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Functional analysis: what have we learned in 85 years?

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Abstract

Purpose: Even though the term "functional analysis" (FA) is prevalent in the current behavioral literature, the concept and process have roots in the early days of basic research in behavior analysis. Furthermore, the methodology developed in the field of FA has been one of the most significant advances in research on challenging behaviors over the past four decades. The current article reviews the history of the term "functional analysis" and research related to experimental FA. The aim is to summarize what the field of behavior analysis has learned about this powerful methodology.

Views: FA is considered a gold standard of functional assessment. However, several arguments about limitations relating to methodological issues in FA and its ecological validity have been put forward. Some of these shortcomings include constraints on the time available for assessment, the risk posed by severe problem behavior, and the inability to exert tight control over environmental conditions.

Conclusions: The literature on the subject clearly shows that refinements have been aimed not only at improving some of the methodological characteristics of FA but also at adapting the strategy for real-world application. Practical functional assessment (known as interview-informed synthesized contingency analysis [IISCA]) is a contemporary approach to assessing and treating problem behavior. Recent research on IISCA offers empirical support for the practical functional assessment and skill-based treatment model, confirming that it can obtain sustainable and socially meaningful reductions in problem behavior. Nevertheless, more research is needed to address procedural variations in, and the utility and social validity of, IISCA.

Key words: functional assessment, functional analysis, experimental functional analysis, challenging behavior, interview-informed synthesized contingency analysis (IISCA).

INTRODUCTION

Functional analysis (FA) methodology has been one of the most significant advances in research on challenging behaviors over the past four decades and is now regarded as the gold standard for practice [1]. FA is an assessment method identifying the contextual factors that influence behavior. The primary clinical goal of conducting FA is to inform therapeutic decision-making so that interventions can be developed to alter specific features of the environment that influence an individual's behavior [2]. When assessing and treating challenging behavior using the principles of behavior analysis, research shows that using a function-based treatment is more effective than a treatment not based on function [3].

Even though the term "functional analysis" is prevalent in the current literature on behavior, the concept and the process of functional analysis have roots in the early days of basic research that laid the groundwork for the field of applied behavior analysis [4]. The term "functional analysis" has been present in behavior analytic literature since the 1940s, but for the last 40 years it has been used mainly in the context of assessing the environmental variables that relate to the occurrence of problem behavior. In the early 1980s, Iwata and colleagues (1982/1994) published their foundational study evaluating the variables that maintain self-injurious behavior [5]. Experimental functional analysis has been widely researched since Iwata's seminal paper [6], but in practice behavior analysts are not routinely using the best assessment methods that have been established in the research literature [7]. Several obstacles to the widespread utilization of FA have been mentioned in this literature [8] and efforts have been made to overcome those hindrances [9]. Since 2012, practical functional assessment or interview-informed synthesized contingency analysis (IISCA), has been dis-

seminated by Hanley and others to provide an effective, comprehensive, and socially valid approach to identifying variables that maintain problem behavior [9].

This article will review the history of the term "functional analysis" and research related to its experimental functional analysis. The aim is to summarize what the field of behavior analysis has learned about this important concept and its powerful methodology in the last 85 years.

TERMINOLOGY

The term "functional" is probably the most widely used adjective to describe the character of the behavior analytic approach [10]. It is central to the applied and basic domains of the discipline in that both branches focus on understanding behavior-environment relations. Given the significance of the term, Schlinger and Normand (2013) discuss its origins [4], writing that the actual term "functional analysis" *was probably first used by Skinner in 1948 in his William James Lectures* (p. 286); but Skinner's earlier publication – "The Behavior of Organisms: An Experimental Analysis" (1938) [11] – included in its title the concept of functional analysis, albeit not used explicitly. Later, Skinner used the phrase "functional relations" in his 1953 book "Science and Human Behavior" [12] to denote the point that *different events tend to occur together in a certain order* (p. 23). Further on in the text, Skinner utilized the term "functional analysis" as a synonym for the cause-and-effect relationship between environmental events and behavior. In other words, to understand why behavior occurs we need to manipulate those variables presumed to be responsible for its occurrence. Thus, functional analysis is synonymous with experimental analysis. If we subscribe to this understanding of the concept, we can state that the idea has been present in the behavioral literature for 85 years. We can trace its history in the experimental analysis of behavior as well as the applied branch. Namely, Baer, Wolf, and Risley (1968), when describing the "analytic" dimension of applied behavior analysis, write about functional relations [13]. They clearly specify what is meant by "analysis": *Analytic behavioral application is the process of applying sometimes tentative principles of behavior to the improvement of specific behaviors, and simultaneously evaluating whether or not any changes noted are indeed attributable to the process of application, and if so, to what parts of that process* (p. 91). This historical definition of "functional analysis", described by Schlinger and Normand (2013) [4] as *the bedrock of the field of behavior analysis* (p. 288), is still used today by behavior analysts when they refer to an effect that a manipulation of the independent variable has on the dependent variable. This is an important point to remember: applied behavior analysis, as opposed to behavior modification, strives to understand how an individual's behavior is learned and maintained through interaction with the social and physical environment. The emphasis is on discovering the relations between the behavior, its antecedents, and its consequences rather than on merely changing the behavior, without identifying its root environmental causes. The term used to describe the latter approach is "default technologies" (p. 630) [14]. It is also crucial to note that the historical explanation of "functional analysis" was not restricted to any particular methodology or behavior under investigation; it simply related to a study being analytical when exploring the relations between the independent and the dependent variables.

A more currently used definition of "functional analysis" was developed by Iwata *et al*. (1982/1994) in their seminal article and denotes a specific methodology for understanding the function of problem behavior [5]. It is narrower than the historical definition but has become a salient part of the vernacular of applied behavior analysis. This gold standard of pre-intervention assessment will be described in the latter part of this paper.

Another term that requires a short explanation is "functional assessment." Hineline and Groeling (2011) [15] define it as *any empirically and environmentally based account of a specified behavior* (p. 40). This encompasses both non-experimental and experimental methods. Functional assessment, also called functional behavior assessment (FBA), includes the following components: a record review and interviews (indirect assessment), direct observation (descriptive assessment), and functional (experimental) analysis [14]. The last element is often called the "gold standard" [1] of FBA. Thus, functional analysis is considered a vital part of functional assessment, albeit not the only part. It is most often preceded by a preliminary, non-manipulative assessment. This first part of the process of discovering the function of problem behavior is not a focus of the current paper and thus will not be discussed in detail.

EARLY STUDIES ANALYZING BEHAVIORAL FUNCTION

From the very inception of applied behavior analysis, the outcome of research and practice was to show socially important and meaningful changes in behavior [13]. Currently, it is widely recognized as best practice to understand a behavior's function when developing an intervention plan (BCBA's task list). However, the functional approach to the treatment of problem behavior was not present in early applications of learning theory. As Mace (1994) [16] writes, in the "behavior modification" model, the use of strong reinforcers and punishers was successful because the arranged and potent contingencies overshadowed the preexisting ones rather than because they ad-

dressed the fundamental purpose of the behavior. Those early applications were focused on behavior management and behavior topography, rather than on understanding its function. The notion of investigating the function of challenging behavior appeared in empirical studies in the 1960s. This was when the shift from "behavior modification" to "behavior analysis" began [16], thus initiating the future concept of functional behavioral assessment.

The first study in which the researchers *attempted control over self-destruction by systematically manipulating the variables of which it might be a function* (p. 68) was published by Lovaas and colleagues in 1965 [17]. In a series of three experiments, the authors showed that a 9-year-old schizophrenic girl's self-injurious behavior (SIB) was under the very strong control of environmental variables, both discriminative stimuli and reinforcers. As for the reinforcer-response contingency, it was shown that SIB increased when a sympathetic comment was administered because of the problem behavior and decreased when the attention was discontinued (i.e., during social extinction). The authors concluded that the SIB of their participant was a lawful, learned, and operant behavior maintained by social positive reinforcement. In another study, Lovaas and Simmons (1969) [18] demonstrated again that the attention-maintained challenging behavior of two children with developmental disabilities ceased when the behavior was not followed by any social comments or even interpersonal contact, as the children were alone during the intervention phase of the experiment. Several other studies conducted in the late 1960s and 1970s provided additional support for the positive reinforcement hypothesis as a function of problem behavior [19, 20].

Another group of studies investigated the negative reinforcement hypothesis, whereby aberrant behavior was an operant repertoire, reinforced by escape from or avoidance of an aversive stimulus or situation [21]. In their landmark 1976 work, Carr and colleagues made the first attempt to experimentally test the negative reinforcement hypothesis. Their research was different from the previous studies because it focused the experimental analysis on antecedent stimulus variables, not on consequent ones. Nevertheless, the authors showed clearly that the SIB of a young disabled boy was functionally related to demands being made on him; high levels of self-destructive behavior were observed in the condition associated with the participant having been instructed to do something when compared to the conditions under which no response was required of him. Additionally, Carr *et al.* manipulated the occurrence of stimuli that had historically been linked to the removal of demands, on the theory that SIB should decrease when the stimulus associated with the termination of instruction first appeared. The results supported this line of thinking – self-injury decreased when the participant was told "Okay, let's go," a statement associated with the end of the issuing of demands. In contrast, SIB continued to be exhibited at high rates when the participant was told "The sky is blue" – a neutral comment regarding the discontinuation of demands. Carr *et al.* provided a convincing demonstration supporting the hypothesis that problem behavior serves a negative reinforcement function.

Finally, some researchers [22] analyzed the relation between behavior and automatic reinforcement, in which the maintaining consequences are non-social, but rather are produced by the behavior itself. They demonstrated that certain participants exhibited higher levels of stereotypic movements in the absence of preferred stimuli, such as recreational items, as compared to the presence of those items. Because the stereotypic movements persisted in the absence of social consequences, these results suggested that the automatic stimulation produced by the movements may have served as automatic reinforcement. Rincover (1978) [23] also supported the notion that stereotypic behavior was functionally related to sensory consequences. The data showed that self-stimulation markedly decreased when sensory extinction was in place (i.e., sensory consequences were removed). Alternatively, self-stimulation increased when the behavior resulted again in automatic reinforcement (i.e., sensory consequences were permitted).

The above-mentioned body of research was very important because it clearly showed that changes in the environmental variables were associated with changes in the behaviors of interest. However, there was not a comprehensive approach that would allow for testing more than one potential function of the problem behavior of one individual. Behavior analysts voiced the need for a complete and inclusive procedure that could include several possible functions for assessing challenging behaviors. Carr (1977) [24] reviewed data pertinent to several behavioral and non-behavioral hypotheses regarding the sources of motivation for SIB. He concluded that several motivating variables, either alone or in combination, are likely to govern SIB and that these variables may be unique to an individual client. To validate the supposition concerning the motivations behind SIB, Carr suggested that researchers manipulate the antecedents and consequences of SIB. He proposed a three-step sequence to determine the sources of reinforcement (i.e., function) of SIB. Carr wrote: *The outlined screening procedure is by no means definitive, but it does reflect our current, rudimentary state of knowledge. As a guide for assessment, it should provide a useful beginning and a basis for deciding which treatment procedures might be appropriate* (p. 812). In a similar vein, a few years later Weeks and Gaylord-Ross (1981) [25] noted that *a useful contribution to the burgeoning field of behavioral assessment would be the development of clear criteria for determining whether aberrant behavior is maintained by positive rein-*

forcement, negative reinforcement, or intrinsic reinforcement (self-stimulation) (p. 461). Neither Carr nor Weeks and Gaylord-Ross may have realized that they were on the cusp of a historical development in behavior analysis. They were making their comments immediately before the publication that changed the landscape of understanding and treatment of problem behavior and that was written by the most prolific author in the discipline in the years 1992-2001 [26].

EXPERIMENTAL FUNCTIONAL ANALYSIS

In 1982, Iwata, Dorsey, Slifer, Bauman, and Richman [5] introduced the methodology that has become the standard for conducting functional analyses of problematic behavior. Nine developmentally disabled children and adolescents participated in this seminal study. They all exhibited self-injurious behavior (e.g., head banging, face-slapping, self-biting). Each participant was exposed to four experimental conditions – three conditions were tested as a separate hypothesis about the function of problem behavior and one condition served as the control. Each condition was set up during multiple 15-min sessions that alternated across several days. The three experimental conditions had the following characteristics: 1) one or more distinct antecedent stimuli signaled the consequence for the SIB; 2) a motivating operation modified the efficacy of the putative reinforcement; 3) a putative reinforcing consequence was provided for SIB.

In the social disapproval condition, the experimenter and the participant were in a room in which they were toys available for play. Upon entering the room, the adult instructed the child to play with the toys, while they would engage in a work-related activity. Hence, the adult's attention was diverted from the child. When the SIB occurred, the adult would immediately comment on the inappropriate behavior and provide brief physical, nonpunitive contact with the child. Other appropriate or problem behaviors that were not SIB were ignored. This condition was designed to mimic the condition of the natural environment in which there is deprivation of attention, but attention is provided for instances of problem behavior. In other words, the social disapproval condition tested a possible function of positive reinforcement in the form of access to the attention of others.

In the academic demand condition, the experimenter and the participant sat at a table and the adult presented learning activities. The task was chosen for each child based on their educational level and was deemed to be challenging for the participant. If the child did not initiate a response within 5 seconds after the instruction, the experimenter used a three-prompt sequence to help the child complete the assignment. Compliance with the request resulted in social praise. Any instance of SIB resulted in the adult terminating the demand and turning away from the child for 30 sec. This condition was designed to mimic the natural environmental condition in which there are demands present and SIB results in in escaping from the existing demands or in avoiding them altoghether. In other words, the academic demand condition tested a possible function of negative reinforcement.

In the alone condition, the participant was placed in an empty room – there were no toys or other sources of stimulation. The experimenter was not present. There were no social consequences programmed for any behavior of the participant. This condition was designed to mimic a natural environmental condition in which there is very little social or physical stimulation. In other words, the alone condition tested a possible function of automatic reinforcement.

In the unstructured play condition, which served as the control condition, the experimenter and the participant were in a room. There were toys to play with and no academic demands were placed on the participant. The experimenter was near the child and engaged with them (praise and physical contact) every 30 sec, provided SIB was not exhibited. Instances of SIB were ignored. This was a suitable control condition to the previously described experimental conditions in the following respects: the experimenter was present and engaged, thus the motivation for obtaining attention was decreased; no demands were made, thus motivation for escape was decreased; the environment was enriched, thus motivation for sensory stimulation was decreased; and SIB did not result in any social consequences.

The results showed that the between- and within-participant variability of SIB was not a random process. Rather, for most of the participants, higher levels of self-injury were consistently associated with a specific stimulus condition. In particular, the results of some participants strongly suggested that their SIB was maintained by attention, whereas the results of others suggested that their SIB was maintained by escape from demands, and the results of still others suggested that their SIB was maintained by automatic reinforcement. The SIB's function did not appear to be significantly connected with the frequency or severity of the behavior. Moreover, those specific conditions for which the SIB of a given participant was highest were the same for different topographies of SIB. All these findings provided substantial support for the idea that the function and topography of any given behavior are separate, and more importantly, that clinicians cannot infer a cause of behavior from merely observing its topography or severity. The authors concluded their article with a statement: *The present study offers a methodology for examining the multiple effects of the environment on the occurrence of self-injury. Whether or not it will contribute to a more thorough understanding of the etiology of self-injury remains to be seen* (p. 207). As described in the following sections, the contributions of this original

study were tremendous, both for the further development of functional analysis methodology and for designing function-based interventions. In the words of Hineline and Groeling (2011) [15], the introduction of this simple yet elegant format for experimentally investigating the function of any behavior created "a watershed change" (p. 39) for applied behavior analysis.

20 YEARS AFTER IWATA *ET AL.* (1982/1994)

In the two decades following Iwata's seminal study, hundreds more were conducted that replicated and extended the methodology of standard functional analysis. The research that followed addressed problem behaviors across a variety of populations, settings, behavior topographies, and idiosyncratic environmental variables. A detailed description of those post-1982 studies is beyond the scope of this paper, but a review by Hanley *et al.* (2003) [8] will be discussed.

The purpose of Hanley's review was to *provide a quantitative and qualitative analysis of research on the functional analysis of problem behavior and to identify unanswered questions that may be addressed in future research* (p. 148). The authors selected, based on the methodology of this review, 277 FA studies that were published before 2000. These studies were published in 34 journals, with about 65% of the research published in the "Journal of Applied Behavior Analysis". A majority of studies were done with children (70%) with developmental disabilities (over 90% of the participants). Slightly less than 40% of studies focused on adults. The most common settings in which the studies were conducted were not natural environments (e.g., hospitals, schools, and institutions), with only 17% of the research being done at the respondents' homes and vocational placements. The three most often investigated problem behaviors were: SIB, aggression, and disruption. A small percentage of studies focused on challenging behaviors exhibited by typically-developing children (e.g., finger-sucking, inappropriate classroom behavior). At that time, there were no studies that researched the function of problematic behaviors of adults without disabilities (e.g., smoking, overeating). As for the type of functional analysis, 87% of studies used the ABC model proposed by Iwata *et al.* (1982/1994) [5]. A much smaller number of studies (about 10%) used supplemental information, such as indirect or descriptive assessment to learn about the participants' problem behaviors. Nearly 90% of the studies included experimental conditions that tested for the negative reinforcement hypothesis, about 85% included conditions that tested the positive reinforcement hypothesis, whereby problem behavior was either maintained by attention or by access to a tangible object, and nearly 60% of the studies included conditions testing the automatic reinforcement hypothesis. In more than 50% of the studies, the length of the session was 10 min and most studies (over 80%) used a multielement design. Some studies included methodological variations related to either antecedent or consequent events. An example of a modification of antecedent variables was a pre-session activity. This was investigated by arranging a fixed cycle of condition presentation (alone, attention, play, demand) that maximized the establishment of operations during the assessment. Another antecedent variation, specifically in the social disapproval condition, was divided attention. In the demand condition, the antecedent modifications included, for example, giving a participant of choice of a task to be done or changing it, (thereby inducing novelty), duration of the instructional session, and rate of task presentation. In the alone conditions, the antecedent variations were rare, but in one study the authors manipulated distant events (i.e., setting events) that influenced the rate of SIB during the experimental sessions.

Variations in consequent events related to the quality, type, duration, and schedule of changes in the environment following problem behavior were investigated. For example, the source of attention was shown to make a difference. In Broussard and Northrup's study (1997) [27], the results of the functional analysis showed that disruptive classroom behavior was more sensitive to peer attention than to adult attention. Similarly, qualitative differences in the reinforcing effectiveness of attention (i.e., tone of voice, volume) and type of attention were shown to be important. In Piazza *et al.*'s study (1999) [28] the authors provided evidence that not all forms of attention were functionally equivalent. In this investigation, verbal reprimand was a higher-quality reinforcer than praise for both participants. Fisher and colleagues (1996) [29], on the other hand, showed that the duration of the reinforcer differentially affected the rates of problem behavior in the various functional analysis conditions, independently of behavioral function. Namely, when all the experimental conditions were equal concerning how long the reinforcing consequences were administered for, the rates of problem behavior were rather similar across conditions. In contrast, when the analysis was conducted according to the standard protocol, problem behavior was most common in the condition in which the duration of reinforcement was the longest. The last source of variation in how the functional analyses had been arranged related to the schedules of reinforcers. In most studies, a continuous schedule of reinforcement was used, but in some the researchers programmed intermittent reinforcement. For example, Mace and Lalli (1991) [30] first conducted a descriptive assessment to inform them how to arrange conditions during functional analysis so that they resemble most closely the natural schedule of reinforcement for the client. Hanley *et al.* (2003) [8]

commented on some difficulties posed by using intermittent schedules in functional analyses (e.g., establishing the parameters of the schedule to be used), but also underscored the possibility of enhanced ecological validity when utilizing intermittent reinforcement.

As for the outcomes of functional analysis, the authors analyzed 536 graphs and concluded that a great majority (over 95%) represented differentiated ones. About 35% of the results pointed to social negative reinforcement as a maintaining contingency and almost the same fraction to social positive reinforcement. Out of the 35% of positive reinforcement outcomes, 25% of the graphs showed attention as the function of problem behavior, whereas 10% pointed to access to a tangible object as the function of problem behavior. Automatic reinforcement as the maintaining contingency was shown in 16% of the graphs. About 14% of cases were maintained by multiple contingencies (multiply controlled behavior occurs when the results of a functional analysis show consistently higher levels of response in two or more test conditions relative to the control condition [31]) and only 4% were considered undifferentiated (an undifferentiated pattern of behavior occurs when the results of functional analysis show relatively high levels of problem behavior across all conditions without any particular test condition having relatively lower levels of problem behavior [32]).

In the discussion section, Hanley and colleagues [8] elaborated on the issue of experimental integrity and ecological validity based on the reviewed studies. The conclusion included several suggestions for future research and practice. Namely, the authors listed best practices for conducting functional assessment: 1) focusing on a single topography within a response class, 2) programming consequences for the instances of the behavior of interest, 3) incorporating motivational variables prior to and during the assessment, 4) facilitating discrimination of the test conditions, 5) conducting short experimental sessions, 6) including tests for the automatic function, 7) considering the duration of relative reinforcement in the analysis of the results, 8) testing for positive reinforcement in the form of access to a tangible object only if preliminary information suggests that such relationships may exist, 9) starting with relatively simple test conditions, and 10) using additional sources of information before planning the FA experiment.

In 2008, Iwata and Dozier [33] published a theoretical paper on the clinical relevance of FA methodology. The authors pointed to a limited application of the vast research on FA to real-world practice. Survey data showed that behavior analysts and psychologists relied more on nonexperimental methods of functional assessment [34, 35]. The possible reasons for this may include practical constraints in the implementation of FA methodology, namely limitations of the time available for assessment, the risk posed by severe problem behavior, and the inability to exert tight control over environmental conditions. The same authors [33] also listed some solutions to those common problems. For example, in a case of limited assessment time, brief FA (shorter and fewer sessions than in standard FA) may be used, or a single-function test may be implemented, especially when there is information that a behavior serves a specific function. In a case of high-risk behaviors, precursor FA (analysis is not done on the dangerous behavior but on responses that reliably precede its occurrence) was shown to be a viable option. Additionally, latency FA (latency to the first response is measured and the session is terminated after the first response) may be indicated. Finally, in a case of limited environmental control, trial-based FA (assessment is embedded into naturally occurring activities at home or at school) is recommended. One more issue that was discussed by the authors is the need for FA to be implemented by trained personnel. Based on previous research, staff training can be effectively accomplished [36] with only a few hours of instruction; undergraduate students, teachers, and workshop participants were able to conduct FA sessions consistently.

30 YEARS AFTER IWATA *ET AL.* (1982/1994)

In 2012, Hanley published a paper entitled "Functional Assessment of Problem Behavior: Dispelling Myths, Overcoming Implementation Obstacles, and Developing New Lore" [9], in which he discussed the difference between how FA is described in the literature on the subject and the ways in which the procedure can implemented in everyday practice. The author admitted that some of his assertions originated from his research experience conducting functional assessments, but also from his conceptual interpretation of the existing analysis. Hanley wrote that one of the myths associated with functional assessment has to do with an assumed necessity of a least restrictive hierarchical approach to it. Namely, there is a recommendation that clinicians should start the functional assessment process with indirect assessment, during which they can use several available closed-ended instruments, then proceed with descriptive assessments, and finally, if needed, utilize functional analysis. Some of the reasons why Hanley does not recommend this approach to FA are the low reliability and validity of closed-ended instruments, the inadequacy of descriptive measures for identifying behavioral function, and the reliance on standard FA. As an alternative, he proposed [9] a different practice for evaluating problem behavior's sensitivity to environmental contingencies, which he called practical functional assessment or interview-informed synthesized contingency analysis.

The first part of the process is a thorough interview and direct observation of the client's behavior in a natural environment so that ecologically valid and controlling variables specific to the individual are discovered. Hanley proposed a set of questions to ask individuals who know the client well to gain information that will inform the design of the functional analysis. The second part of the process is an individually planned functional analysis that consists of two conditions only: test and control. The test condition is proposed based on the information from the interview and direct observation and is intimately matched to the test condition, in the respect that only the contingency between problem behavior and the putative reinforcer is removed. This test–control analysis was presented as an alternative to the standardized, comprehensive functional analysis, which typically involves multiple test conditions that evaluate generic contingencies and a single control condition that varies from the test conditions in multiple ways. According to Hanley, both steps of the process are essential to the functional assessment process. However, he also stated that the whole process involves highly specific skills that should not be expected to be in the repertoire of teachers, social workers, speech and language pathologists, or even psychologists without the BCBA credential. Thus, Hanley recommended that what a behavior analyst should "export" to the other professionals who deal with a client with problematic behaviors is some fundamental assumptions on which functional assessment is based. Namely, that problem behavior is learned like any other behavior and if it continues to be exhibited, it must be reinforced. The procedure of functional assessment, on the other hand, should be conducted only by behavior analysts.

The year 2012 marked the thirtieth anniversary of the publication of Iwata *et al.* (1982/1994) [5]. A special issue of the "Journal of Applied Behavior Analysis" (JABA) devoted to functional analysis commemorated this occasion and was published in 2013. In this issue, Beavers *et al.* (2013) [37] published an update of Hanley's (2003) [8] review. They included studies on functional analysis that were published between 2001 and 2012. 158 studies met the inclusion criteria. Those studies were published in 26 different journals, but – similarly to Hanley's results – most of the research was disseminated in JABA. When the rate of publication is considered across the span of both reviews (i.e., 1961-2012), the number of studies rose rapidly between 1986 and 2000; since then, the rate of publication has stabilized at about 15 per year. Most studies were done with children, and in general with individuals with developmental disabilities. However, the percentage of research using people without intellectual disabilities rose from 9% to 21.5% when compared to the findings of Hanley *et al.* (2003). Hanley and colleagues found that most of the studies they included in their review were conducted in healthcare settings and educational institutions, and the findings of Beaver *et al.* corroborate this. However, there was a significant drop in hospital-based research (from 25.3% to 6.3%), while home-based and outpatient clinic-based research both increased significantly (7.6% to 15.8% and 7.6% to 21.5%, respectively). The topographies studied were very similar to those reported by Hanley (i.e., SIB, aggression, disruption); however, the number of studies on SIB decreased noticeably relative to the data reported by Hanley *et al.* (from 64.6% to 37.3%). As for the outcome data, differentiated FAs decreased slightly when compared to the results of Hanley (2003), but they showed some maintenance patterns – mostly negative or positive social reinforcement and with automatic reinforcement-maintained problem behavior in 17% of cases. The percentage of cases in which problem behavior was maintained by multiple contingencies increased from 14.6% to 24.3%, which may have been due to aggregating multiple response topographies in a single FA.

In the discussion, Beavers *et al.* (2013) [37] referred to the recommendations proposed by Hanley in 2003 [8]. The authors noted that the suggestion of limiting the use of the tangible condition was even more relevant, as the second review revealed the unnecessary inclusion of a tangible condition (i.e., one not based on information from the pre-assessment interview) produced a false positive outcome. Another of Hanley's recommendations dealt with the more frequent use of brief FA, especially in cases of severe problem behavior. However, Beavers *et al.* (2013) showed that brief FA continued to be used in a small percentage of studies. The second review also discussed the issue of supplementary assessment prior to FA. Specifically, the authors emphasized that although results of descriptive analyses had been found to be poor predictors of FA outcomes, they may be helpful in excluding an unlikely function. This, in turn, will impact the efficiency of FA as some conditions may be omitted. Beavers *et al.* (2013) concluded that in the 30 years since the publication of Iwata *et al.* (1982/1994) [5], FA methodology had become an essential part of behavioral assessment, both in applied behavior analysis and in related fields. Improving the efficiency of FA procedures and extending this type of assessment to other populations (e.g., gerontology) are still important goals.

When readers look comprehensively at the Hanley (2012) [9] article, the recommendations of Hanley *et al.* (2003) [8] and Beavers *et al.* (2013) [37], and Hanley's (2014) [38] empirical data, Coffee *et al.*'s (2020) [39] review comes as an expected scientific "next step". Namely, the authors appraised an emerging literature base on an extension of the original FA format – the interview-informed synthesized contingency analysis (IISCA). The IISCA starts with an open-ended interview, followed by synthesized antecedents and consequences that mimic the contingencies in the natural environment in which

the problem behavior usually occurs. During the IISCA process, brief (3-5 min) matched test and control sessions are alternated. These conditions assess the sensitivity of multiple forms of problem behavior to one unique reinforcement contingency, composed of synthesized establishing operations and reinforcers reported by caregivers to occur in an ecologically relevant setting. The rationale behind the IISCA is to address some of the limitations to the standard FA (e.g., length of the procedure, resources required, risk factors, and lack of individualization of the contingencies). Coffee *et al.* (2020) included in their review 17 studies on IISCA published between 2012 and 2018. Six of the 17 studies were conducted by scholars not associated with Hanley's research laboratory. The papers were found in five journals and included a total of 102 IISCA applications with 89 participants. Most participants were under the age of 21 and had a diagnosis of autism spectrum disorder, although many other diagnoses were also present. The settings in which IISCA was conducted included outpatient clinics, homes, schools, and day habilitation programs. The median length of the whole assessment (interview and FA) was about 75 minutes and the authors concluded that IISCA could be completed within one 90-min outpatient visit. The IISCA produced effective treatment gains (i.e., 90% reductions in problem behavior) across all studies. Furthermore, in half of the studies, 100% reductions were shown. Problem behavior, then, was eliminated, or nearly eliminated, and improved social skills were reported when treatments were informed by the IISCA. Functional communication training (FCT) was the intervention in almost all the studies. Social validity was assessed for 40% of participants and the rating of the parents' satisfaction was high. Only 20% of the IISCA studies assessed maintenance and 47% evaluated generalization. Treatment integrity was tested in 20% of the IICSA studies that included an intervention component. The treatment was typically implemented as prescribed. The authors concluded that the available data support the previous descriptions of the IICSA as an efficacious, effective, and efficient procedure that results in "meaningful" outcomes. Many studies indeed generated large and socially valid changes in problematic behavior. However, treatment integrity, generalization, and maintenance need to be further explored to improve the overall effectiveness of the IICSA.

THE CURRENT STATE OF AFFAIRS

The most recent review of the functional analysis literature was published by Melanson and Fahmie (2023) [40]. The authors examined the innovative work within the subject area that was published between 2012 and 2022. Three hundred and twenty six studies from a collection of 48 journals were included in the review. JABA, once again, was the journal in which most FA research was disseminated, but functional analysis studies were published in a broader range of journals than in the previous 30 years. Participant age and disability were similar to the other two reviews – that is, most studies included child participants with developmental disabilities. Most of them were conducted in outpatient clinics, which was a significant change when compared with data reported by Beavers *et al.* (2013) [37] and Hanley *et al.* (2003) [8]. The second most common setting was school and the third was home. Functional analyses were conducted in inpatient hospital units, according to the most up-to-date review, had decreased substantially. The response topographies that were most common were: aggression, SIB, and disruption. Most studies incorporated an antecedent-behavior-consequence (ABC) functional analysis model in which researchers manipulated both the antecedent and consequence variables during the assessment. The same result was reported in the two previous reviews. Supplementary assessment (descriptive or indirect) was included in 25.8% of the studies in the current review, an increase on the number reported by Beavers *et al.* (2013) and Hanley *et al.* (2003). Overall, the combined results of the three reviews show that the outcomes of descriptive and indirect assessments are not often reported in the functional analysis literature. The most common type of condition was a test for social-positive reinforcement (attention or tangible). It was an element in 94% of FAs. A test for social-negative reinforcement was reported in 89% of FAs, and a test for automatic reinforcement was included in about 50% of studies. Most studies incorporated functional analyses with multiple test conditions (89.3%). A single test condition was present in 15.6% of the studies. As for session duration, 10-min sessions were the most common (41.7%), followed by 5 min (35.6%), 15-min (12.7%), and other duration (11.6%). The most common session duration other than 5, 10, or 15 min was 2 min (33.9%). Based on the three reviews, it is apparent that there has been a trend toward shorter sessions. The experimental design implemented most often to compare test and control conditions was the multielement design (67.2%), but there was a substantial increase in the usage of the pairwise design. This change may be because recent studies on the IICS use a pairwise experimental design. Like the previous review papers, a great majority of outcomes (91.1%) showed differentiated responses and 8.9% of outcomes were undifferentiated. Problem behavior maintained by a single function was obtained in 61.0%, a smaller proportion than Hanley *et al.* (2013) and Beaver *et al.* (2013). Conversely, the multiply maintained problem behavior ratio increased to 39.0%. The most common single function reported was escape, followed by automatic reinforcement, attention, and tangible. Multiple control outcomes were most likely to be a blend of escape and tangible reinforcement functions, next was a combination of escape, attention, and tangi-

ble, then escape and attention, and finally attention and tangible.

In their discussion section, Melanson and Fahmie (2023) [40] reminded their readers of the 10 best practice recommendations proposed by Hanley *et al.* (2003) [8] and reevaluated by Beavers *et al.* (2013) [37]. Two of these suggestions were followed at the time of the evaluation by Beavers *et al.* (2013). The first issue was the length of functional analysis sessions, while the second highlighted the growing reliance on the ABC functional analysis model. However, as Melanson and Fahmie point out, over the previous 20 years scholars in the field of functional analysis have departed from several of the other suggestions given by Hanley *et al.* There is, for instance, a movement in the opposite direction of the advice to restrict response classes to only a few behavioral topographies. In the latest review, the authors showed that the procedure was implemented on more than one topography in a little less than 50% of cases of FA. The inclusion of a test for tangible reinforcement represents a second departure from previous recommendations for best practice. Over the past two decades, the prevalence of the tangible test and tangible reinforcement functions has increased. The recommendation to include testing for the automatic reinforcement function was given scant attention in the prior evaluation by Beavers *et al.* (2013). A test for automatic reinforcement was included in 59.6% of the studies reviewed by Hanley *et al.* Twenty years on, researchers have incorporated an automatic reinforcement test into 51.6% of their studies. This decline may be related to the widespread use of IICSA, which rarely contain alone or neglect conditions. Melanson and Fahmie state that FAs continue to be relevant, which can be seen from the fact that 42.8% of all functional analysis studies have appeared in the last decade. One important aspect of successfully disseminating information about behavioral assessment is the variety of journals that publish the results of functional analysis research. Of special importance is that many recent reviews have been published on FA of various types of problem behaviors (e.g., elopement, tics, inappropriate mealtime behavior, verbal behavior), of diverse implementation schemas (e.g., brief functional analysis methodology, precursor functional analysis methodology, methodological variations, trial-based methodology, idiosyncratic functional analysis variables), and of a variety of implementers (e.g., caregiver-implemented functional analyses, functional analyses in public school settings, direct-care staff data collection). As for participant and setting characteristics, it was noted that child participants and participants with autism vastly increased in the last review and were included in nearly 90% and 75% of all studies, respectively. Unfortunately, over the past decade the number of studies that include an FA of the behavior of the neurotypical population has decreased. The current review also noted a rise in the variety of lab groups performing telehealth functional assessments. In summary, Melanson and Fahmie write that functional analysis research has grown significantly over the past decade and that methods have evolved to improve the efficiency of the process (such as reduced session duration), safeguards (such as new experimental designs), and practicality (such as synthesized conditions). Scholars in the field of functional analysis have also begun to investigate uncharted territories to assess and enhance the predictive validity of functional analysis results.

CONCLUSIONS

For the past 85 years, the concept of assessing functional relations between environmental events and behavior has been present in behavior analysis. The use of functional analysis methodology as an assessment tool was described 40 years ago. The core features of standard functional analysis included (a) multiple test conditions, (b) uniform test conditions, (c) isolated test components, and (d) a play control condition (41). Since then, replication and extension have been reported in hundreds of published studies. The wide-scale adoption of FA in clinical research is obvious. However, in the three decades following Iwata *et al.* (1982/1994) [5] there has been limited extension from research to practice. FA's applicability to typical service settings has been questioned because of its time-consuming nature. Expertise in conducting FA has also been considered a disadvantage. It has been suggested that traditional FA conditions may be too limited to accurately account for potential maintenance contingencies. FA may also be unsuitable for use with certain types of problem behaviors, such as those that could harm the individual or others. The literature on the subject clearly shows that refinements have been aimed not only at improving some of the methodological characteristics of FA but also at adapting the strategies for real-world application. Some of the most common variations to standard FA include: brief FA, trial-based FA, latency-based FA, precursor FA, and most recently IISCA. Hanley (2011) [42] summarizes the main characteristics of the practical functional assessment (also known as IISCA) approach to treating problem behaviors. It includes: 1) favoring functional analysis over lengthy non-experimental assessment methods as a pre-treatment evaluation of environmental contingencies related to problem behavior, 2) understanding that there is no standard FA, 3) accepting the necessity to tailor each analysis to the individual client, 4) starting the process of designing an FA with a brief open-ended interview with people who know the client very well, 5) making sure that the FA has the necessary scientific rigor ensured by the direct observation and measurement of problem behavior under at least two different conditions (test–control analyses that differ only in that the test condition includes the putative reinforce-

ment contingency, and the control condition does not), 6) understanding that maintaining contingencies may be synthesized, not presented in isolation, and therefore most likely emulate natural environment contingencies, and 7) designing, on the basis of the interview-informed analysis, a comprehensive skill-based treatment. Additionally, during the process of designing an effective functional analysis, a working partnership between individuals who have a relevant history with the client (e.g., parents, caregivers or teachers) and an expert in FA and contingency management (e.g., a board-certified behavior analyst) is very important. Such collaboration, according to Hanley, is necessary to ensure that there is a balance between the ecological validity and the experimental integrity of the analysis. Using information from the caregivers obtained during open-ended interviews increases the probability that the test-control conditions will reflect the contingencies maintaining the problem behavior in the natural environment. Relying on the behavior analyst's skills, such as direct measurement of behavior, single-subject experimental designs, data graphing, analysis, and interpretation, reinforcement schedules and behavioral processes, warrants that the functional analysis process is truly behavioral, analytical and experimental.

The utility of this approach can be seen in recent research on IISCA that offered empirical support for the practical functional assessment model. Sustainable and socially meaningful reductions in problem behavior have been obtained in a safe, efficient, and ecologically valid manner [39]. Some of the limitations of the conducted studies include circumscribed demographics (mostly children and adults with developmental disabilities) and contexts (public school classrooms or outpatient clinics), an inability to determine control of individual contingencies when more than one is synthesized in the analysis, and the relatively small number of investigations on procedural modifications to the IISCA. More research is needed that addresses different topographies of problem behavior and is conducted in a variety of settings (e.g., inpatient hospitals where the most severe forms of problem behavior are treated). Future exploration could also focus on learning more about the few aspects in which IISCA differs from standard FA. First, as IISCA starts with an open-ended interview to design further analysis, it would be advantageous to know the most efficient set of questions to gather the needed information. This is very important if the interventionist aims to capture the nuances of natural environment contingencies so that they can be used in the test condition. Hanley (2011, 2012) [9, 42] provides an open-ended interview guide, but this group of queries has not been investigated experimentally. Another aspect of IISCA to investigate in future studies is the use of synthesized contingencies for the test and control conditions. The synthesis is intended to more closely align with the natural contexts identified in the interview process. Since IISCA-based treatment will be implemented by the client's caregivers, we should know whether the synthesized contingencies are related to better or worse treatment integrity than in the case of isolated contingencies. Further, there have been very few studies that implemented procedural variations of IISCA. Researchers do not know yet how to proceed, other than going back to the open-ended interview, when the results of the test and control conditions during the analysis stage are undifferentiated. Finally, IISCA is not intended to detect automatically maintained problem behavior. Thus, future research could investigate methods within the practical functional assessment model to rule out the socially mediated reinforcement and design of test and control conditions to ascertain the automatic function of problem behavior. To conclude, in 1994 Mace [16] wrote the following statement in the last paragraph of his article on the significance and future of functional analysis: *Perhaps more significantly, it [the Iwata et al. 1982 publication] has renewed the analytic spirit in applied behavioral psychology and has contributed to closer connections between the basic and applied analysis of behavior* (p. 389). When considering the status of current functional analysis methodology, I would modify the quote so that it emphasizes the very interesting developments related to practical functional assessment and its contributions to developing socially meaningful outcomes in the evaluation and treatment of problem behavior. It could be phrased as follows: IISCA has renewed the applied and generalizable aspect of functional analysis and has contributed to a closer connection between the fundamental assumptions of problem behavior, the behavior analysts' work, and the needs of clients and their families.

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References

1. Miltenberger RG, Valbuena D, Sanchez S. Functional assessment of challenging behavior. Curr Develop Dis Rep 2019; 6: 202-208.
2. Matson JL. Handbook of Applied Behavior Analysis for Children with Autism. Springer; 2023.
3. Jeong Y, Copeland SR. Comparing functional behavior assessment-based interventions and non-functional behavior assessment-based interventions: a systematic review of outcomes and methodological quality of studies. J Behav Educ 2019; 29: 1-41.
4. Schlinger HD, Normand MP. On the origin and functions of the term functional analysis. J Appl Behav Anal 2013; 46: 285-288.
5. Iwata BA, Dorsey MF, Slifer KJ, Bauman KE, Richman GS. Toward a functional analysis of self-injury. J Appl Behav Anal 1994; 27: 197-209.
6. Melanson IJ, Fahmie TA. Functional analysis of problem behavior: a 40-year review. J Appl Behav Anal 2023; 56: 262-281.
7. Oliver AC, Pratt LA, Normand MP. A survey of functional behavior assessment methods used by behavior analysts in practice. J Appl Behav Anal 2015; 48: 817-829.
8. Hanley GP, Iwata BA, McCord BE. Functional analysis of problem behavior: a review. J Appl Behav Anal 2003; 36: 147-185.
9. Hanley GP. Functional assessment of problem behavior: dispelling myths, overcoming implementation obstacles, and developing new lore. Behav Anal Pract 2012; 5: 54-72.
10. Mayville EA, Mulick JA. Behavioral Foundations of Effective Autism Treatment. Sloan Pub; 2011.
11. Skinner BF. The Behavior of Organisms: An Experimental Analysis. Appleton-Century; 1938.
12. Skinner BF. Science and Human Behavior. Macmillan; 1953.
13. Baer DM, Wolf MM, Risley TR. Some current dimensions of applied behavior analysis. J Appl Behav Anal 1968; 1: 91-97.
14. Cooper JO, Heward WL, Heron TE. Applied Behavior Analysis, Global Edition. Pearson Education, Limited; 2020.
15. Hineline PN, Groeling, SM. Behavior analytic language and interventions for autism. In: Mayville E, Mulick J (eds.). Behavioral Foundations of Effective Autism Treatment; 2011, p. 35-55.
16. Mace FC. The significance and future of functional analysis methodologies. J Appl Behav Anal 1994; 27: 385-392.
17. Lovaas OI, Freitag G, Gold VJ, Kassorla IC. Experimental studies in childhood schizophrenia: analysis of self-destructive behavior. J Exp Child Psychol 1965; 2: 67-84.
18. Lovaas OI, Simmons JQ. Manipulation of self-destruction in three retarded children. J Appl Behav Anal 1969; 2: 143-157.
19. Wolf M, Risley T, Mees H. Application of operant conditioning procedures to the behaviour problems of an autistic child. Behav Res Therapy 1963; 1: 305-312.
20. Jones FH, Simmons JQ, Frankel F. An extinction procedure for eliminating self-destructive behavior in a 9-year-old autistic girl. J Autism Childhood Schizophr 1974; 4: 241-250.
21. Carr EG, Newsom CD, Binkoff JA. Stimulus control of self-destructive behavior in a psychotic child. J Abnormal Child Psychology 1976; 4: 139-153.
22. Berkson G, Davenport RK. Stereotyped movements of mental defectives. I. Initial survey. Am J Mental Defic 1962; 66: 849-852.
23. Rincover A. Sensory extinction: a procedure for eliminating self-stimulatory behavior in developmentally disabled children. J Abnorm Child Psychol 1978; 6: 299-310.
24. Carr EG. The motivation of self-injurious behavior: a review of some hypotheses. Psychol Bull 1977; 84: 800-816.
25. Weeks M, Gaylord-Ross R. Task difficulty and aberrant behavior in severely handicapped students. J Appl Behav Anal 1981; 14: 449-463.
26. Shahani DB, Carr JE, Petursdottir AI, Esch BE, Gillett JN. Scholarly productivity in behavior analysis: the most prolific authors and institutions from 1992 to 2001. Behavior Analyst Today 2004; 5: 235-243.
27. Broussard C, Northup J. The use of functional analysis to develop peer interventions for disruptive classroom behavior. Sch Psychol Q 1997; 12: 65-76.
28. Piazza CC, Bowman LG, Contrucci SA, Delia MD, Adelinis JD, Goh HL. An evaluation of the properties of attention as reinforcement for destructive and appropriate behavior. J Appl Behav Anal 1999; 32: 437-449.
29. Fisher WW, Piazza CC, Chiang CL. Effects of equal and unequal reinforcer duration during functional analysis. J Appl Behav Anal 1996; 29: 117-120.
30. Mace FC, Lalli JS. Linking descriptive and experimental analyses in the treatment of bizarre speech. J Appl Behav Anal 1991; 24: 553-562.
31. Beavers GA, Iwata BA. Prevalence of multiply controlled problem behavior. J Appl Behav Anal 2011; 44: 593-597.
32. Virues OJ, Clayton K, Pérez BA, Gaerlan BFS, Fahmie TA. Functional analysis patterns of automatic reinforcement: A review and component analysis of treatment effects. J Appl Behav Anal 2022; 55: 481-512.
33. Iwata BA, Dozier CL. Clinical application of functional analysis methodology. Behav Anal Pract 2008; 1: 3-9.
34. Desrochers MN, Hile MG, Williams-Moseley TL. Survey of functional assessment procedures used with individuals who display mental retardation and severe problem behaviors. Am J Mental Retardation 1997; 101: 535-546.
35. Ellingson SA, Miltenberger RG, Long ES. A survey of the use of functional assessment procedures in agencies serving individuals with developmental disabilities. Behav Interv 1999; 14: 187-198.

36. Iwata BA, Wallace MD, Kahng S, et al. Skill acquisition in the implementation of functional analysis methodology. J Appl Behav Anal 2000; 33: 181-194.
37. Beavers GA, Iwata BA, Lerman DC. Thirty years of research on the functional analysis of problem behavior. J Appl Behav Anal 2013; 46: 1-21.
38. Hanley GP, Jin CS, Vanselow NR, Hanratty LA. Producing meaningful improvements in problem behavior of children with autism via synthesized analyses and treatments. J Appl Behav Anal 2014; 47: 16-36.
39. Coffey AL, Shawler LA, Jessel J, Nye ML, Bain TA, Dorsey MF. Interview-informed synthesized contingency analysis (IISCA): novel interpretations and future directions. Behav Anal Pract 2020; 13: 217-225.
40. Melanson IJ, Fahmie TA. Functional analysis of problem behavior: a 40-year review. J Appl Behav Anal 2023; 56: 262-281.
41. Jessel J, Hanley GP, Ghaemmaghami M. On the standardization of the functional analysis. Behav Anal Pract 2020; 13: 205-216.
42. Hanley GP. Functional analysis. In J. Luiselli (Ed.), Teaching and behavior support for children and adults with autism spectrum disorder: A "how to" practitioner's guide. New York: Oxford University Press; 2011.