

*THIRTY YEARS OF RESEARCH ON THE FUNCTIONAL
ANALYSIS OF PROBLEM BEHAVIOR*

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Hanley, Iwata, and McCord (2003) reviewed studies published through 2000 on the functional analysis (FA) of problem behavior. We update that review for 2001 through 2012, including 158 more recent studies that reported data from 445 FAs. Combined with data obtained from Hanley et al., 435 FA studies, with line graphs for 981 FAs, have been published since 1961. We comment on recent trends in FA research and introduce the studies in the 2013 special issue of the *Journal of Applied Behavior Analysis*.

Key words: functional analysis, problem behavior

Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) presented data on the functional characteristics of self-injurious behavior (SIB) and, in doing so, proposed an approach to behavioral assessment based on the experimental model. Since then, the generality of this approach has been replicated, extended, or discussed in over 2,000 articles and chapters. Hanley, Iwata, and McCord (2003) examined empirical studies published through 2000 in which a functional analysis (FA) was used to assess problem behavior and categorized those studies along a number of dimensions: variations in subject population, setting, response topography; methodological characteristics; and outcomes. Based on the results of their review, Hanley et al. provided recommendations for best practice and suggested areas in need of further research. This paper provides an updated review from 2001 to the present, discusses trends in research observed over that period of time, and briefly comments on studies contained in the 2013 special issue on FA in the *Journal of Applied Behavior Analysis (JABA)*.

METHOD

We conducted a search of the published literature from January 2001 through May 2012 using the following databases: PsycINFO, ERIC, and ISI Web of Science. The key search words were the same as those used by Hanley et al. (2003): *function*, *analysis*, and *behavioral assessment*. We identified additional studies through examination of the reference sections of articles found through the database search.

Inclusion Criteria

Inclusion and exclusion criteria were the same as those used by Hanley et al. (2003). Briefly, studies were included if they reported data in which “(a) a pretreatment assessment based on (b) direct observation and measurement of problem behavior was conducted under (c) at least two conditions involving manipulation of some environmental variable in an attempt (d) to demonstrate a relation between the environmental event and behavior” (pp. 149–150).

FA Methodology, Outcome Summary, and Interrater Agreement

Studies and individual FA outcomes were categorized using the same dimensions as those

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described by Hanley *et al.* (2003). We also categorized studies based on data-collection procedures (continuous vs. discontinuous recording).

A second reader independently evaluated 12.7% of the studies using the same criteria as described above. The two readers' evaluations were compared, and the number of agreements was divided by the number of agreements plus disagreements. Mean interrater agreement across categories was 88.6% (range, 65% to 100%).

RESULTS

Journals That Have Published FA Studies

One hundred fifty-eight studies met the inclusion criteria (a complete list is available from the first author). Studies were published in 26 different journals (see Table 1 for a summary).

Nearly half of the studies (46.2%) were published in *JABA*. Table 1 also lists totals from the current review combined with the data reported by Hanley *et al.* (2003). To date, 435 FA studies meeting the inclusion criteria have been identified, 58.2% of which were published in *JABA*. Thirteen journals in the present review published two or more studies, and 13 journals published one study. Figure 1 shows the cumulative number of published studies and the total number of publishing journals in 5-year intervals from 1961 to 2010 (data from 1961 to 2000 were obtained from Hanley *et al.*). The number of studies rose rapidly between 1986 and 2000; since then, the rate of publication has stabilized at about 15 per year. The number of journals that have published FA studies also showed a sharp increase during the 1980s but has stabilized over the past two decades ($M = 18$). *JABA* published the great

Table 1
Journals That Have Published Functional Analysis Research

Journal	Number of studies ^a	Percentage of sample ^b
<i>Journal of Applied Behavior Analysis</i>	73 (253)	46.2 (58.2)
<i>Education and Treatment of Children</i>	13 —	8.2 —
<i>Behavioral Interventions</i>	11 (16)	7.0 (3.7)
<i>Behavior Modification</i>	8 (18)	5.1 (4.1)
<i>Research in Developmental Disabilities</i>	8 (29)	5.1 (6.7)
<i>School Psychology Review</i>	7 —	4.4 —
<i>Journal of Positive Behavior Interventions</i>	6 —	3.8 —
<i>Journal of Autism and Developmental Disorders</i>	4 (8)	2.5 (1.8)
<i>Journal of Behavioral Education</i>	4 —	2.5 —
<i>Behavioral Disorders</i>	3 (6)	1.9 (1.4)
<i>Education and Training in Autism and Developmental Disabilities</i> ^c	3 (8)	1.9 (1.8)
<i>American Journal on Intellectual and Developmental Disabilities</i> ^d	3 —	1.9 —
<i>Journal of Developmental and Physical Disabilities</i>	2 (6)	1.3 (1.4)
Number of other journals with one study	13 (34)	8.2 (7.8)
Total number of FA studies	158 (435)	

^aNumbers in parentheses indicate current data combined with those from Hanley *et al.* (2003). A dash indicates that data were not reported by Hanley *et al.*

^b"Sample" refers to all included studies.

^cFormerly *Education and Training in Developmental Disabilities* and *Education and Training in Mental Retardation and Developmental Disabilities*.

^dFormerly *American Journal on Mental Retardation*.

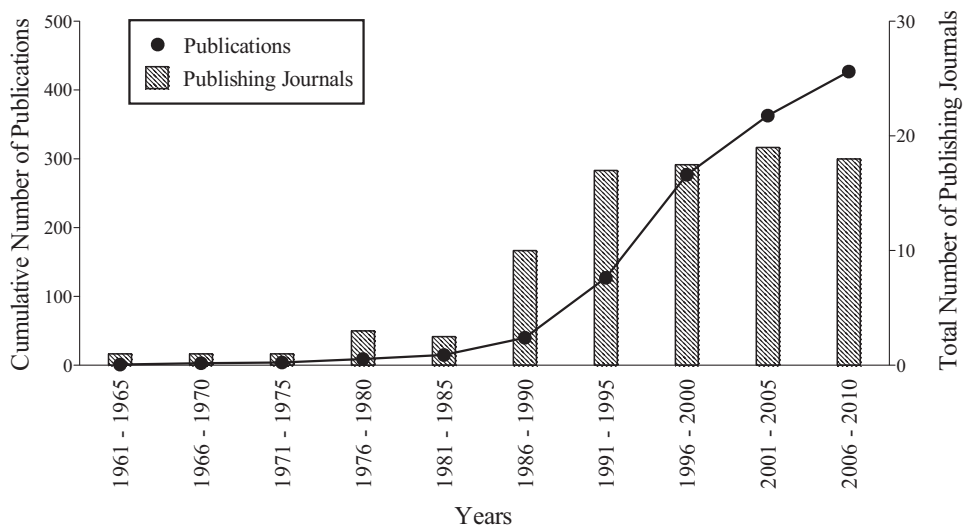


Figure 1. Cumulative number of publications and total number of publishing journals across intervals of 5 years. Data from 1961 to 2000 were obtained from Hanley et al. (2003).

majority of studies during our review period (the same finding was reported by Hanley et al.). However, the percentage of studies published in other journals collectively increased from 35.1% to 53.8%, indicating that FA approaches to assessment have become more widespread throughout the field.

Subjects and Settings

Table 2 summarizes the subject and setting characteristics in studies from the present review as well as combined with the results from Hanley et al. (2003). Most studies (83.5% of studies in the present review; 74.9% of combined studies) were conducted with children. Of the 39 studies from the present review that included adults as subjects, three included geriatric individuals (65 years of age and older). One hundred forty-two studies to date (32.6%) were conducted with adults. The majority of studies (81.6% in the present review; 87.8% of combined studies) were conducted with individuals who had been diagnosed with some form of intellectual disability. Individuals with autism participated

in 37.3% of studies included in the present review (26.9% of combined studies). Seven studies from the present review included only subjects with diagnoses other than intellectual

Table 2
Subject and Setting Characteristics

		Number of studies ^a	Percentage of sample ^b
Participants	Child	132 (326)	83.5 (74.9)
	Adult	39 (142)	24.7 (32.6)
	Developmental disability	129 (382)	81.6 (87.8)
	Autism	59 (117)	37.3 (26.9)
	No disability	34 (59)	21.5 (13.6)
Setting	Hospital (inpatient)	90 (180)	57.0 (41.2)
	School	70 (157)	44.3 (36.1)
	Clinic (outpatient)	34 (55)	21.5 (12.6)
	Home	25 (46)	15.8 (10.6)
	Institution	10 (80)	6.3 (18.4)
	Vocational program	9 (15)	5.7 (3.4)
	Community	1 —	0.6 —

^aNumbers in parentheses indicate current data combined with those from Hanley et al. (2003). A dash indicates that data were not reported by Hanley et al.

^b“Sample” refers to all included studies.

disabilities: dementia (Baker, Hanley, & Mathews, 2006; Buchanan & Fisher, 2002; Dwyer-Moore & Dixon, 2007), Tourette syndrome (Anderson, Vu, Derby, Goris, & McLaughlin, 2002; Watson, Dufrene, Weaver, Butler, & Meeks, 2005), schizophrenia (Wilder, Masuda, O'Connor, & Baham, 2001), and traumatic brain injury (Dixon *et al.*, 2004).

In comparison with the results obtained by Hanley *et al.* (2003), the percentage of studies that included subjects without intellectual disabilities increased from 9% to 21.5%. These data reflect some progress towards extending FA methodology beyond a specific population, which was described as an "underresearched area" by Hanley *et al.* (p. 153). The percentage of studies conducted with children increased from 70% to 83.5%, whereas the percentage of studies conducted with adults decreased from 37.2% to 24.7%. The percentage of studies conducted with individuals with intellectual disabilities as a whole decreased (from 91.3% to 81.6%). However, the percentage of studies conducted with individuals with autism increased (from 20.9% to 37.3%), perhaps reflecting a greater research interest in general in autism-related disorders.

Most FAs were conducted in hospital inpatient units (57% of the present review; 41.2% of combined studies) or schools (44.3% of the present review; 36.1% of combined studies). Outpatient clinics or subjects' homes also were common settings for assessment in the present review (21.5% and 15.8% of studies, respectively). One study (Tarbox, Wallace, & Williams, 2003) was conducted in a public community setting. The finding that the majority of studies included in our review were conducted in hospitals and schools is consistent with data reported by Hanley *et al.* (2003). However, the percentage of studies conducted in institutions decreased dramatically (from 25.3% to 6.3%), whereas the percentage of studies conducted in homes and outpatient clinics increased (from 7.6% to 15.8%, and from 7.6% to 21.5%,

respectively). It is difficult to determine the cause of this noticeable shift in setting, which could be related to a change in typical service settings, an expansion of research in general to nonresidential settings, or the expansion of FA methodology beyond traditional settings for clinical research.

Response Topographies

Table 3 shows the distribution of response topographies examined in FA studies. Problem behaviors studied most frequently in the present review were SIB, aggression, disruption, vocalization, and property destruction (each included in over 25% of the studies). SIB and aggression also were studied in over 25% of combined studies. Studies that involved FAs of SIB decreased noticeably relative to the data reported by Hanley *et al.* (from 64.6% to 37.3%). The largest increases were seen in studies that involved FAs of vocalizations (from 12.6% to 39.9%), property destruction (from 10.5% to 36.7%), and other topographies of behavior (from 3.6% to 25.3%). In addition to the responses listed in the table, a large proportion of studies included in the present review (25.3%) involved extensions to less frequently observed problem behaviors such as licking, mouthing, or sniffing objects

Table 3
Distribution of Response Topographies

Topography	Number of studies ^a	Percentage of sample ^b
Aggression	75 (188)	47.5 (43.2)
Vocalizations	63 (98)	39.9 (22.5)
Self-injury	59 (238)	37.3 (54.7)
Property destruction	58 (87)	36.7 (20.0)
Disruption	42 (95)	26.6 (21.8)
Elopement	18 (26)	11.4 (6.0)
Noncompliance	13 (25)	8.2 (5.7)
Stereotypy	12 (37)	7.6 (8.5)
Tantrums	12 (22)	7.6 (5.1)
Pica	6 (13)	3.8 (3.0)
Other	40 (50)	25.3 (11.5)

^aNumbers in parentheses indicate current data combined with those from Hanley *et al.* (2003).

^b"Sample" refers to all included studies.

(Stichter, Sasso, Jolivet, & Carr, 2004); ruminating, vomiting, or gagging (Najdowski et al., 2008); expelling or packing bites of food (Patel, Piazza, Santana, & Volkert, 2002); spitting (Carter & Wheeler, 2007); hyperventilating (Asmus et al., 2004); disrobing (Kuhn, Hardesty, & Luczynski, 2009); engaging in inappropriate sexual behavior (Fyffe, Kahng, Fittro, & Russell, 2004); and nail biting (D. W. Woods et al., 2001). In addition, several studies have involved FAs of off-task or out-of-seat behavior (e.g., Flood & Wilder, 2002).

Hanley et al. (2003) noted that as of 2000, FA methodology had not been used to assess "behavior problems (e.g., nail biting, complaining, smoking, drug abuse, overeating, or problem behaviors associated with mental illnesses such as depression, bulimia, or anorexia) exhibited by adults without disabilities" (p. 155). Only one study since then attempted an assessment of such behavior (nail biting; D. W. Woods et al., 2001). Thus, extensions to problem behavior observed in the population at large have not occurred. Researchers could use examples of modified FA methodology as a model for how to conduct assessments with typical adult populations. For example, Roantree and Kennedy (2012) assessed the function of inappropriate social behavior exhibited by three children with Asperger syndrome. The authors manipulated the delivery of peer attention following inappropriate social behavior using a trained peer confederate across two test conditions and a control condition, and differential responding was observed across conditions for all three subjects. A similar approach could be used to assess inappropriate social behavior in adults without disabilities. Future research might examine the variables that facilitate or inhibit target behaviors of interest in other populations, in that identification of these variables may suggest useful variations in assessment technique.

The majority of studies in the present review (120 or 75.9%) included at least one FA in which contingencies were placed on multiple response

topographies (similar or dissimilar) simultaneously, which represents a large increase (from 27.8%) in comparison with data reported by Hanley et al. (2003). Only 59 studies (37.3%) included an FA in which only one response topography (e.g., SIB in the form of head banging) was included.

Type of FA

Table 4 shows methodological characteristics of FA studies categorized by assessment model, inclusion of supplementary assessments,

Table 4
Methodological Characteristics of Functional Analyses

		Number of studies ^a	Percentage of sample ^b
Model type	ABC model	146 (387)	92.4 (89.0)
	AB model	19 (75)	12.0 (17.2)
	Both models	7 (27)	4.4 (6.2)
Supplementary assessments	Descriptive	39 (62)	24.7 (14.3)
	Indirect	32 (44)	20.3 (10.1)
	Descriptive or indirect	29 (58)	18.4 (13.3)
	Descriptive and indirect	21 (28)	13.3 (6.4)
Condition types	Social-positive reinforcement	149 (386)	94.3 (88.7)
	Attention	146 (375)	92.4 (86.2)
	Tangible	80 (176)	50.6 (40.1)
	Social-negative reinforcement	145 (392)	91.8 (90.1)
	Automatic reinforcement	78 (243)	49.4 (55.9)
Number of test conditions	Multiple	146 (394)	92.4 (90.6)
	Single	16 (67)	10.1 (15.4)
Assessment length	Full	136 (365)	86.1 (83.9)
	Brief	20 (56)	12.7 (12.9)
	Unknown	9 (23)	5.7 (5.3)
Session duration	5 min	59 (90)	37.3 (20.7)
	10 min	66 (210)	41.8 (48.3)
	15 min	11 (89)	7.0 (20.5)
	Other	20 (32)	12.7 (7.4)
	Unknown	19 (41)	12.0 (9.4)
Experimental design	Multielement	125 (350)	79.1 (80.5)
	Reversal	19 (62)	12.0 (14.3)
	Pairwise	11 (18)	7.0 (4.1)
	Combination	11 (18)	7.0 (4.1)
Data presentation	Unknown	5 (21)	3.2 (4.8)
	Session values	142 (350)	89.9 (80.5)
	Condition means	7 (81)	4.4 (18.6)
	Within-session values	1 (4)	0.6 (0.9)

^aNumbers in parentheses indicate current data combined with those from Hanley et al. (2003).

^b"Sample" refers to all included studies.

condition types, number of test conditions, assessment duration, session duration, experimental design, and method of data presentation.

FA models. The majority of studies (92.4% of the present review; 89% of combined studies) used the ABC FA model (Iwata *et al.*, 1982/1994) in which both antecedent (establishing operation) and consequent events are manipulated, whereas 19 studies (12%) from the present review and 75 (17.2%) of combined studies used the AB model (Carr & Durand, 1985), in which only antecedent events are manipulated. Both types of models (either within or across subjects) were used in 4.4% of studies included in the present review (6.2% of combined studies). In comparison with the results reported by Hanley *et al.* (2003), the percentage of studies that used the ABC model of FA increased somewhat (from 87% to 92.4%), whereas the percentage of studies that used the AB model or both models decreased (from 20.2% to 12%, and from 7.2% to 4.4%, respectively). Thus, given the benefits of controlling both antecedent and consequent events and the negligible effort required to manipulate both rather than one, the utility of assessment conditions in which contingencies are ambiguous seems limited.

Supplementary assessments. Thirty-nine studies (24.7%) from the present review and 62 (14.3%) of combined studies reported results of a descriptive assessment (uncontrolled direct observation) in addition to the results of an FA. Thirty-two studies (20.3%) from the present review and 44 (10.1%) of combined studies included an indirect assessment (based on caregiver report without direct observation of behavior). Twenty-nine (18.4%) of the present studies and 58 (13.3%) of combined studies included either a descriptive or an indirect assessment in addition to an FA, and 21 (13.3%) of the present studies and 28 (6.4%) of combined studies included both. There was an increase (across all categories) in the percentage of studies reporting data from supplementary assessments compared to

Hanley *et al.* (2003). Given clear results of an initial FA, the need for supplementary assessments seems to be low. Thus, the use of alternative assessment procedures may reflect attempts to clarify initial unclear results or comparisons between assessment methods (we did not examine studies in enough detail to determine how often either occurred).

Condition Types

Social-positive reinforcement. One hundred forty-nine studies (94.3%) in the present review included a test for social-positive reinforcement. One hundred forty-six of these studies (98%) assessed the effects of attention on problem behavior, and 80 (54%) assessed the effects of tangible items (food, leisure items, or activities). Seventy-seven studies included both attention and tangible test conditions. Three hundred eighty-six of the combined studies (88.7%) included a test for social-positive reinforcement.

Social-negative reinforcement. One hundred forty-five studies (91.8%) in the present review and 392 (90.1%) of combined studies included a test for social-negative reinforcement (usually escape from demands).

Automatic reinforcement. Seventy-eight studies (49.4%) from the present review (243 or 55.9% of combined studies) included a test for maintenance of behavior by automatic reinforcement (persistence of responding in the absence of social contingencies).

Control conditions. One hundred fifty studies (94.9%) from the present review included a control condition in which the variables assessed in one or more test conditions were absent. Of the eight studies that did not include a specific control condition, five used a contingency reversal strategy (see Thompson & Iwata, 2005), two did not provide sufficient information to determine if a relevant control condition was included, and one did not include a control condition (McCord, Thomson, & Iwata, 2001).

Number of test conditions. The majority of studies (92.4% of the present review; 90.6% of combined studies) included two or more test conditions in an FA, whereas 16 (10.1%) studies from the present review and 67 (15.4%) of combined studies assessed responding in only one test condition in at least one FA.

Comparison with Hanley et al. (2003). The percentage of studies that included tests for maintenance by social-negative reinforcement increased (89.2% to 91.8%), as did the percentage of studies that included tests for social-positive reinforcement (85.6% to 94.3%). The largest increase was seen in the percentage of studies that assessed the influence of tangible items (from 34.7% to 50.6%). Studies that included tests for automatic reinforcement decreased from 59.6% to 49.4%, as did studies that included only one test condition (from 18.4% to 10.1%).

Assessment duration. The majority of studies (86.1% of the present studies; 83.9% of combined studies) included full FAs in which subjects were exposed to assessment conditions three or more times, whereas relatively few studies (12.7% of the present studies; 12.9% of combined studies) included brief FAs in which subjects were given two or fewer exposures to each condition. Assessment duration for FAs was unknown in 5.7% and 5.3% of the present and combined studies, respectively. In comparison with the results reported by Hanley et al. (2003), there was a slight increase in the percentage of studies that involved full FAs (from 82.7% to 86.1%).

Session duration. The majority of studies included in both the present review and combined studies used 10-min sessions (41.8% and 48.3%, respectively) or 5-min sessions (37.3% and 20.7%, respectively). Fifteen-minute sessions were used in 7% of studies in the present review and 20.5% of combined studies. Twenty studies (12.7%) included in the present review (7.4% of combined studies) used other session lengths; these studies often used trial-based FAs

(e.g., Wilder, Harris, Reagan, & Rasey, 2007). Session duration was not identified in 12% and 9.4% of present and combined studies, respectively.

Studies that used 5-min assessment sessions increased (from 11.1% to 37.3%), whereas those using 10- and 15-min session durations decreased (from 52% to 41.8%, and from 28.2% to 7%, respectively) compared with the results obtained by Hanley et al. (2003). The general trend toward briefer sessions most likely reflects an increased emphasis on efficiency. It is unknown, however, whether brief session duration contributed to unclear assessment results (see below, assessment outcomes), thereby necessitating further analyses. For example, Wallace and Iwata (1999) examined 46 sets of FA data and found complete correspondence when session duration was 10 min versus 15 min but a 6.5% loss in correspondence when session duration was 5 min versus 15 min. Thus, the large increase in the use of 5-min sessions may have yielded some loss in assessment accuracy.

Design. The majority of studies (79.1% and 80.5% of present and combined studies, respectively) involved FAs conducted within multielement designs. Reversal and pairwise designs were used in 12% and 7% of present studies, respectively, as well as in 14.3% and 4.1% of combined studies. Some combination of these designs was used in 7% of studies included in the present review and in 4.1% of combined studies. In comparison with the results reported by Hanley et al. (2003), the use of multielement and reversal designs decreased slightly (from 81.2% to 79.1%, and 15.5% to 12%, respectively), whereas the use of pairwise designs and combined experimental designs increased (from 2.5% to 7% each). The experimental design was not described in 3.2% of present studies and in 4.8% of combined studies. Often, these studies included a cursory description of the FA procedures (e.g., "FA methodology was based on Iwata et al., 1982/1994") and did not include line graphs of FA outcomes.

Of the 125 studies included in the present review in which a multielement design was used, 113 (90.4%) involved random sequencing of conditions, whereas 21 studies (16.8%) involved a fixed sequence (alone, attention, play, demand) as suggested by Iwata *et al.* (1994). Sixteen studies (12.8%) included a later condition to test for behavioral persistence in the absence of social consequences, also known as the extended alone or no-interaction phase (Vollmer, Marcus, Ringdahl, & Roane, 1995). The extended alone phase often was used to determine whether behavior was maintained by automatic reinforcement or by multiple contingencies after initial FA results showed undifferentiated responding.

Data display and analysis. The majority of studies (89.9% of present studies, 80.5% of combined studies) displayed FA data as session values in line graphs. One of these studies from the present review also displayed within-session values (Marcus, Vollmer, Swanson, Roane, & Ringdahl, 2001). Seven studies (4.4%) included in the present review and 81 (18.6%) of combined studies displayed data as condition means either in a bar graph or table, or as numerical data within the text. In comparison with the results reported by Hanley *et al.* (2003), there was an increase in the percentage of studies in which data were displayed as session values (from 75.1% to 89.9%) relative to condition means (which decreased from 26.7% to 4.4%), although it is unclear whether this change reflected a greater need to examine within-condition trends rather than author or editor preference. The percentage of studies portraying within-session data decreased from 1.1% to 0.6%, suggesting that researchers have not found this method to be particularly useful in interpreting FA data.

Three studies (1.9%) from the present review displayed data as either the percentage of trials in which responding occurred in bar graph form or as the percentage of time during each session that responding occurred in a numerical table. Seven other studies (4.4%) did not present any FA data;

instead, authors either summarized the outcome of the FA in the text (e.g., “results of the FA indicated that behavior was maintained by social-positive reinforcement”) or made no comments on the results of the FA.

Ninety-seven studies included in the present review (61.4%) used a continuous recording method of data collection: Frequency (frequency or rate) measures were reported in 90.7% of these studies, whereas duration (or latency) measures were reported in 9.3% of studies. Discontinuous methods of recording were reported in 72 studies (45.6%), most of which (68 or 94.4%) used partial-interval recording. One study (1%) used whole-interval recording, and three studies (4.2%) used momentary time sampling. No studies reported data on the magnitude or force of problem behavior.

Three studies included in the present review (1.9%) reported the use of formal criteria to aid in visual data interpretation. Paclawskyj, Matson, Rush, Smalls, and Vollmer (2001) and Langthorne *et al.* (2011) used standard-deviation estimating methods described by Hagopian, Fisher, Thompson, and Owen-DeSchryver (1997). Asmus *et al.* (2004) determined function based on an upward trend (or stability) in three consecutive data points of a given test condition relative to levels of responding in the control condition.

Stimulus Parameters

Hanley *et al.* (2003) summarized the general stimulus conditions incorporated into test and control conditions of an FA and described a number of variations in types of antecedent and consequent events manipulated, including establishing operations (EOs), discriminative stimuli (S^D s), and contingencies for the presence and absence of problem behavior. In the past decade, researchers have continued to use the same types of manipulations documented by Hanley *et al.*, so those variations will not be discussed here.

However, some unusual variations warrant additional comment. Two studies included test

conditions in which some aspect of therapist behavior varied while the consequences for problem behavior were held constant. Northup, Kodak, Lee, and Coyne (2004) compared a standard escape condition with two other conditions: time-out and no instructions. In both additional conditions, procedures were the same as in the escape condition (a task trial was terminated contingent on problem behavior), but in the time-out condition, the therapist told the subject at the start of the session that occurrence of the target behavior would produce a time-out and also said the word "time-out" before initiating the escape interval when problem behavior occurred. In the no-instructions condition, no additional instructions were delivered, and the therapist made no vocalizations following the occurrence of problem behavior. Kuhn et al. (2009) also manipulated antecedent aspects of therapist behavior in an FA: A modified tangible (edible) condition was conducted for one subject in which the therapist consumed the subject's preferred food in close proximity to the subject during the session, and a modified tangible (leisure) condition involved the therapist's saying to the subject that the leisure items (magazines) belonged to the subject before taking them away at the start of the session. A modified attention condition was conducted for another subject in which a confederate therapist modeled the subject's problem behavior while the primary therapist delivered contingent attention to the confederate. Although rationales for the inclusion of these conditions were provided by the authors, it was unclear whether the antecedent manipulations influenced behavior as S^D s versus EOs.

Combining variables within an assessment condition represents another variation (e.g., varying the delivery of attention while holding a task demand constant; Carr & Durand, 1985). Some studies have combined the delivery of several consequences within a single test condition. For example, Mueller, Sterling-Turner, and Moore (2005) and Sarno et al. (2011) implemented a variation of the demand condition in

which problem behavior resulted not only in escape from the demand but also in the delivery of attention (as in the attention condition). Similarly, one subject (Kurtz et al., 2003) was allowed to watch television during the escape interval because the authors noted that this typically occurred in the subject's home environment. A more unusual combination was implemented by LaBelle and Charlop-Christy (2002), in which the therapist changed contingencies based on the behavior of the subject during the session: If the subject moved away from the therapist while engaging in the target behavior, the therapist ignored the subject for 30 s (escape), but if the subject appeared to be attempting to gain access to toys while engaging in the target behavior, the therapist provided access to tangible items. Although any number of events may be varied within a condition, some variations may be problematic because when multiple consequences are delivered in a single test condition, the influence of one source of reinforcement versus another may be difficult to determine.

Summary of FA Outcomes

Table 5 shows a summary of FA outcomes for individual subjects based on data presented in 445 individual line graphs from the present review (981 line graphs from combined studies). This number reflects a rough estimate of the total count of individual subjects who participated in the studies, but is not a precise measure because some subjects participated in more than one FA either within or across studies. In addition, subjects for whom FA outcomes were not presented in line graph form are not included in this total. Differentiated results (based on authors' interpretations) were obtained in 91.7% of present cases (94% combined). Of these, 29.7% (32.2% combined) showed maintenance by social-negative reinforcement, and 29.2% (32.7% combined) showed maintenance by social-positive reinforcement (attention in 17.2% and access to tangible items or activities

Table 5
Summary of Functional Analysis Outcomes

Topography	Undiff	Diff	Esc	Attn	Tang	Auto	Mult
Self-injury	9 (22)	60 (282)	18 (83)	4 (63)	6 (34)	21 (76)	11 (26)
Aggression	10 (12)	45 (95)	17 (41)	12 (21)	10 (16)	1 (2)	5 (15)
Property destruction	0 (0)	7 (9)	2 (2)	2 (2)	0 (2)	1 (1)	2 (2)
Pica	0 (0)	5 (11)	0 (0)	0 (1)	0 (0)	5 (8)	0 (2)
Disruption	0 (0)	10 (26)	0 (11)	0 (3)	0 (1)	6 (7)	4 (4)
Vocalizations	2 (3)	45 (59)	9 (15)	14 (17)	5 (6)	10 (10)	7 (11)
Noncompliance	0 (0)	17 (25)	8 (9)	7 (9)	2 (3)	0 (0)	0 (4)
Elopement	0 (0)	12 (15)	0 (0)	5 (5)	4 (4)	0 (0)	3 (6)
Stereotypy	0 (1)	16 (46)	1 (7)	0 (0)	0 (0)	14 (33)	1 (6)
Tantrums	0 (0)	2 (8)	1 (3)	0 (1)	1 (2)	0 (0)	0 (2)
Other	0 (0)	17 (30)	2 (6)	1 (6)	1 (1)	10 (11)	3 (6)
Aberrant	16 (21)	172 (316)	63 (120)	25 (72)	20 (32)	1 (2)	63 (90)
Total number ^a	37 (59)	408 (922)	121 (297)	70 (200)	49 (101)	69 (150)	99 (174)
Percentage of sample ^b	8.3 (6.0)	91.7 (94.0)	29.7 (32.2)	17.2 (21.7)	12.0 (11.0)	16.9 (16.3)	24.3 (18.9)

Note. Undiff = undifferentiated results, Diff = differentiated results, Esc = maintenance by escape, Attn = maintenance by attention, Tang = maintenance by tangible reinforcers, Auto = maintenance by automatic reinforcement, Mult = multiple sources of control.

^aNumbers in parentheses indicate current data combined with those from Hanley *et al.* (2003).

^b“Sample” refers to all line graphs presented in included studies.

in 12% of present cases). Responding was maintained by automatic reinforcement in 16.9% of present cases (16.3% combined) and by multiple reinforcement contingencies (i.e., multiple control) in 24.3% of present cases (18.9% combined). The majority (63 present cases; 90 combined cases) of the multiply controlled cases involved FAs of aberrant behavior, that is, multiple responses that are topographically dissimilar (e.g., self-injury and aggression).

There was a slight decrease in the percentage of differentiated FAs compared with the results of Hanley *et al.* (2003). Similar to the results obtained by Hanley *et al.*, most cases showed maintenance by social reinforcement (negative or positive). The percentage of cases in which problem behavior was maintained by multiple contingencies increased from 14.6% to 24.3%.

DISCUSSION

Best Practice Recommendations

Based on the results of their review, Hanley *et al.* (2003) presented the following recommendations for best practice:

- (a) limiting response classes to one or a few behavior topographies,
- (b) programming consequences for the occurrence of target behaviors,
- (c) incorporating EO influences before and during assessment,
- (d) including S^Ds to facilitate discrimination of test conditions,
- (e) conducting relatively brief (10-min) sessions,
- (f) including tests to identify behavior maintained by automatic reinforcement,
- (g) considering relative reinforcement durations when interpreting analysis results,
- (h) testing for functional relations between problem behavior and tangible reinforcement only when preliminary information suggests a relation might

exist, (i) starting brief and simple (arranging relatively few test conditions) and progressing to more lengthy or complex assessments as needed, and (j) using other sources of information (e.g., open-ended interviews and observations) as adjuncts to structure more complex analyses. (p. 178)

Results of the current review indicate that some of these recommendations have been largely upheld. For example, most studies now use the ABC FA model and briefer session durations. Other recommendations have not been reflected in recent research. Perhaps most notable has been the increased use of a tangible reinforcement test condition, from about a third of the studies in the Hanley et al. (2003) review to over half of the studies subsequently. Of the 80 studies (overall) that included a tangible condition, only 41.3% of the authors reported doing so based on either informal (interview) or formal (direct observation) preliminary information suggestive of a tangible function. Thus, in more than half of the studies in which a tangible condition was included, either the basis for its inclusion was not reported or it was simply added for no particular reason. Results of several studies (Galitsatos & Graff, 2003; Rooker, Iwata, Harper, Fahmie, & Camp, 2011; Shirley, Iwata, & Kahng, 1999) have shown that unnecessary inclusion of a tangible condition produced a false-positive outcome, that is, data indicative of a tangible function when there was none. Thus, the recommendation made by Hanley et al. about limiting the use of the tangible condition seems more relevant today in light of data published subsequently. Even when there is reason to believe that problem behavior may be maintained by access to tangible consequences, selection of those consequences based on use of a preference assessment may still favor a tangible outcome because potent reinforcers are delivered following a response already in the subject's behavioral repertoire.

More frequent use of a tangible test condition also might yield an increase in multiply controlled outcomes, which was found in the present review. Another factor that may have contributed to the increase in multiply controlled outcomes might be the practice of aggregating multiple response topographies in a single FA, which increased from 27.8% of studies (Hanley et al., 2003) to over 75.9% (current review). Although this practice increases assessment efficiency by reducing the number of responses that require an FA, results of some studies have shown that FAs of multiple response topographies may mask the function of individual topographies (Asmus, Franzese, Conroy, & Dozier, 2003; Richman, Wacker, Asmus, Casey, & Andelman, 1999). In addition, Beavers and Iwata (2011) noted that a great majority of studies in which multiple control was the outcome were based on multiple-topography assessment. An informal review of studies on single response topographies suggests that non-injurious forms of stereotypy rarely are maintained by social consequences, whereas the opposite is true for aggression. Thus, combining these responses into a single class of aberrant behavior is highly likely to yield a multiply controlled outcome: More stereotypy occurs in the alone condition, but more aggression occurs in one of the social reinforcement conditions.

Hanley et al. (2003) noted in their conclusion, "Questions arise concerning the necessity of a rigorous functional analysis and the potential harm to the individual that may be incurred during assessment" (p. 179). Balancing the risk of harm against the benefit of identifying determinants of problem behavior that need to be addressed during treatment remained an important goal for researchers in the past decade. One method for minimizing risk is to improve the efficiency of assessment. However, the brief FA continues to be used in a small percentage of studies because it involves large reductions in both duration and number of sessions. Another way to improve efficiency would involve manipulations that enhance stimulus control by test

conditions or maximize the influence of EOs within a condition. More studies in which antecedent variables are manipulated while consequences are held constant (e.g., Kuhn et al., 2009; Northup et al., 2004) may identify variables that improve assessment efficiency.

An alternative approach might involve the use of supplementary assessments prior to an FA. Mueller and Nkosi (2007) proposed indirect assessments as well as descriptive analyses as part of their model for conducting FAs in school settings (the Behavior Analytic Consultation to Schools model, BACS). Mueller, Nkosi, and Hine (2011) published a summary of 90 FAs conducted with the BACS model, in which they used results of preliminary assessments to determine which test conditions to include in the subsequent FA, allowing a reduction in the overall number of test conditions in some cases. Although results of descriptive analyses have been found to be poor predictors of FA outcomes (see Camp, Iwata, Hammond, & Bloom, 2009, and Pence, Roscoe, Bourret, & Ahearn, 2009, as the most recent comparative analyses), they may be helpful in excluding an unlikely function. For example, the observation that problem behavior occurs in the presence of others but never when the individual is left alone may be the basis for excluding the alone condition from an FA. When such general observations of behavior are used as assessment guides, indirect approaches to assessment (questionnaires) may provide similar information (however, limitations of indirect methods should be noted; see C. M. Smith, Smith, Dracobly, & Pace, 2012, for a recent discussion). Although verbal report is much less reliable than direct observation, the former can be completed in a shorter amount of time.

Another dimension of risk during assessment is the severity of the target behavior, which was addressed by R. G. Smith and Churchill (2002). After noting that four individuals who engaged in SIB or aggression often were observed to engage in precursor behavior (behavior that reliably preceded the occurrence of problem behavior),

they conducted separate FAs of precursor and target behavior and obtained the same outcomes in all cases. Furthermore, lower rates of target behaviors were observed during the precursor FAs. These findings have been replicated and extended (Borrero & Borrero, 2008; Dracobly & Smith, 2012; Herscovitch, Roscoe, Libby, Bourret, & Ahearn, 2009), suggesting the possibility of reducing risk during assessment through an examination of precursor behavior.

Advances in risk reduction notwithstanding, whether FA procedures actually increase risk of harm to the subject is an empirical question that cannot be answered by the available data. Although an FA is designed to evoke problem behavior, it is unclear whether the increase in responding observed in one or more conditions of an FA poses risk greater than that observed outside of assessment sessions or greater than the risk posed by forgoing an FA altogether. Assessment of these types of risk will require advances in measurement to take into account severity (intensity) in addition to frequency, as well as the long-term consequences of treatment that was not based on results of an FA.

ARTICLES IN THE 2013 SPECIAL ISSUE

The articles in this special issue, although they reflect some of the trends identified in this literature review, reveal a growing emphasis on efficiency of assessment process and modifications aimed at transferring FA methodology more widely into community settings. The benefits of the FA for science and practice also continue to be recognized through extension to a variety of problems and application to treatment analysis. The articles fall into one of three categories: (a) refinement of the FA methodology described by Iwata et al. (1982/1994); (b) extension of FA across populations, problems, and settings; and (c) application of FA to better understand and predict variables that influence treatment success. A commentary by Schlinger and Normand (2013) on the origin and meanings

of the term *functional analysis* also joins the research and review articles described in the following sections.

Methodological Refinement

Iwata et al. (1982/1994) initially described the FA methodology as tentative in their paper entitled “*Toward a functional analysis of self-injury.*” Despite 30 years of research, the majority of studies continue to employ a multielement design, evaluate multiple test conditions, analyze results through visual inspection of graphed data, and include the same conditions (e.g., attention, demand, play) described by Iwata et al. For this reason, the original FA is now commonly referred to as the standard or traditional FA. Nonetheless, the literature also suggests an increasing focus on ways to clarify FA outcomes, particularly during the early stages of assessment, via modification to the standard procedures and design. The goal of methodological refinement is a more efficient assessment, with a potential reduction in the risks posed by problem behavior. A number of papers in this issue reflect this trend in the literature.

Several studies evaluated alternative ways to present test conditions. Hammond, Iwata, Rooker, Fritz, and Bloom (2013) examined the utility of a design modification that has been described in the literature but not widely adopted. In their study, presentation of the test and control conditions in a particular sequence rather than randomly yielded more efficient or clearer results for a noteworthy portion of cases. In two papers, a brief FA screening procedure that consisted of a series of alone or no-interaction sessions conducted prior to a full FA successfully differentiated cases of behavior maintained by automatic versus social reinforcement. Querim et al. (2013) evaluated the predictive validity of this screening approach by comparing the results of the brief screen to those of full FAs across a range of problem behaviors and functions. The FA screen predicted the maintaining source of reinforcement (social vs. automatic) in much less time than did full FAs, suggesting that it would

increase the efficiency of the FA for behaviors that are likely to be maintained by automatic reinforcement (e.g., stereotypy). Roscoe, Iwata, and Zhou (2013) demonstrated the utility of a similar approach in a study with a large number of subjects on the environmental determinants and treatment of hand mouthing, a behavior that is commonly maintained by automatic reinforcement. Successful treatment did not require a full pretreatment FA for all 14 subjects who participated in both assessment and treatment evaluations.

In two studies, Fahmie and colleagues evaluated modifications to the standard FA conditions described by Iwata et al. (1982/1994). Fahmie, Iwata, Harper, and Querim (2013) found that a variation of the attention condition in which the experimenter’s attention was diverted to someone else was just as effective as or more effective than the standard attention condition for identifying attention as a maintaining reinforcer. In light of these findings, the authors suggested that this variation, which has been described previously in the literature, could replace the attention condition in the standard (i.e., initial) FA. Fahmie, Iwata, Querim, and Harper (2013) examined potential replacements for the standard control condition (i.e., play) of the FA. As designed originally, the play condition was a convenient control for multiple EOs and consequences manipulated in the test conditions. Nonetheless, some research findings suggest that the play condition may not be ideal for behaviors with particular functions (e.g., escape). Results of Fahmie et al. indicated that two conditions routinely included in the standard FA (play and ignore or alone) provide adequate control for the test conditions typically alternated in a multielement design.

Some forms of problem behavior warrant special consideration for design of the FA. For example, severe behavior disorders that increase the risk of physical injury require measures to ensure client safety during assessment. As noted previously, one potential strategy to minimize client risk is to identify and assess precursor

behavior. In the most extensive evaluation of this approach to date, Fritz, Iwata, Hammond, and Bloom (2013) illustrated an objective yet efficient method for identifying behaviors (e.g., mild forms of problem behavior) that reliably predicted the occurrence of more severe problem behavior for 16 individuals with intellectual disabilities. Of particular relevance was the fact that caregiver interviews failed to identify the precursor behavior in nearly every case. FAs then confirmed that the precursor and target behaviors were members of the same response class. Most notably, the subjects engaged in little severe problem behavior during the FA of precursors, replicating prior work in this area. Subsequent treatment of the precursor behavior with a package that included noncontingent and differential reinforcement not only reduced the precursor behavior but suppressed severe problem behavior as well.

Elopement is another form of problem behavior that presents some unique challenges for the design of the FA, in that it necessarily involves client movement outside of confined (and highly controlled) areas and the introduction of potential confounding variables (e.g., attention in the form of physical retrieval). In this issue, two studies explored modifications to the standard FA with the aim to reduce these potential confounding effects. Neidert, Iwata, Dempsey, and Thomason-Sassi (2013) extended previous research on a trial-based FA format that uses latency to the first instance of elopement as the primary dependent variable. Lehardy, Lerman, Evans, O'Connor, and LeSage (2013) delivered test contingencies for movement across a room in lieu of elopement from the room in modified FAs. Both approaches eliminated the need to retrieve the client following elopement and appear promising for the assessment of this common problem behavior.

A literature review by Schlichenmeyer, Roscoe, Rooker, Wheeler, and Dube (2013) reflects an increasing interest in manipulations that identify idiosyncratic influences on behavior after a

standard FA produces undifferentiated outcomes. A retrospective analysis of 176 cases conducted by Hagopian, Rooker, Jessel, and DeLeon (2013) demonstrated the success of this approach when adopted as part of routine clinical practice. A clear function was identified in just 47% of initial FAs; this percentage increased to 87% when clinicians implemented up to two modified FAs after inconclusive outcomes. These modifications primarily consisted of changes to the design (e.g., use of a pairwise design) and to antecedents in the test conditions (e.g., demands).

As discussed earlier in this paper, a review of research conducted between 2001 and 2012 revealed greater use of the FA in naturalistic settings, such as homes and schools, an inevitable and welcome extension indicative of the fact that practitioners who work in more diverse settings are adopting FA methodology. A number of studies in this issue examined refinements to the traditional FA that could affect the likely success of this technology transfer. The lack of qualified individuals to conduct the assessment is one barrier to extending the FA more broadly. Wacker *et al.* (2013) evaluated the use of a telehealth system to provide remote consultation services to 20 parents of children with autism who engaged in problem behavior. Parents implemented standard FAs with their children at regional medical clinics while they were coached by consultants via video conferencing. The highly promising results suggest that telehealth systems could increase access to FA services in areas that lack qualified professionals. In three other studies, experimenters evaluated a methodology for conducting FAs more readily in classrooms and other community settings, which involved teachers or caregivers periodically presenting FA trials within the context of naturally occurring activities. Bloom, Lambert, Dayton, and Samaha (2013) and Kodak, Fisher, Paden, and Dickes (2013) demonstrated that classroom staff could successfully conduct trial-based FAs in their classrooms. Moreover, Bloom *et al.* showed that results of these FAs led to effective interventions

for students' problem behavior. Extending the trial-based FA to another setting, Lambert, Bloom, Kunnavatana, Collins, and Clay (2013) taught supervisors of a residential facility to train house managers to conduct FAs of clients' problem behavior. Results of all three studies provide further evidence of the utility of this format for conducting FAs in natural settings.

Regardless of the FA methodology, conducting assessments in naturalistic settings has potential advantages and disadvantages that have not been thoroughly explored. Thomason-Sassi, Iwata, and Fritz (2013) addressed this issue by comparing the results of FAs conducted by experimenters in a clinic setting to those conducted by caregivers or in the home setting. Although FA outcomes were similar in the majority of cases, results for two subjects indicated that the use of familiar versus unfamiliar people could alter the likelihood of identifying behavioral function. Implications of these findings for conducting FAs are complicated by the fact that a familiar person was critical for identifying the function in one case, whereas an unfamiliar person was critical for identifying function in the other case.

The use of formal criteria for interpreting FA data is another refinement that could lead to more efficient FAs and promote transfer of the methodology more broadly. As noted previously, the criteria for visual data inspection described by Hagopian et al. (1997) have not been widely adopted, perhaps because they were established for FAs comprised of lengthy data sets (10 sessions per condition). To address this limitation, Roane, Fisher, Kelley, Mevers, and Bouxsein (2013) modified these criteria so that they could be applied to FAs of any length and found that the use of these criteria by reviewers with varying levels of expertise substantially improved the reliability of data interpretation. They then demonstrated the utility of the visual inspection criteria by having experts apply them to 141 data sets.

In the final paper consistent with the theme of methodological refinement, Iwata, DeLeon, and

Roscoe (2013) examined the reliability and validity of a caregiver questionnaire about conditions under which problem behavior might occur. Such indirect assessments are now a common supplement to (and, in practice, a common replacement for) the FA, despite decades of research that has demonstrated the inadequate reliability of these instruments. Iwata et al. developed the Functional Analysis Screening Tool (FAST) with items derived from conditions used in current FA research in an attempt to improve the consistency of verbal report. The resulting moderate reliability of the FAST, however, was similar to that of previously studied instruments. Not surprisingly, the validity of the FAST was found to be inadequate for determining function when caregiver report was compared to the results of standard FAs. Further research is needed on the potential contribution of indirect assessment to the design or modification of FAs.

Extension

The application of the FA methodology to treat atypical behavior problems and the problems of individuals without intellectual disabilities has continued to receive some attention in the FA literature, as indicated by the selection of articles in this issue. This research indicates that scientists and clinicians recognize the benefits of taking a function-based approach to understanding and treating behaviors of social importance, regardless of response typography or client population. The FA was extended to such problems as sleep disorders (Jin, Hanley, & Beaulieu, 2013), bruxism (Lang et al., 2013), perseverative speech (Fisher, Rodriguez, & Owen, 2013), crying (Bowman, Hardesty, & Smith, 2013), and rumination (K. E. Woods, Luiselli, & Tomassone, 2013). In addition, Plavnick and Normand (2013) provided an overview and critique of recent research on the use of FA to assess verbal behavior. In a particular novel application of the methodology, Larson, Normand, Morley, and Miller (2013) evaluated

conditions under which typically developing children were more or less physically engaged during recess. Such an approach holds promise for the development of function-based interventions to promote physical activity in children. Greer *et al.* (2013) also extended the FA to assess behavior problems in typically developing children. Therapists conducted standard FAs of aggression and property destruction of four children in a preschool classroom and developed effective, function-based interventions on the basis of the outcomes.

Treatment Analysis

Several studies in this issue illustrate the contribution of the FA methodology to our understanding of variables that affect treatment success. Knowledge of function is essential when attempting (a) to identify mechanisms that underlie commonly used interventions (e.g., extinction), (b) to develop strategies for improving treatment outcomes (e.g., schedule thinning), and (c) to evaluate treatment components most likely to be effective for particular behavioral functions (e.g., automatic reinforcement; social avoidance). Two studies focused on variables that alter resistance to extinction, a particularly important concern given that extinction is a ubiquitous component of function-based treatments. Treatments for behavior maintained by automatic reinforcement are an exception, however, because the functional reinforcer typically is difficult to identify and withhold. Dozier, Iwata, Wilson, Thomason-Sassi, and Roscoe (2013) examined the possibility that response-contingent arbitrary (social) reinforcers might displace automatic reinforcers that maintain stereotypy, leading to successful extinction of responding when the social reinforcer is withheld. Despite making a number of methodological improvements over prior work in this area, Dozier *et al.* found no evidence for the success of this approach with nine subjects. Knowledge of behavioral function also was essential for studying the relation between reinforcement schedule and

resistance to extinction. Consistent with behavioral momentum theory, MacDonald, Ahearn, Parry-Cruwys, Bancroft, and Dube (2013) found that problem behavior was more resistant after continuous reinforcement than after intermittent reinforcement. Such an outcome suggests that behavior may be easier to treat in the natural environment, where reinforcement is typically delivered on an intermittent basis. Nonetheless, the authors also noted that possible challenges may arise when treatment follows exposure to FAs in which behavior contacts continuous reinforcement.

Extinction effects may be implicated in other aspects of treatment delivery. For example, when an FA identifies the reinforcer maintaining problem behavior, the same reinforcer may be provided for appropriate behavior within the context of such treatments as functional communication training. The effectiveness of this intervention, however, often depends on the continued availability of the reinforcer for the alternative behavior (i.e., communication response). Such an arrangement is not practical and may result in excessively high levels of the alternative behavior. With this in mind, Betz, Fisher, Roane, Mintz, and Owen (2013) further evaluated the use of multiple schedules (alternating periods of reinforcement and extinction) to thin the schedule of reinforcement for appropriate behavior during treatment with functional communication training. After successful discrimination training, treatment remained effective even when the reinforcer was unavailable for lengthy periods of time. Furthermore, a component analysis revealed that the success of this approach did not depend on a gradual lengthening of the extinction period.

Thirty years of research on FA has firmly established the relevance of assessment outcome to the selection and design of treatments for problem behavior. As two studies illustrate, this recognition drives research on treatments for behavior disorders with particular functions (e.g., escape) rather than on treatments for particular

behavior problems (e.g., aggression). Harper, Iwata, and Camp (2013) evaluated multiple treatments for problem behavior maintained by escape from social interaction, a function that has rarely been addressed in the literature. After modifying the standard FA to confirm maintenance by escape from social interaction per se, the experimenters examined the effects of vicarious reinforcement, conditioning of social interaction, stimulus fading, and differential reinforcement plus extinction during separate treatment conditions. The aim was to reduce the aversiveness of social interaction as demonstrated through a corresponding reduction in problem behavior during baseline. Only differential reinforcement plus extinction reliably reduced problem behavior under both treatment and baseline conditions, suggesting the superiority of consequence-based interventions for reducing social avoidance. Results of modified FAs conducted by Roscoe et al. (2013) revealed that hand mouthing was maintained by automatic reinforcement for nearly all of the 64 subjects. In a subsequent treatment analysis with 14 individuals, the experimenters demonstrated a model for introducing treatments in a least-to-most intrusive hierarchy based on patterns of responding under each intervention component. The outcome of this large-scale analysis provides the field with valuable information regarding the likely success of commonly used reinforcement-based treatments for behavior maintained by automatic reinforcement.

Conclusions

In the 30 years since the original publication of the experimental model proposed by Iwata et al. (1982/1994), FA methodology has become an integral part of behavioral assessment. This is true not only in the field of applied behavior analysis but also in related fields, as evidenced by the increased number of traditional journals that represent a range of human services research in which FA studies are published. Improving the efficiency of assessment while maintaining its

accuracy is still an important goal for future research, especially if FA methodology is to be extended to problems experienced by the typical population (only two studies in this special issue focused on typically developing subjects). One area in which FA methodology may be particularly useful in future years is behavioral gerontology. Although problem behavior exhibited by geriatric individuals was examined in only three studies in the present review, its importance as a clinical challenge will surely increase as the largest segment of our population (those born immediately after World War II) continues to age.

Extension to problem behavior associated with aging represents only one of the many areas in which additional research is needed. For example, traditional approaches to the assessment of most clinical disorders are based on structural aspects of behavior (observed symptoms) rather than on cause-effect demonstrations. This fact has not escaped the attention of many psychiatrists for several years. Most recently, McHugh and Slavney (2012), in commenting on revisions to the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association, 2000), suggested a benefit for organizing clinical disorders based on causation:

Psychiatrists would start moving toward the day when they address psychiatric disorders in the same way that internists address physical disorders, explaining the clinical manifestations as products of nature to be comprehended not simply by their outward show but by the causal processes and generative mechanisms known to provoke them. Only then will psychiatry come of age as a medical discipline. (p. 1854)

The challenges posed in developing function-based approaches to assessment of problems such as obsessive compulsive disorder, chronic depression, and so on, are many, but resolution of complexities related to definition, measurement, and control has always been the strength of our

field. Baer, Wolf, and Risley (1968) noted that “applied research is constrained to examining behaviors which are socially important, rather than convenient for study” (p. 92). If the goal of applied behavior analysis is to solve problems of social significance, regardless of the ease with which this can be done, there is no end to the possible extensions of FA methodology that have yet to be accomplished.

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