A Systematic Review of Caregiver-Implemented Functional Analyses

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Abstract

The purpose of this systematic review was to systematically locate and analyze the research on caregiver-implemented functional analyses and subsequent function-based interventions. We included 36 studies and examined multiple features of the studies, including participant demographics, functional analysis characteristics, intervention characteristics, procedural fidelity, risks of bias, and social validity. Overall, the studies showed that caregivers were able to implement functional analyses that yielded differential responding, although few studies reported procedural fidelity data. Caregivers were also able to implement function-based interventions that led to socially significant changes in challenging behavior. Implications for practice and future research are discussed.

Keywords Functional analysis · Functional behavior assessment · Caregivers · Parents · Challenging behavior

Parenting can be a challenge under the most optimal conditions and can be even more difficult for caregivers of children who engage in challenging behavior. Interventions for persistent challenging behavior have changed dramatically in the last 40 years. Before the 1970s, researchers and practitioners attempted to reduce or eliminate challenging behaviors by teaching replacement behaviors, often without conducting analyses of the contingencies maintaining challenging behavior (Dunlap & Fox, 2011). Interventionists focused more on the topography (i.e., physical description) of challenging behavior than on its function, which was often communication.

The concept of challenging behavior being communicative and serving specific functions gained popularity in the late 1970s (e.g., Carr, 1977; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). Contemporary behavior-change interventions focus on studying both the form and the function of challenging behavior, with an emphasis on the function, so interventionists can alter the underlying contingencies maintaining the behavior. More recent studies have compared the effectiveness of function-based interventions to non-function-

based interventions (e.g., Ingram, Lewis-Palmer, & Sugai, 2005; Meyer, 1999; Schill, Kratochwill, & Elliot, 1998; Taylor & Miller, 1997). Findings from these studies showed overwhelming support for the use of function-based interventions to reduce or eliminate challenging behavior.

When the function of a behavior is understood, interventionists can target the specific contingencies maintaining the behavior and teach socially appropriate replacement behaviors that serve the same function. To do this, researchers must understand both the antecedents (i.e., what occurs immediately before), or what sets the occasion for challenging behavior, and the consequences (i.e., what occurs immediately following) of challenging behavior. Other important contextual variables include motivating operations (i.e., something that alters the effectiveness of a reinforcer or current frequency of behavior; Laraway, Snyckerski, Michael, & Poling, 2003) and setting events (i.e., distal events occurring before challenging behavior; Kantor, 1970; Wahler & Fox, 1981).

To determine the function of behavior, researchers and practitioners use functional behavior assessments (FBAs). FBAs are a set of methods for gathering information about antecedents, behaviors, and consequences related to a specified challenging behavior (Gresham, Watson, & Skinner, 2001). Information about setting events and motivating operations also informs decisions made about the function of behaviors when FBAs are conducted. The data collected from FBAs are used to inform and confirm hypotheses about the function of a behavior.

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Three categories of FBAs have been described in the literature: indirect assessments, descriptive assessments, and functional analyses (FAs). Indirect assessments collect information related to challenging behavior through interviews, checklists, rating scales, or historical/archival records (Gresham et al., 2001). These assessments are conducted with individuals (e.g., caregivers, teachers, therapists) who have observed the challenging behavior in the actual setting(s) in which the behavior occurs (Hanley, 2012). Indirect assessments include questions related to caregivers' concerns about challenging behavior; the topography of challenging behavior; typical triggers of challenging behavior; caregivers' responses to challenging behavior; and, if applicable, whether different types of challenging behavior co-occur. In interviews, caregivers respond to either open- or closed-ended questions asked directly by the interviewer. Rating scales and checklists ask caregivers to rate the aforementioned dimensions of behavior based on frequency (e.g., sometimes, never), intensity, or duration (Gresham et al., 2001; Hanley, 2012). Indirect assessments can also include information related to motivating operations and setting events.

Descriptive assessments are direct behavioral observations documenting the frequency, intensity, or duration of challenging behavior and the associated antecedents and consequences that occur in proximity to the challenging behavior. The antecedent-behavior-consequence analysis, or A-B-C recording, is the most common of these descriptive assessments (Gresham et al., 2001). When using A-B-C recording, observers record the antecedent and consequence for each instance of challenging behavior. Data are then summarized by antecedent and consequent events to develop a hypothesis of the function that the behavior is serving. Typically, the consequence that most often follows challenging behavior is hypothesized to be the function.

A systematic, experimental method of identifying the functions of behavior is an FA (Iwata et al., 1982/1994). During FAs, antecedents and consequences are intentionally manipulated to temporarily evoke challenging behavior and identify the maintaining variables (i.e., consequences). The seminal study on FAs conducted by Iwata et al. (1982/1994) included four conditions: attention, demand, ignore/alone, and free play, which acts as the control condition. A tangible condition was added in a later study (Vollmer, Marcus, Ringdahl, & Roane, 1995) and is now used in most FAs. Each condition reflects a different function of behavior.

In each condition, the FA implementer provides a different predetermined antecedent in an attempt to evoke challenging behavior. Then, contingent on the occurrence of challenging behavior, the implementer provides a predetermined consequence. In the attention condition, the implementer initially provides and then removes attention. If challenging behavior occurs, the implementer provides attention. In the demand condition, the implementer places a task demand (e.g., sit

down), and if challenging behavior occurs, the implementer removes the demand (e.g., the participant is no longer required to sit down). The ignore/alone condition, in which the child is in the assessment location by him- or herself for the duration of the session, is used when automatic reinforcement is considered likely (Vaughan & Michael, 1982). During free play, the participant has access to preferred items and attention, and no task demands are placed. The tangible condition is similar to the attention condition; however, the implementer initially provides and then removes a preferred item and, contingent on challenging behavior, returns the item.

Implementers take data on the occurrences of challenging behavior during each session, which is typically 5 or 10 min in length. The number of sessions per condition varies based on how long it takes for differentiated responding to occur. However, there is usually a minimum of three sessions per condition to allow for a trend or level in the data to be established (Kennedy, 2005). Implementers then graph the results for each session and use visual analysis techniques to determine differentiated responding and confirm hypotheses about the function of challenging behavior (Gresham et al., 2001).

Researchers have created multiple variations of traditional FAs in an effort to make FAs more efficient and to reduce the duration or intensity of challenging behavior that occurs during the FA. For example, Northrup et al. (1991) designed a brief FA, in which implementers initially use only one session of each condition and then select the condition that evokes the highest level of the target challenging behavior for further analysis. In the second analysis that follows, the same contingency that is hypothesized to maintain challenging behavior is provided contingent on appropriate behavior, whereas challenging behavior is ignored. A reversal back to challenging-behavior reinforcement takes place, followed by a second appropriate behavior condition.

Another variation is the trial-based FA (Sigafoos & Sagers, 2009). In trial-based FAs, implementers use the same conditions as those used in traditional FAs; however, single, discrete trials for each condition are embedded into naturally occurring activities throughout the day. Typically, the control segment for each condition occurs immediately prior to the test condition. After 1–2 min of the control segment, the implementer immediately manipulates the antecedent to evoke challenging behavior (i.e., conducts the test condition). The predetermined consequence is then provided contingent on challenging behavior, and the trial (i.e., condition) ends.

Two literature reviews, locating over 400 studies on FAs (i.e., Beavers, Iwata, & Lerman, 2013; Hanley, Iwata, & McCord, 2003), have been conducted. Across reviews, 94% of the studies yielded differential responding under different conditions, demonstrating that FAs can be used to confirm hypotheses about the function of behavior. Beavers et al. (2013) noted the increasing popularity of natural

environments as settings for conducting FAs. Hanley et al. (2003) found that over 63% of FAs were conducted in hospital, institutional, or outpatient settings. School settings accounted for 31% of FA settings; only 7.6% of the FAs located in the included studies were conducted in homes. In the later review conducted by Beavers et al. (2013), 51% of FAs were conducted in hospital or clinical settings, 29% were conducted in schools, and 10% were conducted in homes. Neither review reported the characteristics or qualifications of the person conducting the FA.

Historically, FAs have been implemented by trained researchers and clinicians (e.g., Iwata et al., 1982/1994; Vollmer, Northrup, Ringdahl, LeBlanc, & Chauvin, 1996). There is also an emerging body of research on training teachers and other school personnel to implement FAs (e.g., Bloom, Lambert, Dayton, & Samaha, 2013; Lloyd et al., 2015). This body of research has demonstrated that authentic agents (i.e., personnel without advanced behavioral training) can conduct FAs. An additional group of underutilized FA implementation agents remains: parents or caregivers.

Caregivers are often taught to implement function-based interventions that are based on the results of FAs (e.g., Fettig & Barton, 2014), but they are rarely taught to implement the FA procedures. Although we acknowledge that having caregivers implement FAs is a variation of the original methodology, we assert it might be important for several reasons. First, it is not known whether the implementer of the FA (e.g., caregiver vs. therapist) might have an effect on the results. It is possible that challenging behavior might serve a different function based on the person who conducts the assessment. If this premise is correct, and caregivers are implementing the function-based intervention but not the FA, the intervention may not be as effective because the function was not correctly identified. Second, including caregivers in the assessment might also increase motivation for the linked assessment-intervention processes. Finally, involving caregivers in the FA and function-based intervention process eliminates the need for researchers or interventionists to transfer stimulus control of behavioral contingencies from the interventionist to the caregiver. The present review focuses on variations from the original FA methodology by analyzing a body of literature in which caregivers implemented FAs.

Purpose of Current Review

We conducted a systematic review of empirical research in which caregivers were involved in the implementation of FAs. We also examined whether the caregivers who conducted FAs also implemented the subsequent function-based interventions. The following specific research questions guided this systematic review:

1. Are caregivers able to implement FAs and function-based interventions with fidelity?
2. What are the characteristics of the caregivers, children, and settings in studies in which caregivers implemented FAs?
3. What methods were used to train caregivers to implement FAs?
4. Do caregiver-implemented function-based interventions lead to significant reductions in or the elimination of children's challenging behavior?
5. What were caregivers' perspectives on implementing FA and function-based interventions?

Method

Search Strategy

We used methods and procedures consistent with recommended practice for conducting systematic reviews (i.e., Preferred Reporting Items for Systematic Reviews and Meta-Analyses; Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009). We systematically searched the literature for relevant articles using two procedures: an electronic database search and "snowball" search methods (Greenhalgh & Peacock, 2005). First, we conducted an electronic database search of Academic Search Premier, the Education Resources Information Center (ERIC), and PsycINFO on November 11, 2017, then updated on January 31, 2019. A sample electronic search strategy is shown in the Appendix. All search results were imported into EndNote X8® (2018) reference software and deduplicated. To identify relevant articles meeting our inclusion criteria, we then used a two-stage screening process, which was completed independently by two coders (the first and third authors), with disagreements resolved through mediation to reach a consensus. The first stage included screening of titles and abstracts to exclude articles that clearly did not meet our inclusion criteria. For the remaining articles, full-text articles were located and examined to confirm inclusion or exclusion. For the snowball methods, we conducted an ancestral search by screening the references of each included article for inclusion and a forward search by locating included studies on Google Scholar® to examine articles citing the included studies.

Inclusion and Exclusion Criteria

To be included in this review, studies had to meet the following criteria: (a) they used a single-case experimental design; (b) participants on whom the FAs were being conducted were under the age of 21; (c) the studies included an FA in which a caregiver implemented at least one component of the FA; (d)

the FA targeted challenging behavior; (e) the authors stated that caregivers were trained or coached, or the authors explained the training or coaching procedures used with caregivers; (f) the articles were written in English; and (g) they were published in a peer-reviewed journal. Exclusion criteria were (a) caregivers attended but did not implement the FA conditions, (b) caregivers only completed indirect or descriptive assessments about their child's behavior, (c) caregivers were trained on FA procedures but did not implement the FA, or (d) caregivers implemented FAs with spouses with intellectual disabilities.

Data Extraction

We adapted the DEC Recommended Practices Evidence Synthesis Group single-case experimental design coding form (DEC Recommended Practices Evidence Synthesis Group, 2018) to obtain specific information from the included studies. The first author extracted data from all included studies, and the third author conducted reliability coding for 33% of the included studies. The mean percentage agreement for extracted data was 93% (79%–100%). The following data were extracted from all studies: primary purpose of study, number of child-caregiver dyads, caregiver gender and relation to child, age of child participants, number of children with disabilities and disability types, FA setting, children's challenging behaviors, caregiver training components, type of FA, FA conditions implemented, condition length, occurrence of differential responding, procedural fidelity, interventions used following FAs, and reduction in or elimination of target behavior.

We also assessed each study for risks of bias using the single-case design risk of bias assessment developed by Reichow, Barton, and Maggin (2018). Reichow et al. (2018) stated that bias relates to possible systematic errors in the results or conclusions drawn from a study based on potential threats to internal validity. Risk of bias was selected for this review, as opposed to a quality indicator assessment, because the risk of bias assessment provides information on study characteristics as described in the published research article to help readers make informed decisions about the validity of the conclusions drawn from study results. The assessment of risk of bias also acts as a measure of transparency for published research. We assessed three domains of bias: (a) selection bias, including sequence generation and participant selection; (b) performance bias, including blinding of participants and personnel and procedural fidelity; and (c) detection bias, including blinding of outcome assessors, selective outcome reporting, dependent measure score reliability and agreement, and data sampling. Risk of bias was assessed and reported separately for FA components and follow-up intervention procedures for each study. A secondary coder provided interobserver agreement on 33% of coded articles. Mean interobserver agreement was 98% (87.5%–100%) for both FA and

intervention risk of bias components. To examine the risk of bias across all included studies, we used Cochrane's Review Manager software (Review Manager, 2014) to create risk of bias graphs.

Results

Study Selection

In the electronic database search, 4,764 records were located. After deduplication, 4,277 records remained. Following title and abstract screening, 60 studies remained, for which we screened the full text of the article. Twenty-two articles met all inclusion criteria. The snowball search led to an additional 47 studies screened at the full-text level, with 14 studies meeting our inclusion criteria. Across all search methods, we identified 36 studies meeting all inclusion criteria. Figure 1 shows a PRISMA flow diagram (e.g., Moher et al., 2009) of study selection.

Caregiver Implementation Fidelity

The first research question explored whether parents would be able to implement FAs with fidelity. Twelve of the 36 studies (33%) reported procedural fidelity data specifically collected during the FAs. Seven of the 12 studies (58%) reported mean fidelity above 90%. The most common methods of collecting procedural fidelity across the 11 studies were calculating the percentage of correct contingency delivery ($k = 5$, 41.6%) and the percentage of steps performed correctly ($k = 4$, 33%). The means of caregiver implementation fidelity across studies ranged from 66% to 98%. Procedural fidelity data are shown in Table 1. Importantly, across the 453 FAs conducted in studies, 92% ($n = 417$) of the caregiver-implemented FAs yielded differential responding.

Study Characteristics

Training caregivers to implement FAs was identified as the primary purpose of 4 (11%) of the 36 studies. The most common study purpose was to examine an application of functional communication training (FCT; $k = 9$, 25%). Seven studies (19%) compared functions of caregiver-implemented FAs to those of novel therapist-implemented FAs and examined the use of telehealth as a method of coaching caregivers to implement FAs from a distance. Two studies (5.5%) sought to clarify undifferentiated FAs, conduct FAs specifically for finger sucking, or test equivalent functions for challenging behavior and communication. Comparing FBA methods, conducting FAs on self-injurious behavior, and treatment comparisons for challenging behavior were the primary purpose of one study (2.78%).

Fig. 1 PRISMA flow diagram

Participant Characteristics and Setting

Across the 36 included studies, 465 caregivers participated in FA implementation. In nine studies, there were 383 participants (82%), with 210 participants coming from two studies (i.e., Lindgren et al., 2016; Wacker et al., 2017). Ten studies, which represented 309 (67%) of the participants, stated “parents” or “caregivers” implemented the FA without specifying which specific caregiver (e.g., mother, father) conducted the FA. As shown in Table 2, for the remaining 156 participants, caregivers were mostly identified as mothers ($n = 132$; 84%), with fathers ($n = 17$; 11%) and grandparents ($n = 7$; 4%) also being described in the research.

In the 36 studies, 453 children participated. Child participants ranged in age from 1 to 22 years. In 20 studies (55%), the mean age of child participants was under 5 years old. Individual ages were not reported for over 60% of children. Nearly all children ($n = 435$; 96%) had an identified disability; many were diagnosed with multiple disabilities. Autism spectrum disorder was the most common disability diagnosis ($n = 191$, 42%). Fifty-eight (13%) of the 453 participants were

diagnosed with intellectual disabilities, and another 11% were diagnosed with developmental delay. Forty children (9%) were diagnosed with a sensory impairment, and 36 (8%) were diagnosed with a seizure disorder. Additional information about child characteristics is shown in Table 3.

Participants exhibited a variety of challenging behaviors across studies. The most commonly occurring challenging behaviors across the 453 children were aggression (e.g., hitting, kicking, biting; $n = 165$, 36%) and self-injurious behavior (SIB; e.g., head banging, head hitting, self-biting; $n = 154$, 34%). In three studies, researchers targeted discrete behaviors including inappropriate mealtime behavior ($n = 6$, 1.3%; Najdowski et al., 2008) and finger sucking ($n = 5$, 1.1%; Ellington et al., 2000; Miltenberger, Anderson, Tulloch, & Deaver, 2002). Information related to challenging behavior is shown in Table 3.

As shown in Table 4, a majority of the caregiver-implemented FAs ($n = 322$; 71%) were conducted in the families’ homes. Caregiver-implemented FAs were also conducted in clinics ($n = 126$, 28%), inpatient hospital units ($n = 4$, 0.8%), and a day school program ($n = 1$, 0.2%).

Table 1 Caregiver procedural fidelity

Study: First Author (Year)	PF Reported	PF Method	% of Sessions	<i>M</i> (Range)
Amdorfer (1994)	no			
Benson (2018)	yes	% of steps performed correctly	NR	86 (33-100)
Berg (2007)	no			
Brown (2000)	no			
Danov (2010)	no			
Derby (1997)	yes	% of correct contingency delivery	NR	66 (48-99)
Ellingson (2000)	no			
English (2004)	yes	% of correct contingency delivery	NR	91 (43-100)
Gerow (2019)	yes	% of steps performed correctly	NR	97
Harding (2005)	no			
Harding (2009a)	no			
Harding (2009b)	no			
Huete (2010)	no			
Kurtz (2003)	yes	% of correct contingency delivery	27 (0-100)	73 (33-94)
Kurtz (2013)	yes	% of correct contingency delivery	NR	93 (82-100)
Lindgren (2016)	no			
Machalicek (2016)	yes	% of correct steps performed correctly	36.3 (35-39)	86.6 (60-100)
Martens (2019)	yes	% of opportunities child's caregivers' follow coach instruction w/in 5 s	68.5 (36-7)	96.3 (50-100)
McAdam (2004)	no			
Moes (2002)	no			
Najdowski (2008)	yes	% of correct contingency delivery	NR	98 (84-100)
O'Reilly (1999)	no			
O'Reilly (2000)	no			
Parks (2012)	no			
Ringdahl (2000)	no			
Robertson (2013)	yes	% of problem behaviors reinforced within 5 s	43.1	95.1 (71-100)
Schieltz (2010)	yes	% of correct consequence delivery and withholding of reinforcement for mands	NR	98 (88-100)
Schieltz (2011)	no			
Simacek (2017)	no			
Stricker (2002)	no			
Suess (2014)	no			
Thomason-Sassi (2013)	no			
Wacker (1998)	no			
Wacker (2005)	no			
Wacker (2013)	yes	% of steps performed correctly	24	96
Wacker (2017)	no			

Note. PF = procedural fidelity, NR = not reported.

Caregiver Training

Researchers used many strategies to train caregivers to implement FAs; however, descriptions of training procedures were often general. Five studies (14%) stated parents were trained but did not report specific

training methods. As shown in Table 2, half of the studies ($k = 18$, 50%) used in-person coaching (i.e., researchers specifically stated they used in-person coaching, assisted caregivers, or provided feedback during the FA). Verbal instructions (i.e., expressively stating instructions before the FA) were used in 15 of

Table 2 Caregiver characteristics and training components

Study: First Author (Year)	N	Caregiver				Training Components						
		Mom	Dad	GP	NS	IPC	VI	RP	WI	VC	FA V	NS
Arndorfer (1994)	5	5					x					
Benson (2018)	2	2								x		
Berg (2007)	4	4				x						
Brown (2000)	2*	2	1			x						
Danov (2010)	1	1				x						
Derby (1997)	4	4					x					
Ellingson (2000)	2	2					x	x				
English (2004)	3	2		1			x	x	x		x	
Gerow (2019)	3	3				x	x		x			
Harding (2005)	2	2				x						
Harding (2009a)	1	1				x						
Harding (2009b)	3	3				x	x					
Huete (2010)	5	5					x	x	x		x	
Kurtz (2003)	21				21	x	x	x	x		x	
Kurtz (2013)	60*	45	10	5		x	x	x	x		x	
Lindgren (2016)	107				107	x				x		
Machalicek (2016)	3	2	1					x	x	x		
Martens (2019)	4				4					x		
McAdam (2004)	2*	1	1			x	x	x				
Moes (2002)	3				3							x
Najdowski (2008)	6	6				x	x	x				
O'Reilly (1999)	1	1										x
O'Reilly (2000)	2				2							x
Parks (2012)	1	1							x			
Ringdahl (2000)	3	2		1		x						
Robertson (2013)	2	2				x						
Schieltz (2010)	10	9	1			x						
Schieltz (2011)	10				10	x	x					
Simacek (2017)	2	3	2							x		
Stricker (2002)	3				3		x	x				
Suess (2014)	3				3					x		
Thomason-Sassi (2013)	5	5				x	x				x	
Wacker (1998)	28				28							x
Wacker (2005)	25				25							x
Wacker (2013)	20	19	1							x		
Wacker (2017)	103				103	x						
Total	465	132	17	7	309	18	14	8	6	7	5	5

Note. GP = Grandparent, NS = Not Specified. IPC = In-Person Coaching, VI = Verbal Instructions, RP = Role Play, WI = Written Instructions, VC = Video Coaching, FA V = FA Videos. * denotes studies in which there were multiple caregivers per child.

the 36 (42%) studies. Other caregiver training methods reported were role-playing ($k = 9$, 25%) and written instructions ($k = 7$, 19%). Video coaching was used in seven (19%) studies, and training videos were used in 17% ($k = 6$) of the 36 studies.

FA Characteristics

As shown in Table 4, four types of FAs were used across the 36 studies: traditional FAs, trial-based FAs, brief FAs, and modified FAs (i.e., alternating between two conditions

Table 3 Child participant characteristics and challenging behaviors

Study: First Author (Year)	<i>N</i>	Age in Yrs <i>M</i> (Range)	# (%) w/Dis.	Participant Disabilities	Challenging Behaviors
Arndorfer (1994)	5	5.6 (3-13)	4 (80)	ASD, DD, ID, SL, O, N	SIB, Ag, PD, O
Benson (2018)	2	6.5 (5-8)	2 (100)	ASD, None	SIB
Berg (2007)	4	4.25 (4-5)	4 (100)	DD	Ag, PD, NC
Brown (2000)	2	9 (5-13)	2 (100)	ID, Other	SIB, Ag, PD, NC, O
Danov (2010)	1	3	1 (100)	ASD	SIB
Derby (1997)	4	2.5 (2-3)	4 (100)	DD, SL., Other	SIB, PD, NC, O
Ellingson (2000)	2	8.5 (7-10)	0 (0)	None	FS
English (2004)	3	7.3 (5-10)	3 (100)	ASD, ID	SIB, Ag, DB,
Gerow (2019)	3	5.5 (5-7)	3 (100)	ASD, SL	SIB, Ag, VA
Harding (2005)	2	3.54 (1-5)	2 (100)	DD, ID, Other	SIB
Harding (2009a)	1	2	1 (100)	DD, SL, Other, None	SIB, Ag, PD,
Harding (2009b)	3	2 (1-3)	2 (67)	DD, Other, None	SIB, Ag, PD,
Huete (2010)	5	3.2 (2-5)	5 (100)	DD, ID, SL, Other	SIB, Ag, PD, O
Kurtz (2003)	21	2.75 (1-5)	15 (71)	ASD, ID, Other, None	SIB
Kurtz (2013)	52	8.4 (2-19)	52 (100)	ASD, ID, Other	SIB, Ag, DB, O
Lindgren (2016)	107	4.16 (1-7)	107 (100)	ASD, DD	VA, O
Machalicek (2016)	3	11 (8-16)	3 (100)	ASD, Other	SIB, Ag, PD, VA, O
Martens (2019)	4	6.5 (4-8)	4 (100)	ASD, Other	SIB, Ag, PD, O
McAdam (2004)	1	18	1 (100)	ID, Other	Ag, PD, VA
Moes (2002)	3	3	3 (100)	ASD	Ag, PD, O
Najdowski (2008)	6	3.5 (2-4)	5 (83)	ASD, None	IM
O'Reilly (1999)	1	10	1 (100)	ID	Ag
O'Reilly (2000)	2	15.5 (9-22)	2 (100)	ID, Other	SIB, Ag, PD
Parks (2012)	1	17	1 (100)	ASD, ID, SL	SIB, Ag,
Ringdahl (2000)	3	7.67 (5-13)	3 (100)	ASD, DD	SIB, Ag, DB, PD
Robertson (2013)	2	4.17 (2-5)	2 (100)	ASD	SIB, Ag, PD
Schieltz (2010)	10	3.25 (1-4)	10 (100)	ASD, ID, Other, None	SIB, Ag, PD
Schieltz (2011)	10	2.5 (1-4)	8 (80)	ASD, ID, Other, None	O
Simacek (2017)	2	3.67 (3-4)	2 (100)	ASD, Other	FS
Stricker (2002)	3	9.36 (6-14)	3 (100)	Other	SIB, Ag, PD
Suess (2014)	3	2.92 (2-3)	3 (100)	ASD	SIB, Ag, PD
Thomason-Sassi (2013)	5	8 (5-10)	5 (100)	ASD, DD, Other	SIB, Ag, PD
Wacker (1998)	28	4.2 (1-5)	24 (92)	ASD, SL, Other, None	SIB, Ag, PD
Wacker (2005)	25	4.33 (1-6)	23 (92)	ASD, SL, Other, None	SIB, Ag
Wacker (2013)	20	4.4 (2-7)	20 (100)	ASD	NS
Wacker (2017)	103	3.75 (1-7)	103 (100)	ASD, ID, Other	NS
Total	453		426 (94)		

Note. ASD = Autism Spectrum Disorder, DD = Developmental delay, ID = Intellectual Disability, SL = Speech-language impairment, O = Other, SIB = Self-injurious behaviors, Ag = Aggression, NC = Noncompliance, DB = Disruptive behavior, PD = Property Destruction, FS = Finger sucking, NS = Not specified, VA = Verbal aggression, IM = Inappropriate mealtime behavior.

compared to four). The most commonly used FA type was the traditional FA, which was used in 31 of the 36 (86%) studies. Brief FAs were used in three studies (18%; Brown et al., 2000; Moes & Freia, 2002; O'Reilly, Lancioni, King, Lally, & Dhommnaill, 2000), and trial-based FAs and modified FAs were both used in one study (3%; Arndorfer, Miltenberger, Woster, Rortvedt, & Gaffaney, 1994;

Gerow, Rispoli, Gregori, & Sanchez, 2019). Researchers in 15 studies (42%) used other FBA formats alongside FAs. Interviews were conducted with caregivers in 13 of the 36 (36%) studies. Researchers used descriptive assessments in 10 of the 36 (28%) studies. Rating scales and antecedent analyses were less common and used in two (6%) studies and one (3%) study, respectively.

Table 4 FA setting, type, supplemental assessments, and challenging behaviors

Study: First Author (Year)	N	FA Setting			FA Type				Supplemental Assessment				Dif. Res.	
		H	C	O	T	TB	B	O	DA	I	C/R	AA	#	%
Arndorfer (1994)	5	x						x	x	x	x		4	80
Benson (2018)	2	x			x				x	x			2	100
Berg (2007)	4	x			x								1	25
Brown (2000)	2	x			x		x			x			2	100
Danov (2010)	1	x			x				x	x			2	100
Derby (1997)	4	x			x				x				4	100
Ellingson (2000)	2	x			x								2	100
English (2004)	3		x		x				x	x			3	100
Gerow (2019)	3	x				x				x			3	100
Harding (2005)	2	x			x								2	100
Harding (2009a)	1	x			x				x	x	x		1	100
Harding (2009b)	3	x			x								3	100
Huete (2010)	5		x		x								5	100
Kurtz (2003)	21		x		x					x			20	100
Kurtz (2013)	52		x		x								51	98
Lindgren (2016)	107	x	x		x								107	100
Machalicek (2016)	3	x			x					x			3	100
Martens (2019)	4	x			x				x				3	75
McAdam (2004)	1			x	x								1	100
Moes (2002)	3	x					x			x		x	3	100
Najdowski (2008)	6	x			x								6	100
O'Reilly (1999)	1	x			x								1	100
O'Reilly (2000)	2	x					x						2	100
Parks (2012)	1			x	x								1	100
Ringdahl (2000)	3			x	x								3	100
Robertson (2013)	2	x			x								1	50
Schieltz (2010)	10	x			x								10	100
Schieltz (2011)	10	x			x								-	-
Simacek (2017)	2	x			x				x	x			2	100
Stricker (2002)	3	x			x								3	100
Suess (2014)	3	x			x								3	100
Thomason-Sassi (2013)	5	x	x		x								2	80
Wacker (1998)	28	x			x				x	x			26	93
Wacker (2005)	25	x			x								22	84
Wacker (2013)	20		x		x				x	x			18	90
Wacker (2017)	103	x			x								95	95
Total	453	28	7	3	32	1	3	1	10	13	2	1	417	92

Follow-Up Interventions and Results

Two thirds ($k = 24$) of the studies implemented interventions following completed FAs. In 19 of these 24 studies (79%), researchers used some application of FCT (Carr & Durand, 1985) as the intervention to reduce or eliminate challenging behavior and to teach a communicative

replacement behavior. Other interventions included non-contingent reinforcement (3 of 24, 13%), differential reinforcement of other behavior (1 of 24, 4%), and the use of gloves and a negative reinforcement intervention (1 of 24, 4%). All studies that implemented interventions reported socially significant decreases in challenging behavior, with only one study (i.e., Wacker et al., 2005) having any

participant who showed no reduction in his or her challenging behavior. Most studies reported behavioral reduction to zero or near-zero levels. Twelve of the 24 studies (50%) reported average reductions in challenging behavior above 90%, and seven of these studies averaged a 100% reduction. All studies averaged more than 75% reduction in challenging behavior. Intervention results are shown in Table 5.

Social Validity

Researchers collected social validity data in 14 of the 36 (38%) studies, four of which explicitly stated social validity data reflected only the intervention. In the other 10 studies, the researchers did not explicitly state whether social validity data were collected separately for the FA and intervention, and all 10 studies also included an intervention following the FA. Therefore, it was not possible to determine if social validity data reflected the FA alone, the FA and intervention package combined, or the intervention package alone.

With respect to the measures used to gather social validity data, the Treatment Acceptability Rating Form–Revised (TARF-R; Reimers & Wacker, 1988) was used in 8 of the 36 ($k = 23\%$) studies. The TARF-R (Reimers & Wacker, 1988) is a Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Other methods used to gather social validity data included an author-designed survey on the goodness of contextual fit (i.e., Moes & Frea, 2002) and cost analyses (i.e., Lindgren et al., 2016). When collected and reported, social validity ratings were generally high. Lindgren et al.'s (2016) cost analysis compared the weekly cost of in-home treatment with visiting clinicians, clinic-based telehealth, and in-home telehealth. Cost analyses showed in-home telehealth was more cost effective than the other two models.

Risk of Bias

Risk of bias: FA components Figure 2 shows the risk of bias across studies for FA components. All studies were rated as having an unclear risk of bias for sequence generation, indicating session types were not randomized. All studies were rated as having a high risk of bias for blinding participants and study personnel, which is to be expected in research regarding challenging behavior, as participants and study personnel must be aware of the conditions for implementation to occur. All studies were also rated as having a high risk of bias for blinding of outcome assessors, indicating data collectors were aware of the FA conditions. All studies were rated as having a low risk of bias for participant sampling because all participants needed behavioral intervention. Finally, nine studies (25%) were rated as having a low risk of bias for procedural fidelity. This finding suggests that a majority of the studies reported insufficient information on procedural fidelity or

reported procedural fidelity data that do not meet contemporary standards.

Risk of bias: Intervention components Risk of bias for the intervention components across studies is shown in Figure 2. All risk of bias ratings for sequence generation, participant selection, blinding of participants and study personnel, and blinding of outcome assessors were the same for both FA components and follow-up interventions (i.e., they were also rated as having a high risk of bias for the intervention components). Six of 24 studies (25%) with interventions were rated as having a low risk of bias for procedural fidelity. Twenty-one studies (88%) were rated as having a low risk of bias for selective outcome reporting. Twenty-two studies (92%) and 10 studies (42%) were rated as having a low risk of bias for dependent variable score reliability and data sampling, respectively.

Discussion

Cumulatively, the results of this review suggest that caregivers are able to participate in and make meaningful contributions to FAs. The first research question asked whether caregivers were able to implement the contingencies of FA conditions with fidelity and whether these FAs yielded differential responding. Only 12 (36%) studies reported procedural fidelity data, replicating the findings of Fettig, Schultz, and Srekovic (2015), who also found that underreporting of procedural fidelity in the FA literature was common. For nine of the studies reporting fidelity, very high levels of correct implementation of FA procedures were reported, suggesting that caregivers can conduct the contingencies of an FA with fidelity. Given that implementing contingencies incorrectly could lead to misidentifying the function of behavior, potentially leading to an ineffective behavior plan, it is critical that FAs and interventions are implemented with fidelity. Therefore, it is essential for future researchers using FA procedures to report implementation fidelity of the FA contingencies.

The next research question addressed for whom and under what conditions caregivers were used as implementers of FAs. Caregivers who implemented the FAs were predominantly mothers, with a small number of studies involving fathers and grandmothers. Future studies might consider including different types of caregivers (e.g., both mothers and fathers) or exploring if there are different FA results between caregivers of the same child. Seven studies examined differences between caregivers and novel therapists and found there were often different functions identified across implementers. This suggests the individual who implements the FA might have a significant impact on the results (i.e., accuracy of identified function) of the FA. For interventions to be most effective, the function of behavior must be correctly identified. To ensure

Table 5 Intervention Results

Study: First Author (Year)	N	Intervention Type	Experimental Design	Reduction in CB	% Reduction in CB: <i>M</i> (Range)
Arndorfer (1994)	5	FCT	Reversal	yes	82.5 (75-90)
Benson (2018)	2	FCT	Reversal	yes	-
Berg (2007)	4	FCT	Reversal, AB	yes	87.5 (50-100)
Brown (2000)	2	FCT	Reversal	yes	100
Danov (2010)	1	FCT	Reversal	yes	100
Derby (1997)	4	FCT	Multiple Baseline	yes	91.75 (83-100)
Ellingson (2000)	2	Glove, awareness enhancement device	Multiple Baseline/Reversal	yes	99.8 (99.6-100)
English (2004)	3	none			
Gerow (2019)	3	FCT	Multiple Baseline	yes	100
Harding (2005)	2	FCT	Alternating Treatments	yes	76.3 (52.6-100)
Harding (2009a)	1	FCT	Reversal	yes	100
Harding (2009b)	3	FCT	Multiple Baseline	yes	100
Huete (2010)	5	none			
Kurtz (2003)	21	FCT, NCR, DRO,	Multiple Baseline/Reversal	yes	94 (74.5-100)
Kurtz (2013)	52	none			
Lindgren (2016)	107	FCT	NR	yes	> 90
Machalicek (2016)	3	FCT, Social Stories, visual timer, DRA	Multielement	yes	-
Martens (2019)	4	none			
McAdam (2004)	1	none			
Moes (2002)	3	FCT and contextualized FCT	Multiple Baseline	yes	-
Najdowski (2008)	6	none			
O'Reilly (2000)	2	Noncontingent Attn	AB	yes	100
O'Reilly (1999)	1	NCR, EXT	Alternating Treatments	yes	100
Parks (2012)	1	none			
Ringdahl (2000)	3	none			
Robertson (2013)	2	Differential Reinforcement	Reversal	yes	100
Schieltz (2010)	10	none			
Schieltz (2011)	10	FCT	Reversal	yes	90 (84-95)
Simacek (2017)	2	FCT	Multiple Baseline	yes	-
Stricker (2002)	3	none			
Suess (2014)	3	FCT	Multielement	yes	-
Thomason-Sassi (2013)	5	none			
Wacker (1998)	28	FCT	NR	yes	87 (45-100)
Wacker (2005)	25	FCT	Multiple Baseline	yes	84.78 (0-100)
Wacker (2013)	20	none			
Wacker (2017)	103	FCT	NR	yes	90 (45-100)

Note. CB = Challenging behavior, FCT = Functional Communication Training, NCR = Noncontingent reinforcement, DRO = Differential reinforcement of other behavior. NR = Not reported. If not reported, percentage reduction in challenging behavior was calculated based on available data. Dashes represent instances in which no calculation for reduction of challenging behavior could be made.

the function of the child's behavior is identified correctly, it would be important to include parents as implementers if they are also to deliver the function-based intervention.

Children in the included studies varied greatly in age (1 to 22 years of age) and disability diagnosis. The children also exhibited a wide variety of challenging

behaviors, including SIB, aggression, property destruction, and verbal aggression. The positive findings are encouraging, given the broad range of child characteristics, and suggest that caregivers should be able to implement FAs with children with a range of challenging behaviors and disabilities.

Fig. 2 Risk of bias ratings for functional analysis (2a) and intervention (2b)

a

b

The most common type (86%) of FA used across studies was the traditional FA (Iwata et al., 1982/1994). Traditional FAs are often time consuming and have been criticized for the purposeful evocation of challenging behavior for prolonged time periods (Hanley, 2012). Trial-based FAs (e.g., Sigafoos & Sagers, 2009) require less time, and multiple researchers (e.g., Gerow et al., 2019; Lambert, Bloom, & Irvin, 2012) have had success teaching authentic assessors (caregivers and teachers, respectively) to implement trial-based FAs in natural settings. Therefore, trial-based FAs might be very useful when caregivers are implementing the FAs in their homes (cf. Prykanowski, 2018). Future researchers should consider multiple factors, including family preferences and efficiency, when choosing what format of FA to use.

The third research question addressed the training methods used by researchers when training caregivers to implement FAs. Researchers trained caregivers to implement FAs and interventions using a variety of methods. The amount of detail provided on caregiver training methods varied greatly but was generally limited, precluding our ability to draw conclusions as to which methods were most effective. Most studies simply

stated caregivers were trained or coached to implement FA and intervention procedures (e.g., Berg, Wacker, Harding, Ganzer, & Barretto, 2007). Describing training procedures is important for two reasons. First, describing training methods allows readers to determine if the methods used were sufficient to allow caregivers to implement FA and intervention procedures with fidelity. Second, describing experimental procedures with replicable precision is essential for future replication. Future research should include detailed descriptions of training procedures for both research and practical considerations.

The fourth research question asked if caregiver-implemented function-based interventions led to significant reductions in or the elimination of children's challenging behavior. Two thirds of the included studies provided function-based interventions to address children's challenging behavior, with the majority of researchers using FCT as the intervention. Interventions were implemented by caregivers and yielded socially significant reductions in challenging behavior. Training caregivers to implement interventions might equip them with the skills to improve their child's behavior

for both current and future manifestations of challenging behavior. Similarly, having caregivers implement procedures from the start of the assessment and intervention process removes the need to transfer stimulus control for behavior reduction from a therapist to a caregiver. Researchers should continue efforts to train caregivers to implement function-based interventions.

The final research question evaluated the status of the assessment of social validity from the caregivers' perspective on implementing FAs and function-based interventions. As with other variables evaluated in this review, there was limited information on social validity as it directly related to the implementation of the FA. Therefore, it was not possible to determine whether reported social validity data were related to the FA, follow-up intervention, or both. This made it difficult to interpret the perspectives of caregivers in relation to the FA procedures. When social validity data were collected, the majority of studies used the TARF-R (Reimers & Wacker, 1988), which assesses dimensions such as the caregivers' opinions on the effectiveness of the intervention, their willingness to continue using the intervention, the sustainability of the intervention following the conclusion of the study, and the goodness of fit of the intervention. Future research conducted on FAs should consider assessing social validity data on the FA and intervention separately to obtain more specific data related to social validity and to assess multiple types of social validity (e.g., Wolf, 1978). Future researchers might also want to compare the efficiency of conducting FAs with caregivers versus conducting them with novel therapists to determine if capitalizing on a child's learning history increases the efficiency of the FA. Increasing efficiency while maintaining high levels of procedural fidelity and effectiveness of interventions should be considered in any behavioral intervention.

Limitations

Limitations of the included studies One limitation of the present study was the inability to extract the specific characteristics of individual participants (e.g., age, challenging behaviors exhibited) and which caregivers implemented the FA and intervention. Researchers also provided very little, if any, data on caregiver characteristics. We initially attempted to extract data related to ethnicity, socioeconomic status, dual-language-learner status, culture, family and cultural values or beliefs, and educational status of included participants; however, these data were so infrequently reported that there were not enough data to draw meaningful conclusions for these demographic data variables. The lack of specificity on caregiver training components and procedural fidelity was also a major limitation. Providing additional information about participants, training components, and procedural fidelity enhances interpretations of study results and helps inform systematic or direct replications.

A second limitation is the possibility that some participants' data were used across multiple studies; 12 of the 36 studies included in this review were conducted by one research group (Wacker and Harding), which published multiple articles using subsets of participants from larger studies. Because it was not possible to separate which participants were included in multiple articles, there may be data from individual FAs that were indicated as multiple FAs, which would weigh the conclusions from this review more heavily toward those studies. Additionally, the total number of reported participants across the reviewed studies was likely higher than the actual number of participants.

Limitations of review methods With respect to the review methods, a possible limitation is that we did not locate all of the studies in which caregivers implemented FAs. If an article did not explicitly state that caregivers were used to implement the contingencies of the FA, we excluded the study. Additionally, there were risks of bias across studies, which could have impacted the results of the studies and thus our findings. All studies had risks of bias due to the lack of randomization and the close involvement of researchers in implementing both the study procedures and collecting data. Future studies might consider ways to reduce these risks.

Conclusions and Future Directions

In summary, we located 36 studies that used caregivers to implement the contingencies of FAs. Although procedural fidelity data were not always reported, when these data were reported, they suggested caregivers were able to implement FAs with fidelity. Across studies, caregivers implemented the FAs with children of all ages who exhibited a wide variety of challenging behaviors. We located limited information on how caregivers were trained to implement the FAs; this is an area on which future research might focus. Finally, the findings from this review suggest that authentic agents—in this case, caregivers—can successfully implement the contingencies of the FAs and subsequent function-based interventions to reduce challenging behavior. Researchers and behavior analysts should continue to increase their use of caregivers in these capacities, especially caregivers of children with challenging behaviors. Training caregivers to conduct FAs and conduct behavior-reduction interventions might provide them with important behavior management skills.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Appendix: Search terms and order

1. Famil*
2. Parent*
3. Caregiver*
4. Care-giver*
5. 1 or 2 or 3 or 4
6. “functional analysis”
7. “functional analyses”
8. “functional behavior* assessment”
9. “functional behaviour* assessment”
10. “functional assessment”
11. “behavior* assessment”
12. “challenging behavior assessment”
13. “problem behavior assessment”
14. 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13
15. involv*
16. implement*
17. perform*
18. teach*
19. train*
20. 15 or 16 or 17 or 18 or 19
21. S5 and S14 and S20

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