inappropriate times. Decreasing the rate of requests so that the intervention can be supported in the natural environment may safeguard against increases in problem behavior and weakening of the communication response (Hanley et al., 2001; Thompson & Iwata, 2001). Concerns about relapse are supported by a number of studies that reported increases in problem behavior after minor changes in reinforcement for communication during schedule thinning (e.g., Hagopian, Toole, Long, Bowman, & Lieving, 2004; Tiger & Hanley, 2004).

In Hagopian et al. (1998), schedule thinning was conducted using either delay to reinforcement or response chaining (i.e., demand fading). An alternative method involves the use of multiple schedules (Hanley et al., 2001). In this procedure, a discriminative stimulus (S^D) is correlated with the availability of reinforcement (on a fixed-ratio [FR] 1 schedule), and another stimulus (S^Δ) is correlated with extinction of appropriate responses. Tiger and Hanley (2004) found that this type of schedule thinning was an effective means to maintain appropriate responding exhibited by three children of typical development. That is, the children requested attention when the S^D was present but not when the S^Δ was present. Sidener, Shabani, Carr, and Roland (2006) found that multiple-schedule fading was more effective than delay to reinforcement for maintaining low levels of communication at a terminal schedule. Furthermore, the use of multiple-schedule training may be ideal in many situations because it relies on bringing the communication response under some stimulus control. Kuhn, Chirighin, and Zelenka (2010) applied this technology to establish naturally occurring social stimuli to be discriminative for reinforcement. They taught two individuals to discriminate when attention was available (e.g., when the caregiver was reading a magazine) and when attention was unavailable (e.g., when the caregiver was on the phone).

The purpose of the current study was to extend and update the Hagopian et al. (1998) study by including cases for which FCT was used in combination with components not routinely used at that time (namely, alternative reinforcement schedules and multiple schedules during schedule thinning). A consecutive case series design was used in which all cases for which FCT was used that met certain criteria were included, regardless of outcome. The analysis was modeled after Hagopian et al. (1998) in principle, in that it involved the progression of FCT-based treatments from less to more restrictive (but it omitted FCT without extinction), and included FCT with alternative reinforcement (noncontingent or differential reinforcement). That is, this study examined FCT with extinction (hereafter referred to as FCT), FCT with alternative reinforcement (DRA, differential reinforcement of other behavior [DRO], or NCR), FCT with punishment, FCT with both punishment and alternative reinforcement, and schedule thinning (in some cases).

METHOD

Participants and Settings

Fifty-eight applications of FCT conducted across 50 cases were selected for the present study (for four cases of multiply controlled problem behavior, FCT was implemented across more than one functional class, resulting in the number of FCT applications exceeding the number of cases). The sample was drawn from a population of individuals who received treatment for severe behavior disorders as inpatients (72% of the sample) or as outpatients in the same program. Participants ranged in age from 2 to 18 years (see Table 1 for demographic information). Although procedures varied based on the individual needs of each case, all met the following criteria for inclusion: (a) A functional analysis (FA) that consisted of at least three sessions of each condition had been conducted and had identified that at least one topography of the individual's problem behavior was maintained by access to attention, escape, or preferred items; (b) treatment that involved FCT with extinction had been evaluated for the participant's problem behavior (sometimes in combination with other treatment components); (c) the design of the treatment analysis permitted demonstration of experimental control; and (d) interobserver agreement scores had been obtained for at least 25% of sessions. Treatments that did not include FCT or occurred subsequent to FCT but did not include an FCT component were not evaluated in this study.

Table 1
Demographic Information and Functional Analysis Results

Case	Application	Age	Level of intellectual disability	Target behavior	Test	Control	Function
1	1	10	Not specified	SIB, agg, dis, other	1.16	0	Tangible
2	2	12	Not specified	Agg	0.32	0	Tangible
3	3	9		Agg, dis	1.63	0	Tangible
4[a]	4	6	Not specified	SIB, agg, other	4.72	4.6	Attention
5	5	7	Not specified	SIB, agg, dis, other	3.64	0.06	Escape
	6	9	Not specified	SIB, agg, dis, other	25.8	0.18	Attention
6	7	9	Moderate	SIB, agg, dis, other	0.56	0.03	Escape
7	8	9	Not specified	SIB, agg, dis	2.73	0.15	Attention
8[a]	9	2		SIB, agg, dis	0.76	0.17	Tangible
9[a]	10	8	Moderate	SIB, agg, dis	0.28	0.22	Tangible
10[a]	11	2		Agg, dis, other	3.07	0	Attention
11	12	6	Severe	SIB, agg, dis	1.18	0.13	Attention
12	13	13	Not specified	SIB, agg, dis, other	1.75	0.38	Attention
13	14	5	Severe	Agg, dis, other	0.68	0	Tangible
14[a]	15	10	Develop delay	SIB, agg, dis	1.43	0.03	Tangible
15[a]	16	9	Not specified	SIB	1	0.2	Escape
16[a]	17	13	Moderate	SIB, agg, dis	1.03	0.22	Tangible
17[a]	18	12	Severe	Agg, dis	1.06	0.03	Tangible
18[a]	19	2	Develop delay	SIB, agg, dis, other	3.27	0.52	Attention
19	20	12	Not specified	SIB, agg, dis	0.31	0	Escape
20	21	9	Profound	SIB, dis, other	5.68	0.25	Escape
	22				4.01	0.86	Tangible
21	23	11	Severe	Agg, dis	2.76	0.13	Escape
22[a]	24	7	Not specified	Agg, dis, other	2.57	0	Tangible
23	25	10	Moderate	SIB, agg, dis	4.39	0.7	Tangible
24[a]	26	6	Not specified	SIB, agg, dis, other	2.06	0.13	Tangible
	27				1.45	0.61	Attention
25	28	8	Not specified	Agg, dis	6.92	0.08	Attention
26	29	17	Severe	SIB, agg, dis	4.7	0.04	Attention
27	30	8	Not specified	SIB	2.06	0.4	Escape
	31				6.66	0.22	Attention
28[a]	32	2		SIB, agg, dis	13.68	0.48	Escape
29	33	7	Mild	Other	0.77	0	Tangible
30	34	8	Moderate	Agg, dis, other	7.27	0	Tangible
31	35	9	Severe	Agg, dis	2	0.38	Attention
32	36	13	Mild	SIB, agg, dis	6.4	1	Attention
33	37	18	Severe	SIB, agg, other	0.68	0	Tangible
34	38	18	Moderate	SIB, agg, dis	3.83	0	Attention
35[a]	39	7		SIB, agg, dis	54.85	0.26	Attention
36	40	10	Moderate	Agg, dis, other	0.4	0	Attention
37	41	10	Profound	SIB	0.5	0.01	Escape
38	42	13		SIB, agg, dis	6.38	0.99	Attention
39	43	13		SIB, agg, dis	1.6	0.25	Attention
40	44	15		SIB, agg, dis	0.22	1.3	Interruption
41	45	13	Not specified	SIB, agg, dis	1.94	0.33	Attention
	46				1.94	0.33	Attention
42	47	11	Moderate	Agg, dis, other	2.775	0	Escape
43	48	9	Severe	SIB, agg, dis	0.52	0	Tangible
44	49	12		Agg, dis	8.55	0	Interruption
45	50	8	Severe	Agg, dis	1.66	0	Tangible
46	51	16	Severe	SIB, agg, dis	1.28	0	Attention
	52				0.62	0	Escape
	53				1.34	0	Tangible
	54				1.34	0	Tangible
47	55	8		SIB, agg, dis	1.14	0	Tangible

(*Continued*)

Table 1 (*Continued*)

Case	Application	Age	Level of intellectual disability	Target behavior	Test	Control	Function
48	56	12	Moderate	SIB, agg, dis	4.2	1.08	Tangible
49	57	17	Moderate	Agg, dis, other	2.36	0	Interruption
50	58	10	Moderate	SIB, agg, dis	2.53	0	Tangible

Note. Individual data for each participant, including: age, level of intellectual disability, target behavior, rates of behavior in test and control FA conditions, and the function determined. SIB = self-injurious behavior, agg = aggression, dis = disruption, other = a variety of behavior (e.g., dropping, dangerous acts, inappropriate verbal behavior, emesis, disrobing, pica, rumination, elopement, fecal smearing). Test and control data are in responses per minute.

[a]Outpatient cases.

The study represents a consecutive case series analysis, because all participants who received FCT during an identified time period (from 2000 through 2011) were included in this study; none was excluded if the above criteria were met, thereby minimizing selection bias that could favor particular outcomes. Trained therapists under the supervision of faculty-level expert behavior analysts had implemented all treatment procedures. Sessions had been typically conducted in a padded session room (3 m by 3 m) and lasted 10 min.

Response Definitions

The topographical features of problem behavior were specific to each participant and were operationally defined on an individual basis. However, the most common forms of problem behavior included self-injury, aggression, and disruption. *Self-injury* included hitting parts of one's own body with an open hand or closed fist, head banging, self-biting, and self-scratching. *Aggression* included hitting other people with an open hand or closed fist, scratching, kicking, pulling hair, and throwing objects at other people. *Disruption* included hitting objects with an open hand or closed fist, swiping, throwing, ripping, and turning over furniture. *Other* behaviors included elopement, spitting, and inappropriate verbalizations (both volume and content).

Data Collection and Reliability

Trained observers recorded the target responses using laptop computers. Two observers independently and simultaneously collected data during 29% to 71% of the total sessions conducted for each participant. Exact agreement coefficients were calculated using consecutive 10-s intervals by dividing the number of agreements by the sum of the number of agreements and the number of disagreements and then converting the result to a percentage. Agreement within the interval was defined as the same number of responses being recorded by both observers. A disagreement was defined as the number of recorded responses between two data collectors, within the same interval, that did not match. Across participants, exact agreement coefficients ranged from 85% to 100% for self-injury, 83% to 100% for aggression, 83% to 100% for disruption, and 88% to 99.8% for other behaviors.

Similar to Hagopian et al. (1998), the mean of the test and control conditions of the FA were calculated using all data from that assessment, and the percentage reduction in problem behavior was calculated by taking the mean of the last five baseline data points and comparing this to the mean of the last five treatment data points. If less than five data points existed in the condition, the mean of all data points was calculated.

Procedure

Functional analysis (FA). An FA, similar to that described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994), was conducted for each patient who had been admitted to an inpatient or outpatient program for the treatment of severe behavior (see Table 1 for FA results). FA

sessions and treatment evaluations were overseen by a faculty-level expert behavior analyst and carried out by trained clinical staff. Most FAs consisted of three to four test conditions (i.e., alone, attention, demand, tangible) and a control condition (i.e., toy play). In some cases, FAs identified more than one maintaining variable. If the treatments applied to these functions met the previously defined criteria for inclusion, both functions were reported. After the FA had identified the reinforcer maintaining problem behavior, clinical staff used procedures similar to those described by Tiger et al. (2008) to teach the participant to exhibit a communicative response to produce the equivalent consequence.

Treatment evaluationacross populations. Treatment effects were evaluated using reversal or multiple baseline designs. The initial baseline was identical to the test condition of the FA that involved the identified controlling variables for problem behavior. Therefore, the target response continued to produce reinforcers on an FR 1 schedule in baseline. Next, all subjects received FCT with extinction targeting communication for the functional reinforcer. During FCT, the maintaining reinforcer was presented on an FR 1 schedule contingent on the occurrence of the appropriate communication response, and problem behavior was placed on extinction. In all 58 applications of FCT described in the current case series analysis, the treatment analysis began with FCT. Additional treatment components (described below) were evaluated based on the needs of each case. Additional treatments that did not include an FCT component were not evaluated.

Treatment evaluation with individualized procedures. The supervising behavior analyst selected any supplementary treatments that were used in combination with FCT. The clinical team made the decisions to use reinforcement-based (e.g., DRA) and punishment-based (e.g., 30-s contingent basket hold) treatments based on the individual needs of the case. However, common considerations for the use of one treatment over another were as follows: (a) ease of implementation; (b) ability of the posttreatment caregivers to implement the procedure; (c) severity of the behavior; and (d) social acceptability. In some cases, additional treatment components were implemented because the initial treatment or treatments were ineffective (e.g., Application 13), schedule thinning could not advance without resulting in increases in problem behavior under the current treatment (e.g., Application 20), or an increasing trend in problem behavior was observed even though treatment was not yet deemed ineffective (e.g., Application 32).

During FCT with alternative reinforcement, NCR, DRA, or DRO was overlaid on FCT with extinction. FCT with NCR was used in nine applications, and included noncontingent access to highly preferred items or competing stimuli. These items were identified via a formal preference or competing stimulus assessment. In these cases, a dense schedule of reinforcement (typically determined from obtained amount of reinforcement during baseline) was superimposed on the FCT procedure. This reinforcer was the functional reinforcer for problem behavior in most cases. When the reinforcer was an arbitrary reinforcer, it took the form of toys that were thought to mitigate the motivating operation for problem behavior. For example in Application 3, toys were available during reinforcer delays. FCT with DRA was used in three applications with escape-maintained behavior and involved reinforcement for compliance. FCT with DRO was used in two applications in Case 41. In this case, a highly preferred edible item was provided for not engaging in problem behavior, and the functional reinforcer was provided for the communication response.

During FCT with punishment, a brief punishment procedure was implemented contingent on the occurrence of problem behavior (concurrently with reinforcement for communication). These punishment procedures included 30-s basket hold, facial screen, or hands down (similar to procedures described in Fisher, Piazza,

Bowman, Hagopian, & Langdon, 1994). FCT with punishment was implemented in 13 applications, and only when the severity of the behavior warranted its use.

During FCT with punishment and alternative reinforcement, FCT was combined with both punishment and additional reinforcement, as described above. FCT with punishment and alternative reinforcement was implemented in five applications.

Reinforcement schedule thinning was conducted in some cases when an effective procedure had been identified (usually a greater than 80% reduction in the target behavior or very low levels of responding), there was sufficient time for systematic thinning, and the rate of communication was determined to be too high to be maintained in community settings. Schedule thinning took the form of either (a) increasing the delay to reinforcement; (b) increasing the chain of responses required before reinforcement; or (c) introducing a multiple schedule. The delay to reinforcement required the individual to wait for the item requested (attention, escape, or tangible) for a predetermined period of time following the initial communicative response. The delay interval was then systematically increased across sessions if problem behavior remained low. This procedure was conducted in 14 applications. When the chain of responses required to obtain reinforcement was increased, the individual was required to complete a certain number of tasks prior to reinforcement being provided. In response chaining, the number of required responses was then systematically increased across sessions if problem behavior remained low. This procedure was conducted in one application. Use of multiple schedules established two periods of time (schedule components), each correlated with a specific stimulus that signaled either the availability or unavailability of reinforcement (see Hanley et al., 2001). The period of time during which reinforcement was available (reinforcement component duration) was decreased systematically, and the period of time during which reinforcement was unavailable (extinction component duration) was increased systematically across sessions if problem behavior remained low. This procedure was conducted in 16 applications. The individual treatment team determined the criteria for advancing schedule thinning on a case-by-case basis, but it typically involved a continued 80% reduction in responding from baseline in order to continue thinning. When schedule thinning was deemed ineffective and an additional procedure was introduced, schedule thinning was suspended while the new treatment was evaluated. Following this, schedule thinning resumed if problem behavior remained low and the clinical goal had not yet been met (e.g., Figure 2, Application 36).

Design

FAs were conducted using either a multielement or reversal design. Treatments were evaluated within single-subject designs. A reversal design was used to evaluate results for 48 applications. The remaining 10 applications were conducted using a multiple baseline design across functions (see Table 2).

RESULTS

Table 1 displays the mean rate of problem behavior in the relevant test and control condition of each participant's FA, as well as the interpretation of the results made by the supervising behavior analyst. Problem behavior was maintained by attention in 16 cases, by tangible items in 22 cases (including three cases in which problem behavior was occasioned by interruption of an ongoing activity), and by escape from demands in seven cases. In addition, five of the individuals engaged in problem behavior maintained by multiple sources of reinforcement. In two cases, an identical function was evaluated in treatment (Case 41, attention; Case 46, escape). FCT was evaluated as treatment for all of these functions, resulting in 58 applications of FCT across the 50 cases.

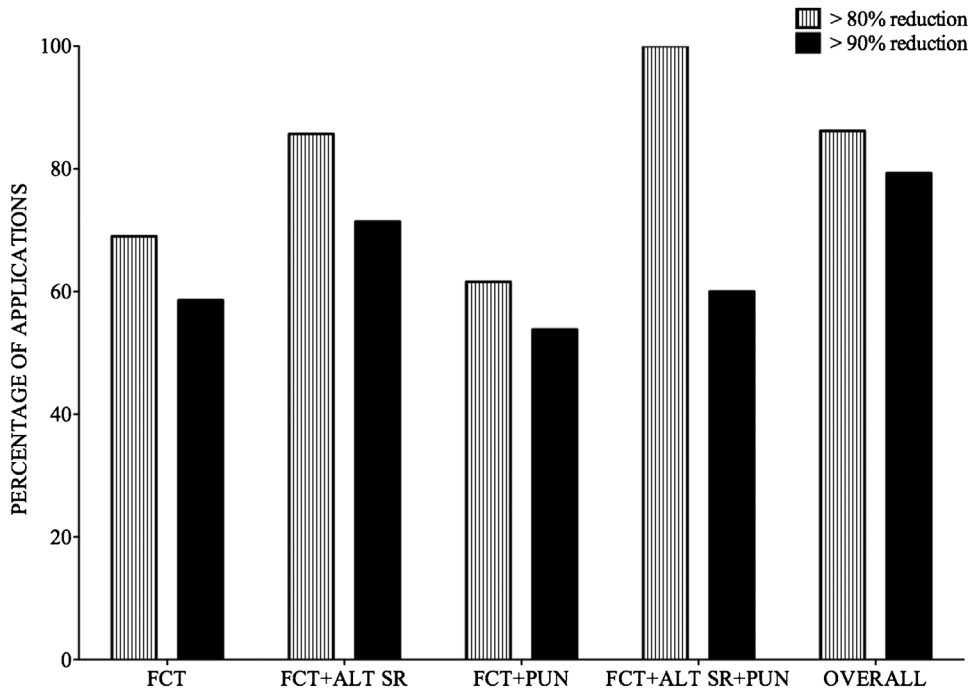

Figure 1. Effectiveness of treatments across all patients. Functional communication training (FCT), Functional communication plus alternative reinforcement (FCT + ALT SR), functional communication plus punishment (FCT + PUN), functional communication plus alternative reinforcement and punishment (FCT + ALT SR + PUN), and the overall number of applications (OVERALL) that achieved a greater than 80% or 90% reduction.

Table 2 displays the percentage of reduction in problem behavior from the initial baseline across all variations of FCT-based treatments, and a summary of these data is displayed in Figure 1. Figure 1 displays the percentage reduction in problem behavior during FCT, FCT with reinforcement, FCT with punishment, and FCT with reinforcement and punishment, as well as across all FCT-based procedures. Some variation of FCT produced a greater than 90% reduction in problem behavior during 79% (46 of 58) of applications and a greater than 80% reduction in problem behavior in 86% (50 of 58) of applications. FCT produced at least a 90% reduction in 59% of applications (34 of 58) and at least an 80% reduction in 69% of applications (40 of 58). When schedule thinning was conducted for cases in which FCT produced a 90% reduction, treatment effects were maintained in 48% of applications (11 of 23); at least an 80% reduction was maintained in 74% of these applications (17 of 23). FCT with alternative reinforcement (NCR or DRA) produced at least a 90% reduction in 71% (10 of 14) of applications and at least an 80% reduction in 86% (12 of 14) of applications. The 90% reduction was maintained under schedule thinning in 75% (three of the four) of applications; at least an 80% reduction was maintained in 100% of cases (four of four). FCT with punishment produced at least 90% reduction in 54% of applications (7 of 13) and a least an 80% reduction in 62% (8 of 13) applications. The 90% reduction was maintained under schedule thinning in 100% of applications (one application). FCT with punishment and alternative reinforcement (labeled as FCT + Alt SR + PUN) produced a 90% reduction in 60% of

Table 2
Summary of Treatment Analyses, Including Design and Percentage Reduction Relative to Baseline

Case	Application	Design	FCT	FCT + ST	FCT + Alt SR	FCT + Alt SR + ST	FCT + PUN	FCT + PUN + ST	FCT + Alt SR + PUN
1	1	ABAB	91.56	100					
2	2	ABAB	100						
3	3	ABABCAC	87.4	87	98.8				
4	4	ABAB	97.89						
5	5	ABABCBC	89.84	18.8			95.53	96.1	
	6	ABABCBCDCD	98.73	86.8	88				97.07
6	7	ABABCAC	86.89		88.52	86.5			
7	8	ABAB	65.43						
8	9	ABAB	81.25						
9	10	ABABCAC	81.71				100		
10	11	ABAB	100						
11	12	ABABCAC	23.34		95.91				
12	13	ABABCAC	32.58		100	100			
13	14	ABAB	100						
14	15	ABAB	100						
15	16	ABAB	93.94	100					
16	17	ABAB	96.68				98.53		
17	18	ABABCAC	85.47				79.48		
18	19	ABABCACDAD	−314.2				12.5		81.37
19	20	ABABCAC	91.3	13			98.44		
20	21	Multiple BL	96.3	97					
	22	Multiple BL	93.74	85					
21	23	ABCBCDBD	48.39				83.93	51	92.47
22	24	ABAB	100	100					
23	25	ABAB	47.62						
24	26	ABABCADAD	44.63				−309.7		92.68
	27	ABABCAC	0.44				6		
25	28	ABABCBC	94.64				98.8		
26	29	ABAB	100	96.3					
27	30	Multiple BL	74.49				100		
	31	Multiple BL	92.31						
28	32	ABABCAC	93.93		99.81				
29	33	ABABCAC	62.38		99.75				
30	34	ABABCBC	6.05		93.26				
31	35	ABABCBC	33	−322			98.14		80.5
32	36	ABABCBC	96.06	66.1	98.1	100			
33	37	ABAB	100						
34	38	ABAB	100	96.6					
35	39	ABABCBCDCD	99.6	8.2	93.68	89	0		
36	40	ABAB	92.47	87.59					
37	41	ABAB	63.4	57.8					
38	42	ABAB	74.36						
39	43	ABAB	48.61						
40	44	ABAB	91.67	84.5					
41	45	Multiple BL	97.82	20.4	37.5	97.1			
	46	Multiple BL	95.75	100	100	100			
42	47	ABABCBC	75.38	100	100				
43	48	ABAB	93.88	76.7					
44	49	ABAB	100	90.9					
45	50	ABAB	100						
46	51	Multiple BL	74.85	42.1					
	52	Multiple BL	−27.5		36.6				
	53	Multiple BL	94.31	62.6					
	54	Multiple BL	91.73	82					
47	55	ABAB	94.94	100					

(*Continued*)

Table 2 (*Continued*)

Case	Application	Design	FCT	FCT + ST	FCT + Alt SR	FCT + Alt SR + ST	FCT + PUN	FCT + PUN + ST	FCT + Alt SR + PUN
48	56	ABAB	97.89	86.3					
49	57	ABAB	100	100					
50	58	ABAB	94.64	94.3					

Note. FCT = proportional decrease from baseline when FCT was used alone; FCT + ST = the proportional decrease from baseline when FCT was combined with schedule thinning; FCT + PUN = proportional decrease from baseline when schedule thinning was halted (if any had been ongoing) and FCT and punishment were implemented together; FCT + PUN + ST = proportional decrease from baseline when FCT and punishment were combined with (either the resumption of or the initiation of) schedule thinning; FCT + Alt SR = proportional decrease from baseline when schedule thinning was halted (if any had been ongoing) and FCT and reinforcement (either contingent or noncontingent) were implemented together; FCT + Alt SR + ST = proportional decrease from baseline when FCT and reinforcement were combined with (either the resumption of or the initiation of) schedule thinning.

applications (three of five) and at least an 80% reduction in 100% of cases (five of five). No instances of schedule thinning were conducted during applications of FCT with punishment and alternative reinforcement.

The results of treatments applied following a failed treatment outcome are of interest and can be separated. For seven applications (Applications 7, 12, 13, 32, 33, 34, and 52), FCT was combined with alternative reinforcement after FCT did not reduce behavior by at least 90% of baseline and schedule thinning was not initiated. This intervention decreased responding by at least 90% in five applications and by at least 80% in one additional application (combined, 88% of the seven applications). For nine applications (Applications 10, 17, 18, 19, 23, 26, 27, 28, and 30), punishment was added because FCT alone did not reduce behavior by at least 90% initially or because treatment effects were trending in the wrong direction (Application 28). The addition of punishment produced at least a 90% reduction in behavior in five applications and at least an 80% reduction in one additional application (combined, 67% of the nine applications; Applications 10, 17, 23, 28, and 30). In one case, FCT was combined with alternative reinforcement following the failure of FCT with punishment (Application 39). In this case, punishment was discontinued and replaced by reinforcement, which produced a 94% decrease in behavior from baseline. FCT with reinforcement and punishment was never initiated immediately after the failure of FCT alone, rather either punishment or reinforcement was added to an FCT application when the other was already present in two cases (Applications 19 and 26). In these cases, problem behavior was reduced by at least 90% of baseline in one case and by at least 80% of baseline in the other case (combined, 100% of the two applications).

In addition, some treatments were added because schedule thinning did not maintain the therapeutic effect. In these cases, schedule thinning was suspended while the supplementary treatment was evaluated. The addition of reinforcement procedures following failed FCT plus schedule thinning (Applications 3, 6, 36, and 45) produced at least a 90% reduction in two applications and at least an 80% reduction in one application (combined, 75% of applications). However, the trend of responding was to blame for the failure of the fourth application of this procedure (Application 45), and no behavior was observed in the last two sessions of FCT plus alternative reinforcement (the effectiveness of subsequent schedule thinning provides evidence of this), indicating that this procedure was effective in all cases. When punishment was added because FCT plus schedule thinning was

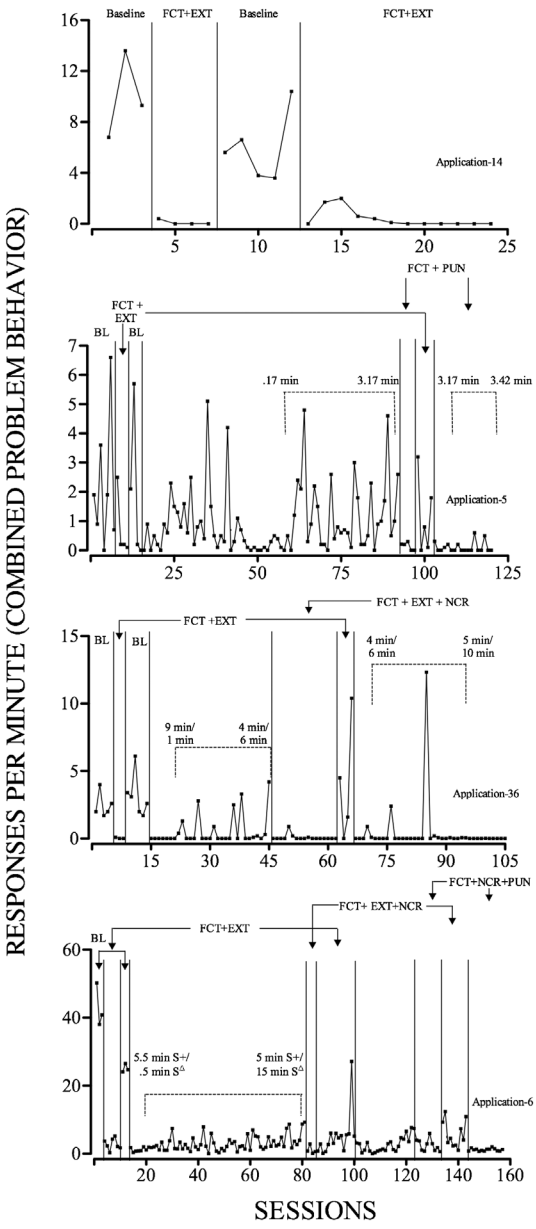

Figure 2. Representative graphs of treatment outcomes. Responses per minute of aggression (AGG), self-injurious behavior (SIB), and disruption (DIS) across baseline (BL) and functional communication training (FCT), functional communication training and punishment (FCT + PUN), functional communication training and alternative reinforcement (FCT + NCR), and functional communication training and other procedures (alternative reinforcement and punishment; FCT + NCR + PUN). Dashed brackets indicate schedule thinning.

considered ineffective (Applications 6, 20, 36, and 39), the treatment produced at least a 90% reduction in three of the four applications (75%) for which this additional procedure was implemented. Similar to when FCT was ineffective initially, FCT plus alternative reinforcement and punishment was never directly added to FCT with schedule thinning; rather, it was added either following FCT and punishment with ineffective schedule thinning (Application 23) or FCT and alternative reinforcement with ineffective schedule thinning (Application 6). In both cases, this procedure created at least a 90% reduction in problem behavior compared to the baseline rate.

In one case (Application 35) a reinforcement procedure was introduced while a successful FCT and punishment was in place to increase the overall level of reinforcement in these sessions. In two cases, the introduction of alternative reinforcement was not related to failures of a treatment procedure or schedule thinning. In one application, alternative reinforcement was added as part of a control procedure for a multiple baseline. That is, treatment was ineffective on one baseline but had not yet failed in the other procedure (Application 46). In the other application, alternative reinforcement was added because levels of reinforcement were not similar to the baseline. Therefore, additional reinforcement procedures were added to supplement this level (Application 47).

Of additional interest was the comparative effectiveness of FCT for inpatient versus outpatient cases. Although FCT alone was similarly effective at producing a 90% reduction (outpatient, 57%; inpatient, 59%), FCT was more likely to produce at least an 80% reduction for outpatient cases (outpatient, 79%; inpatient, 66%). FCT with punishment and FCT with alternative reinforcement were more effective for outpatients than inpatients. Finally, FCT plus reinforcement and punishment was the most effective treatment for inpatients; however, these results were difficult to assess due to the limited number of cases.

Figure 2 displays four graphs that provide examples of the use of FCT and additional treatment components. For Application 14, FCT was immediately effective. For Application 5, FCT became ineffective during schedule thinning, so we suspended thinning and evaluated FCT with punishment. Following this, fading resumed with FCT and punishment in place. A punishment component was necessary to reduce problem behavior to clinically acceptable levels. For Application 36, FCT was ineffective during schedule thinning, so we suspended thinning and evaluated an NCR component. Following this, fading resumed with NCR in place. For Application 6, FCT was ineffective in reducing problem behavior following schedule thinning; therefore, a combination of FCT and NCR was introduced. This procedure was initially effective; however, problem behavior reemerged and a punishment component (a hands-down procedure) was added to this context.

Table 3 displays the schedule-thinning procedures used across applications. Delay to reinforcement and multiple-schedule thinning were used approximately the same number of times. Procedures were added in two cases of delay thinning (Applications 5 and 39) and three cases of multiple-schedule thinning (Applications 36, 45, and 46). In two cases, additional procedures were added at the terminal schedule due to the reemergence of problem behavior (Applications 6 and 23). Because this is a case series, the reasons for termination of thinning varied (e.g., terminal target reached, discharged from the hospital, etc.); therefore, it is unclear based on these data what type of schedule thinning was more effective and efficient. However, multiple-schedule thinning was used more often, suggesting that this procedure was preferred clinically, either due to ease of implementation or to the effectiveness of this procedure.

DISCUSSION

This case series analysis provides additional data on the effectiveness of FCT when used alone and in combination with other treatment components for the treatment for severe problem behavior. FCT, with extinction or in some combination with alternative reinforcement or punishment, produced at least a 90% reduction in 46 of 58 (79%) of applications, and at least an 80% reduction in 50 of 58 (86%) applications. A smaller percentage of cases achieved an 80% or 90% reduction relative to the Hagopian et al. (1998) study. However, in the current study, FCT with extinction was more effective (59% of applications produced at least a 90% reduction, relative to 44% reported previously) and punishment was used less often than in Hagopian et al. FCT procedures overall were more effective in producing at least an 80% reduction for outpatients relative to inpatients. One likely explanation for this finding is that individuals are typically admitted as inpatients after outpatient treatment has been tried and failed. In addition to inpatient cases having treatment-resistant behavior, their behavior is often more severe in terms of the risks for injury to self and others. This hypothesis is also supported by the fact that inpatients were more likely to have additional treatment components than outpatient cases.

The current study included a broader range of treatment components that were not routinely used in combination with FCT at the time of the Hagopian et al. (1998) study. These components included the use of alternative reinforcement procedures (NCR, DRA, and DRO) concurrently with FCT and multiple schedules during schedule thinning. Perhaps the most important finding of the current study is that it demonstrates how FCT can be enhanced with the use of alternative reinforcement. FCT with alternative reinforcement (NCR, DRA, or DRO) produced at least a 90% reduction in 71% of applications overall and resulted in a 90% reduction in five of seven (71%) applications after FCT had been attempted but failed. An 80% reduction in problem behavior was achieved in 86% of the applications in which FCT was combined with NCR, DRA, or DRO.

Table 3
Summary of Procedures for Applications in Which Schedule Thinning Was Implemented

Application	Condition	Type	Terminal value	Additional condition	Type	Terminal value
1	FCT	FI delay	2.5 min			
3	FCT	FI delay	5 min			
5	FCT	FI delay	3.17 min	FCT + PUN	FI delay	3.42 min
6	FCT	Multiple	15 min unavailable 5 min available	FCT + NCR + PUN		
12	FCT + Alt SR	FI delay	2 min			
16	FCT	FI delay	5 min			
20	FCT	FI delay	15 min			
21	FCT	FI delay	10 min			
22	FCT	FI delay	9.5 min			
23	FCT + PUN	FR chain	FR 10	FCT + DRA + PUN		
24	FCT	FI delay	5 min			
29	FCT	FI delay	0.87 min			
35	FCT	Multiple	1.5 min available 0.5 min unavailable			
36	FCT	Multiple	4 min available 6 min unavailable	FCT + Alt SR	Multiple	5 min available 10 min unavailable
38	FCT	FI delay	36 min			
39	FCT	FI delay	0.25 min	FCT + Alt SR	FI delay	240 s
40	FCT	FI delay	7 min			
41	FCT	FI delay	6 min			
44	FCT	Multiple	2.5 min available 7.5 min unavailable			
45	FCT	Multiple	6.75 min available 3.25 min unvailable	FCT + Alt SR	Multiple	1 min available 9 min unavailable
46	FCT	Multiple	5.75 min available 4.25 min unvailable	FCT + Alt SR	Multiple	1 min available 9 min unavailable
47	FCT	Multiple	5 min available 15 min unavailable			
48	FCT	Multiple	5 min available 10 min unavailable			
49	FCT	Multiple	5 min available 5 min unavailable			
51	FCT	Multiple	0.5 min available 4.5 min unavailable			
53	FCT	Multiple	0.25 min available 4.75 min unavailable			
54	FCT	Multiple	1 min available 4 min unavailable			
55	FCT	Multiple	15 min available 10 min unavailable			
56	FCT	Multiple	0.25 min available 4.75 min unavailable			
57	FCT	Multiple	2 min available 8 min unavailable			
58	FCT	Multiple	1.5 min available 8.5 min unavailable			

Note. FI delay = increasing the delay to reinforcement; FR chain = increasing the chain of responses required prior to reinforcement; Multiple = introducing a multiple schedule.

The addition of alternative reinforcement to FCT facilitated schedule thinning (and maintenance of low levels of problem behavior during thinning) in all cases in which alternative reinforcement was presented (Applications 3, 6, 36, and 45). One explanation is that access to the alternative reinforcer attenuated the motivating operation for both problem behavior and the alternative communication response. Therefore, when schedule thinning was introduced, problem

behavior was less likely to reemerge during periods when the communication response was not reinforced; however, simple competition of responses might also produce this difference.

Because of these improved outcomes, punishment was implemented in a smaller proportion of applications in the current study (22%) than in the Hagopian et al. (1998) study (68%). When punishment was added to FCT, it was successful (at least a 90% reduction) in 54% of applications and in 60% of applications for which FCT, punishment, and alternative reinforcement were combined. However, FCT and punishment was less successful than reported in the 1998 study and less effective than FCT alone in this study.

Effective treatments maintained their effects during schedule thinning for a slightly higher proportion of applications in the current analysis compared to that in Hagopian et al. (1998; 48% of applications, relative to 42% reported previously). In addition, multiple-schedule thinning was the most commonly used method to reduce rates of communication response in the current study. This finding suggests that the use of multiple schedules for FCT thinning was a more effective procedure than delay to reinforcement thinning, which was most typically used in the 1998 study. And, although a direct comparison was not possible in this study (given the varied termination points for thinning; see Table 3), this finding is consistent with other studies that involved direct comparisons that seem to indicate that multiple schedules are more effective than delay schedules (e.g., Hanley et al., 2001).

Hagopian et al. (1998) suggested that one possible reason for failures in the effectiveness of FCT with schedule thinning was the possibility that the alternative response may become a member of the same response class as severe problem behavior. That is, in the initial stages of FCT with extinction, responding is often allocated to the communication response while problem behavior occurs at near zero levels. Although extinction is procedurally in place in the initial phases of FCT, problem behavior may not actually contact extinction until schedule thinning is initiated. It is possible that during this transitional period, when the alternative communication response is occurring and contacting reinforcement but before problem behavior is being emitted and contacting extinction, these responses become members of the same response class (see also Hagopian et al., 2004). Additional research is needed to determine if this is one reason why FCT with extinction is ineffective after schedule thinning in more than 50% of cases. This knowledge could be used to design interventions and thinning procedures that minimize the reemergence of problem during schedule thinning.

Additional research should continue to explore how FCT can be enhanced further through the use of additional treatment components and how schedule thinning can be best accomplished. The current case series analysis retrospectively reports on findings obtained in the course of providing individualized treatment and is not a systematic prospective treatment study. Thus, procedural variations that occurred across cases limit the extent to which one can draw firm conclusions about the outcomes obtained. Future research should conduct analyses of outcomes that use manualized interventions in which there are fewer inconsistencies among the individual procedures. In addition, this study does not address the ease of implementation of these treatment procedures.

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