Functional analysis in behavior therapy: Behavioral foundations and clinical application[1]

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ABSTRACT. This theoretical study reviews the theoretical and applied foundations of a functional analysis strategy in clinical case-formulation. Functional relations between variables are those that demonstrate a mathematical association. Causal functional relations between variables require: (a) covariance, (b) a logical connection, (c) temporal precedence of the causal variable, and (d) absence of a third variable explaining the relation. There are unidirectional, bidirectional, moderating, and mediating (i.e., explanatory) causal functional relations. In a functional analysis the relevant, controllable, and causal functional relations that apply to particular behaviors of an individual are identified. A functional-analytic approach to case-formulation is designed to minimize clinical judgment bias and optimize clinical decision-making in the assessment and treatment processes. Additional features of a functional analysis and its use for intervention design are discussed within the context of a patient diagnosed with Schizophrenia Paranoid Type. This article also considers the conditional nature and limitations of a functional-analytic approach in clinical psychology.

KEYWORDS. Clinical case-formulation. Functional analysis. Functional relationship. Schizophrenia. Theoretical study.

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RESUMEN. En este estudio teórico se revisan los fundamentos teóricos y aplicados de un modelo de análisis funcional en formulación clínica de casos. Las relaciones funcionales entre variables demuestran una asociación matemática; el subconjunto de relaciones funcionales causales requiere además: (a) covarianza, (b) conexión lógica, (c) precisión temporal de la variable causal y (d) exclusión de terceras variables que expliquen la relación. Hay relaciones funcionales cuasales unidireccionales, bidireccionales, moderadoras y mediadoras (explicativas). En el análisis funcional se identifican las relaciones funcionales relevantes, controlables y causales que se asocian a determinados comportamientos del individuo. Una aproximación analítico-funcional a la formulación clínica de casos está concebida para minimizar los sesgos de juicio clínico y optimizar la toma de decisiones durante los procesos de evaluación y tratamiento. Aspectos adicionales del análisis funcional y de su uso para el diseño de intervenciones se ilustran en el contexto de un caso diagnosticado de esquizofrenia tipo paranoide; entre ellos, un modelo matemático sencillo para estimar la eficacia del tratamiento basado en análisis funcional. Finalmente, consideramos las limitaciones en el contexto clínico de la aproximación al análisis funcional propuesta.

PALABRAS CLAVE. Formulación clínica de casos. Análisis funcional. Relación funcional. Esquizofrenia. Estudio teórico.

RESUMO. Neste estudo teórico revêem-se os fundamentos teóricos e aplicados de um modelo da análise funcional em formulação clínica de casos. As relações funcionais entre variáveis demonstram uma associação matemática; o subconjunto de relações funcionais causais requer: (a) covariância, (b) conexão lógica, (c) precisão temporal da variável causal e (d) exclusão de terceiras variáveis que expliquem a relação. Há relações funcionais causais unidireccionais, bidireccionais, moderadoras e mediadoras (explicativas). Na análise funcional identificam-se as relações funcionais relevantes, controláveis e causais que se associam a determinados comportamentos do indivíduo. Uma aproximação analítico-funcional à formulação clínica de casos está concebida para minimizar os viés de juízo clínico e optimizar a tomada de decisões durante os processos de avaliação e tratamento. Aspectos adicionais da análise funcional e do seu uso para o planeamento de intervenções ilustram-se no contexto de um caso diagnosticado com esquizofrenia tipo paranoide; entre eles, um modelo matemático sensível para estimar a eficácia do tratamento baseado na análise funcional. Finalmente, consideramos as limitações no contexto clínico da aproximação à análise funcional proposta.

PALAVRAS CHAVE. Formulação clínica de casos. Análise funcional. Relação funcional. Esquizofrenia. Estudo teórico.

Introduction

Clinical case-formulation in psychological assessment is often discussed but infrequently the topic of empirical research. Although significant contributions have been made (Buela-Casal and Sierra, 1997; Eels, 1997; Nezu, Nezu, Peacock, and Girdwood, 2004), clinical case-formulation entry is missing in recent handbooks on psychological assessment (e.g., Goldstein and Hersen, 2000; Groth-Marnat, 1999; see an exception in

Haynes and Heiby, 2004). A clinical case-formulation is a summarization and integration of pre-treatment and/or within-treatment behavioral assessment information about a client (Haynes and O'Brien, 2000, p. 9) that includes a number of clinical decisions. A well-defined case-formulation procedure integrates multiple and heterogeneous sources of information gathered during the assessment phase and can extend into the treatment phase. Within applied settings a clinician may be confronted with large amounts of information from interviews with the patient and caregivers, self-monitoring, questionnaires, observations, and data from medical charts. Assessment information may come from different assessment methods and involve data with varying levels of specificity (e.g., frequency of the behavior *versus* personality traits), validity, and utility.

When clinicians deal with large amounts of information about a client, they sometimes resort to short-cuts in clinical judgments (e.g., using heuristics [Nezu, Nezu, Friedman, and Haynes, 1997]). For example, the clinician may emphasize information that is consistent with his or her theoretical orientation, that confirms early judgments about the person, or that is similar to that from recently treated clients. These biases in clinical decision-making can lead to unreliable or invalid selection of target problems (e.g., Hay, Hay, Angle, and Nelson, 1979; Wilson and Evans, 1983) and errors in the identification of controlling variables (Felton and Nelson, 1984; Godoy and Gavino, 2003). A more systematic strategy of clinical decision-making, such as that associated with the functional analysis, may increase the validity of clinical case-formulation.

The complex features of psychological disorders further increase the importance of a systematic case-formulation procedure. It is often not possible to understand important aspects of a patient's behavior problems through diagnosis. For instance many features (e.g., family interaction patterns, obsessive thoughts, social skills deficits) of depression not delineated in the DSM-IV-TR (American Psychiatric Association, 2000) diagnostic criteria can have a bearing in the patient's problem. In addition, as noted by Dougher and Hackbert (1994), a number of causal processes (e.g., low rate of reinforcement, reinforcement of depressive behaviors, cultural influences), in varying idiosyncratic combinations, may be present in patients with depressive symptoms. Clinical features have been shown to often result from multiple causes. Furthermore, those causal varia-bles could be interrelated in complex ways (e.g., Bandura, 1981; O'Brien and Haynes, 1993).

In summary, a structured case-formulation process may address a number of practical issues in clinical assessment: (a) organizing the results from multiple assessment instruments, (b) reducing bias in clinical judgment (e.g., Garb, 1998), and (c) identifying complex causal variables for behavioral problems (e.g., Bandura, 1981; Haynes, 1992). There are several clinical case-formulation approaches (see compilations of case-formulation models of different orientations in Eels, 1997; and Westmeyer, 2003). Within behavioral psychology, several case-formulation models have been proposed (see Haynes and O'Brien, 1990; Nezu and Nezu, 1993).

One type of behavioral case-formulation is the functional analysis (Haynes, 1994; Haynes and O´Brien, 1990, 2000; Haynes and Williams, 2003; O´Brien and Haynes, 1993, 1997). Functional analysis is defined by Haynes and Associates as the "identification of relevant, controllable and causal functional relations that apply to particular behaviors

of an individual" (Haynes, Uchigakiuchi, Meyer, Orimoto, Blaine, and O´Brien, 1993, p. 191). In a functional-analytic framework the case is formulated in terms of the relations between behavioral features and associated causal and non-causal events. Such relations are estimated from data derived from a number of empirically supported assessment methods, guided by prior empirical research with similar behavior problems.

This theoretical study (Montero and León, 2005) reviews the theoretical and applied foundations of a functional analysis strategy in clinical case-formulation. First, we discuss distinctive features of functional relations. Then, we briefly review the different approaches to functional analysis. Third, we describe a functional analysis in the context of a patient diagnosed with schizophrenia. Finally, we address the conditional nature and limitations of the functional analysis.

Introduction to functional relations and the functional analysis in clinical case formulation

A functional approach to understanding behavior problems considers the behaviors to be conditional in that their occurrence, intensity, or duration can covary with different arrays of causal variables[3]. From this framework, the functional relation between two variables (i.e., causal variable, behavioral variable) implies only that both variables share variance. In other words, two variables are functionally related when they demonstrate a mathematical relation[4] (Haynes, 1992, p. 31; Haynes and O´Brien, 1990).

Although functional relations need not be causal (e.g., Blalock, 1964), the functional analysis emphasizes the importance of causal, modifiable and relevant causal variables, those that most account for the client's behavior problems[5]. These variables, to be

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[3] Several factors have prevented a wide acceptance of the functional character of behavior and they are not to be listed here exhaustively. Ordinarily, we may have been culturally taught to attribute behavior to labels addressing unspecified and unmodifiable causes (e.g., "personality", "madness", "the way someone is"). But personality, for instance, is a collection of correlated behaviors. As a result, it is part of the behaviors to be explained and not part of the explanation itself. In addition, the unobservable character of the causal chains that lead to a particular behavior outcome –including factors like the impact of private behaviors, complex interaction with biological processes, delay between antecedent conditions and behavior, influence of mediating processes, etc. (Bandura, 1982; Russo and Budd, 1987) – make difficult for an external observer to point out the link among independent and dependent events (e.g., early abuse experiences association with depressed mood in the adulthood). Furthermore, as Ferster (1973) indicated, many naturally occurring behaviors might be controlled by variable-interval schedules making impossible for naive observers to discover the functional relation among events (see also Godoy and Gabino, 2003; O'Brien, 1995). Other factors may be adding to this state of affairs (e.g., efficiency tied to immediate external contingencies, reliance on observational methods) that go beyond the scope of this paper.

[4] This definition does not exclude the operant concept of contingency as Perona and Rivas have stated. "[Haynes and O´Brien (1990)] loose the perspective of the contingency...as an interchange...between the individual and the environment, confusing it with the methodological concept of mathematical functional relation....This error leads to the adoption of a purely pragmatic approach. As a result, the functional analysis of behavior is limited to be an organizing script of the described events" (Translated from Perona and Rivas, 1996, pp. 252-253).

[5] «Client» can refer to an individual, family, couple, classroom, work setting, etc.

considered causal, may observe covariation, absence of a third variable explaining the covariance, and a logical connection between them (see Bunge, 1961; Haynes, 1992, p. 32-41). Consider, for instance, the association between social reinforcement and mood. The results from self-monitoring could show that the variables covary (i.e., that reduced social reinforcement is associated with increased depressed mood). In addition, the covariation makes sense from a theoretical and empirically based standpoint (e.g., research on the effects of social isolation on mood). Finally, once alternative variables that would explain such a relation have been ruled out (e.g., when isolated the patient engage in obsessive activities that in turn influence the mood) we can be more confident that low social reinforcement may be one factor that affects the client's mood.

Functional relations can vary in their strength, for example, the degree of covariation between two variables. The strength of a causal functional relation refers to its degree of influence over another variable. For instance, the self-injurious behaviors of a child may be strongly influenced by some consequences (e.g., social attention), but only weakly by others (e.g., tangible reinforcement, aversive stimuli avoidance) (e.g., Iwata, Dorsey, Slifer, Bauman, and Richman, 1994).

Functional relations are also dynamic. When causal variables change, new moderating variables enter the picture, or there are changes in mediating mechanism, behavioral outcomes can also change. For example, a patient's delusional speech can change as a function of changes in life stressors, responses by others to the speech, medication, and the acquisition of alternative communication skills. Functional relations are also non-exclusionary (Haynes, 1992). One set of causal variables does not preclude other causal pathways by which the same behavior could be affected. In other words, there may be several important causal relations for one behavior problem and clinical case formulations can emphasize different permutations of behavioral, environmental, cognitive, and physiological variables. Functional relations and a case-formulation can also be at different levels of specificity. A higher level, more molar, functional relation will link less specific, molar processes (e.g., traits, classes of events, such as «life stressors»). A functional analysis at a molar level can be useful to guide the initial foci of assessment or treatment. Nevertheless, treatment design often benefits from a lower-level (i.e., higher level of specificity) functional analysis.

Within a higher-level analysis of the relations between family interactions and schizophrenic symptoms, a functional relation between conflictive interactions within the family and increased schizophrenic symptoms might be highlighted along with other high-level variables (e.g., medication non-compliance, self-management skills). A lower-level analysis with the same patient might focus on specific types of statements of certain family members (e.g., criticism regarding patient's self-management skills). Functional relations can be unidirectional or bidirectional. In a bidirectional relation both variables affect each other. The bidirectional relations can be reciprocal, unequal, or even opposite in direction. For instance, social avoidance could be a result of the emotional responses elicited by certain social settings (e.g., talking in public). The avoidance in turn makes extinction of anxiety more difficult because it prevents social stimuli from being paired with less distressing emotional reactions. On the other hand, in moderating causal functional relations a variable can influence the strength and the

direction of the relation between two or more other variables (Baron and Kenny, 1986). For instance, the level of marital stress and drug consumption could moderate the degree to which work demands are linked with emotional outbursts. Finally, mediating variables account for, or explain, the relation between two other variables; similar to a "causal mechanism" (Baron and Kenny, 1986; Shadish, 1996). For instance, positive reinforcement could be a mechanism underlying the relation between certain psychotic behaviors and contingent caregivers' attention (e.g., Ayllon and Michael, 1959; Schock, Clay, and Cipani, 1998).

There are several ways to estimate causal relations in a clinical assessment setting (Haynes, Spain, and Oliveira, 1993). These include: (a) systematic manipulation of hypothesized causal variables while observing their effects (i.e., multielement design; see a monograph by Repp and Horner, 1999), (b) mathematical relations based on conditional probability and time-series design[6] (e.g., Haynes and O'Brien, 2000, pp. 255-258; Schlundt, Johnson, and Jarrel, 1985), (c) questionnaires specially designed to identify functional relations (e.g., Motivation Assessment Scale, Durand, 1990), (d) interviews focused on the detection of causal factors, and (e) analysis of the available literature on causal relations regarding the particular behavior problem being analyzed.

Issues of definition: Functional analysis and functional assessment

In psychology and education, the term functional assessment often refers to the assessment of a patient's «level of functioning» (e.g., assessment of self-management or cognitive abilities after a brain injury). Within behavioral psychology, the term «functional analysis» was originally used with reference to the empirical demonstration of the control of behavior by the consequent events (Skinner, 1953, p. 35). Its' application to clinical settings was suggested initially by Ferster (1965) and presented more precisely by F. H. Kanfer. "[A]n effective [functional analysis as a] diagnostic procedure would be one in which the eventual therapeutic methods can be directly related to the information obtained from a continuing assessment of the patient's current behaviors and their controlling stimuli" (Kanfer and Saslow, 1965, p. 533). Cone (1997) tied «functional assessment» to the activities involved in describing and formulating hypothesis about potentially controlling variables, while he tied «functional analysis» to verifying those hypotheses through the manipulation of environmental events. Hanley, Iwata, and McCord

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[6] Conditional probability analyses are statistical procedures. They are used to assess if the target behavior occurrence is conditional upon the occurrence and non-occurrence of other variable. The assessor evaluates the overall probability that the target behavior will occur relative to the probability of its occurrence given that some variable has occurred. If there are substantial differences the assessor concludes that both variables are functionally related. On the other hand, time-series analyses "involve taking repeated measures of the target behavior and one or more causal variables across time. An estimate of the relations among these variables is then calculated after the variance attributable to serial dependency is partitioned. When assessment data are measured at nominal or ordinal levels, Markov modeling and lag sequential analysis can be used to evaluate functional relations (Haynes and O'Brien, 2000, pp. 255-256; see also Barlow and Hersen, 1988; Wei, 1990).

(2003, p. 148) proposed two conceptions of functional analysis. One referred to the identification of causal relations associated with the consequences of behavior and the other, more general, referred to the detection of relations between events[7].

A restricted conception of functional analysis, based on the application of reversal or multielement designs (Baer, Wolf and Risley, 1968, p. 94; Barlow and Hersen, 1988; Sidman, 1974) where controlling events (i.e., antecedent stimuli, reinforcing consequences) are systematically administered, is difficult to implement with behavior problems in which complex, infrequent, and/or unobservable features are involved (e.g., severe conduct disorders, mood disorders). An experimental functional analysis of this sort requires restrictions in the complexity of the behavior to be analyzed: (a) observability, (b) reproducibility, (c) fast reactivity to antecedent or consequent events, (d) amenability to precise measurement (e.g., frequency, duration, intensity), and (e) responsiveness to consequences that can be presented and removed systematically (e.g., attention, tangible rewards, avoidance/escape of aversive events [Iwata *et al.,* 1994]). In fact, within the applied behavior analysis few published studies have analyzed more than a single functional relation at one time (for an example of exception, see Kennedy, Meyer, Knowles, and Shukla, 2000). As Hanley *et al*. (2003, pp. 154-155) indicated, experimental functional analytic procedures have been applied to a narrow range of behavioral disorders (e.g., self-injurious, disruptive/challenging behavior, aggressive behavior) and populations (e.g., children with developmental disabilities).

Because of the multi-causal processes involved in behavior problems, the functional analysis paradigm outlined herein relies on multiple assessment methods and can include multiple response modes. The assessment information from multiple sources is integrated in an hypothesized model of the client's behaviors, causal and correlated variables, and functional relations. In the following section, we present the relevant features of a functional-analytic case-formulation using the example of a patient referred for outpatient treatment.

Mr. Bernal: A 50-year-old male with mocial anxiety and psychotic symptoms

Mr. Bernal is a fifty-year-old outpatient male diagnosed with Schizophrenia Paranoid Type (American Psychiatric Association, 2000). His main referral reasons were his

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[7] Although a terminological update of the term is beyond the scope of this article it should be noted that many connotations of the term functional analysis have been used within behavioral psychology. Among them, Sturmey (1996, pp. 8-19) has pointed out: (a) statements regarding the mathematical form of the relation between variables (e.g., Haynes and O'Brien, 1990), (b) statements associated with the function or the purpose of behavior, (c) a generic and atheoric approach to assessment and case formulation (e.g., Owen and Ashcroft, 1982), (d) descriptive and eclectic functional analysis, (e) descriptive behavioral functional analysis (Ayllon, Haughton, and Hughes, 1965), (f) systematic environmental manipulations oriented to show the functional relation between behavior and discriminative, and reinforcing events (e.g., Baer *et al.,* 1968; Repp and Horner, 1999), and (g) functional analysis as a therapeutic component or method (e.g., Goldiamond, 1975). The relative presence of the abovementioned meanings vary across authors and publications. The reader is referred to Cone (1997), Perona and Rivas (1996) and Sturmey (1996) for further details.

social anxiety and psychotic symptoms. Mr. Bernal lives with his elderly parents. He is single, unemployed, and has been receiving pharmacological treatment for twenty years. His current psychiatrist recommended that Mr. Bernal participate in a functional-analytic behavioral assessment in order to improve his treatment plan. According to his psychiatrist he "has a hard time being around people, thinks that others talk about him, is afraid that people will attack him, and he feels that he is being watched." He also has auditory hallucinations, usually in the form of indistinct voices, delusional verbalizations of paranoid content (i.e., people are able to read his thoughts, people talk about him and insult him), and self-derogatory thoughts when he is with other people (i.e., "I am stupid," while interacting with strangers). When interacting with his parents and with other people he does not know well, Mr. Bernal experiences high levels of anxiety. In these situations, he also has difficulties in expressing his thoughts, in following the topic of conversation, and maintaining eye contact. Mr. Bernal also avoids these social situations leading to almost total social isolation.

The ongoing medication is an atypical inhibitor of serotonin uptake with antidepressant effects (nefazodone, 200 mg/d) and a monoaminergic antagonist of antipsychotic effect (olanzapine, 25 mg/d). Treatment adherence has been variable. Mr. Bernal has received psychotherapeutic attention (i.e, counseling, psychological support) for the last three years, but attends only about half the weekly scheduled sessions.

*Clinical assessment methods*

The assessment strategy was selected on the basis of initial interviews with the client, information from the referral source, and his medical records. Assessment methods included multiple interviews with the patient, family, psychiatrist, and caseworker; self-monitoring of anxiety and psychotic symptoms (e.g., Critical Event Sampling of Anxiety; Craske and Tsao, 1999); mood and anxiety-related self-report measures (e.g., Fear of Negative Evaluation, Watson and Friend, 2001; Obsessive Compulsive Scale, Gibb, Bailey, Best, and Lambirth, 1987); naturalistic observation of his social behavior in two public settings, videotaped analogue observation in different social settings (i.e., someone else in the room, basic interaction with a stranger, advanced interaction with a stranger); and review of his clinical history (see a methods compilation in Haynes and Heiby, 2004).

Functional Analysis and Functional Analytic Clinical Case Model (FACCM)

The assessment methods were focused on the identification of functional relations relevant to his primary behavior problems (i.e., social anxiety, psychotic symptoms, social avoidance behaviors, social isolation, and depressive mood). In addition, the empirical literature relevant to Mr. Bernal's behavior problems was also examined.

Each hypothesized functional relation is derived from the results of multiple assessment procedures. For instance, the relation between interaction with strangers and anxiety responses (see X4-Y1 functional relation in Figure 1) was estimated thorough naturalistic observation, analogue observation, and interviews with the patient and with

FIGURE 1. FACCM (Functional-analytic clinical case model) of Mr. Bernal. The model is supported in a number of assessment strategies: interview oriented to causal relations with patient and significant others, self-inform, self-monitoring, naturalistic observation, analogue observation, clinical chart, and relevant functional relations pointed out by previous literature.
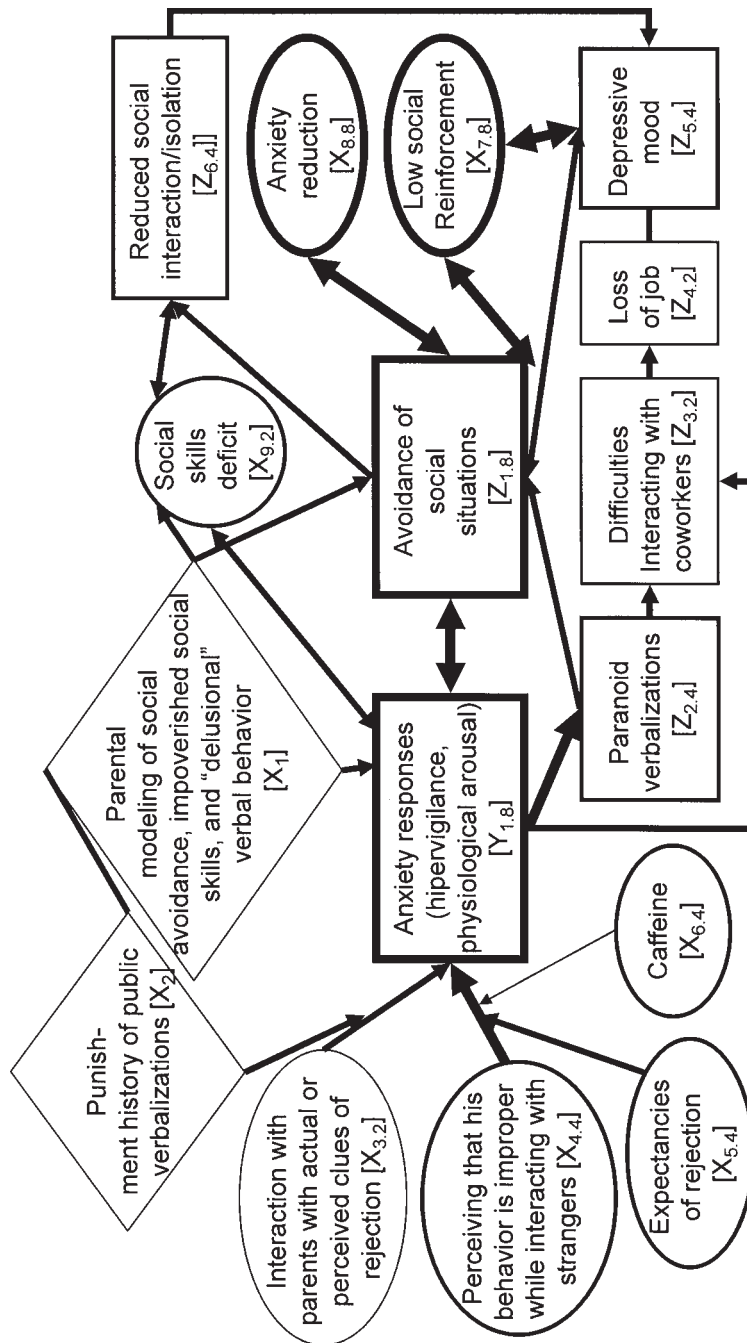
his psychiatrist. The Functional Analytic Clinical Case Model (FACCM) depicted in Figure 1 illustrates the constellation of variables and relations among causal variables, behaviors and effects of behaviors.

FIGURA 2. Legend for the illustration of functional-analytic clinical case models (FACCM). The suggested system considers class, direction, and strength of the functional relations. The importance of the behavioral problem and the modifiability of causal variables are also coded. The estimations assigned to the importance/ modifiability and to the strength of the functional relations should be consider as a ratio measure scale level with regards to the calculations (adapted from Haynes and O'Brien, 2000).
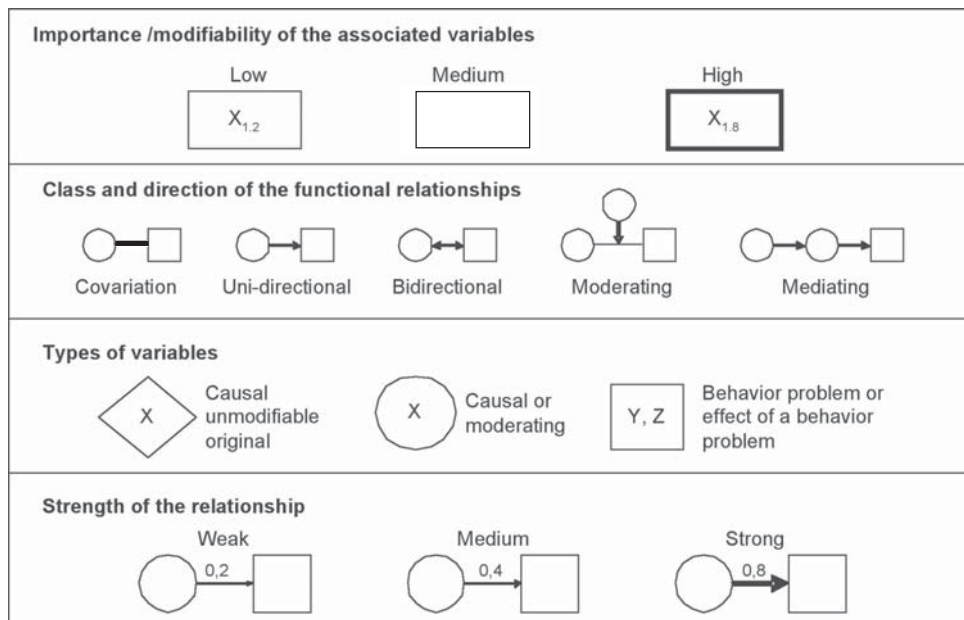
A few authors have used graphic depictions of clinical case-formulation (e.g., Clinical Pathogenesis Maps by Nezu and Nezu, 1989). A FACCM is a vector-graphic diagram of a functional analysis (Haynes, Leisen, and Blaine, 1997). The FACCM includes behavior problems, the importance and relations among behavior problems, the strength and direction of causal and non-causal functional relations, and the modifiability of causal variables. The strength (S) of a functional relation is the estimated degree of correlation between two variables across time for a client. For causal functional relations strength coefficients represent the degree to which change in the causal variable will result in change in the behavior problem. The estimated magnitude is coded with a three-level ordinal scale (i.e., weak, medium, high, see Figure 2). The modifiability of causal variables (M) refers to which degree a causal variable is susceptible to change

through treatment. (A high level of modifiability would be coded as 0.8, medium as 0.4 and low as 0.2). The casual variable modifiability and the estimated importance of the behavioral problem (I) for clients with multiple behavior problems address clinical judgments regarding the best initial treatment focus. Importance is weighted in a three-level ordinal scale (i.e., low: 0.2, medium: 0.4, high: 0.8). In Figure 2, we show basic nomenclature applied in FACCMs. The interested reader will find further details in Haynes (1992, pp. 95-119), Haynes (1994), Haynes and O'Brien (2000, pp. 265-291) and Haynes *et al.* (1993).

The FACCM has several goals: (a) it organizes the assessor's clinical judgments; (b) it encourages a sequential and systematic approach to the multiple judgments involved in clinical-case formulation; (c) it helps identify areas in need of further assessment; (d) it facilitates clinical-case presentations and communication between professionals with different backgrounds, and (e) it illustrates variables affecting treatment goals and guides decisions about which variables should be selected as treatment targets (Haynes and O'Brien, 2000, pp. 285-286).

Mr. Bernal's FACCM

Five main behavioral and emotional problems were identified: anxiety responses (i.e., hypervigilance, subjective distress and physiological arousal) in the presence of his parents and strangers, avoidance of social situations, paranoid/delusional beliefs, social isolation, and depressed mood. Several contemporaneous and noncontemporaneous (i.e., proximal and distal) causal variables for Mr. Bernal's behavior problems were postulated. We hypothesized that parental modeling of social avoidance, impoverished social skills and "delusional" verbal behavior during the childhood led to skill deficits and discomfort in social situations. In terms of current family interactions we observed a high frequency of disapproving and infrequent positive, supportive, nurturing comments from his parents. We hypothesized a past history of punishement of verbalizations involving points of view and personal opinions. These early learning circumstances may have contributed to an isolated childhood and social skill deficits (this hypothesis is consistent with findings by other researchers such as Eisen, Spasaro, Brien, Kearney, and Albano, 2004; Kortlander, Kendall, and Panichelli-Mindel, 1997; Riggio, 2004). The absence of a basic social skills repertoire (e.g., inadequate attention in social situations, inability to start or maintain a conversation) could have led to frequent rejection and subsequent anxiety in social situations. These inferences were confirmed with findings from naturalistic observation of his social behavior in two public settings, videotaped analogue observation (e.g., start and maintain a basic conversation), his self-reports and reports by others. Thus, social skills deficits are considered to be bidirectionally related to the development of conditioned anxiety responses toward the interaction with strangers (see Heinssen and Glass, 1990; Stravynsky and Amado, 2001 and X_7-Y_1 functional relation in Figure 1).

Mr. Bernal's social anxiety involves physiological arousal and hypervigilance for subtle signs of rejection or disapproval from others. On the basis of self-monitoring and interview data, we hypothesized that his anxiety responses are potentiated by caffeine intake. Mr. Bernal avoids most situations in which he would be forced to interact with

strangers. His avoidance of these situations prevents the extinction of his social anxiety. According to self-monitoring data, the rate of paranoid beliefs seems to covary with his anxiety level (see Blalock and Joiner, 2000; Freeman and Garety, 2003; Haynes, 1986 for a discussion on the impact of anxiety and emotional factors on psychotic features). Paranoid delusions may also operate as a cause of avoidance. In addition, Mr. Bernal's social anxiety and paranoid thoughts contribute to his employment difficulties by interfering with his job performance and relationships with his coworkers. Finally, as suggested by data from self-monitoring, interview and previously published studies, his social avoidance behaviors lead to a low rate of social reinforcement, contributing to his depressed mood (see Ferster, 1973 and Ottenbreit and Dobson, 2004 for a discussion on the avoidance-depression relation).

Functional response classes

If several behavior problems demonstrate similar functional relations with contextual and consequent variables, they can be part of the same functional response class. For instance, physical avoidance of social situations and paranoid verbalizarions, although topographically different could be, in Mr. Bernal case, associated with the same causal functions. In this case, physical and "cognitive" avoidance (i.e., social isolation, delusional beliefs and verbalization) can be triggered by the same situations and be reinforced through anxiety reduction. Functional response classes can be useful in clinical case formulation because they simplify clinical judgments and can suggest alternative, more desirable behaviors that might be part of the same functional response class[8].

Level of specificity

As we indicated earlier, a functional relation can be described at different levels of specificity. In the case of Mr. Bernal, at a less specific level, inadequate parental models during childhood contributed to paranoid ideation in adulthood. At a more specific level, we could emphasize the role of parental modeling of social avoidance, impoverished social skills, and paranoid verbalizations, reinforcement of the patient's paranoid verbalizations, and insufficient reinforcement of prosocial behaviors. Both levels of the functional analysis can be valid and useful for different purposes (e.g., the first for selecting an initial target problem from many and the second for selecting an

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[8] A functional criterion of grouping responses is a key concept in the construction of a functional analysis. Other grouping criteria (e.g., statistical, diagnostic, trait-based questionnaires), could be misleading in this respect. In other words, they are not designed to detect causal, but statistical associations. Furthermore, a functional analysis that uses diagnoses or traits as the unit of analysis will show considerable shortcomings: (a) the diagnoses or trait is abstracted from the common aspects of agroup of subjects (i.e., covariations of behaviors derived from idiosyncratic history will be neglected), (b) behaviors may by correlated for different causes aside from the sharing of a functional class (e.g., correlated behaviors in a questionnaire do not discriminate between causes and behaviors), (c) the traits and diagnoses are usually at a high level of specificity (i.e., they can hardly be used in case-formulation and intervention designs), and (d) they usually assume the invariant nature of behavior (see Bisset and Hayes, 1999; Hayes and Follete, 1992; Nelson-Gray and Paulson, 2004; O'Brien and Haynes, 1988; Tryon, 1999).

initial causal variable from the many that affect the selected target problem [see Haynes, 1992, p. 27]).

Domain of functional relations

The validity of a functional analysis can be limited because causal relations often operate only within certain conditions. For example, Mr. Bernal's avoidance behaviors and their negative reinforcement functions occur only in certain social situations (i.e. when he perceives rejection). Functional relations may be limited to certain states (e.g., medicated, not medicated; after caffeine intake, without caffeine intake, etc.) and situations (e.g., aggression reinforced by peers may occur only in the classroom, causes of delusions can be different inside vs. outside a psychiatric hospital, etc.).

Treatment selection and design

The goal of a functional analysis-based clinical case-formulation is to increase the validity of clinical decision-making, particularly in the design or refinement of interventions. Manualized treatments match a patient's behavior problems or diagnosis with a particular empirically based treatment. With manualized treatments, intervention strategies are implemented without respect to the causal variables that operate for an individual patient. For instance, a smoking-cessation behavioral contract arranges contingencies for smoking regardless if whether smoking is functionally related to coping with daily stressors, the consumption of other psychoactive substances, a physical dependence, social facilitation, or other idiosyncratic causal variables. In contrast, treatments based on a functional analysis address the variables that maintain behavior problems for an individual patient. For instance, if a functional analysis shows that a child's aggressive behavior is causally related to modeling and intermittent reinforcement by his or her parents (e.g., Patterson, 1986), the child might benefit from an intervention focused on the family interactions.

Functional analytic clinical case models

A Functional Analytic Clinical Causal Model (FACCM) is a vector diagram that summarizes the functional analysis for a patient. The FACCM is designed to illustrate, organize, and clarify the clinician's judgments about the components of the functional analysis for a single patient. It includes estimates of the importance of and interrelationships among behavior problems, causal variables, the modifiability of causal variables, and the direction, form, and strength of causal and non-causal relationships. A FACCM is a visual representation of the clinician's judgments about a patient's behavior problems, goals, and the variables that affect them. The FACCM is intended to promote a careful and sequential clinical case formulation, to improve communication among professionals and students about a clinical case formulation, to break down the multiple judgments of the functional analysis into its component parts, and to encourage a step-by-step approach to treatment-related judgments. The primary purpose of the FACCM is to increase the degree to which treatment decisions are influenced by assessment data for an individual patient. Although FACCMs can be presented without quantitative indexes,

they can also be used to calculate expected treatment effects, based on a number of parameters (i.e., modifiability [M] $\Diamond$ strength of the relation [S] $\Diamond$ importance of the behavioral problem [I]). The index can be used to illustrate the relative impact of the causal variable on the behavior problem and, consequently, the selection of causal variables that are to be the focus of treatment. In the case of Mr. Bernal (Figure 1), an intervention focus on the causal variable "perceiving that his behavior is improper while interacting with strangers [X_4]" would have the maximum treatment effect over anxiety responses ($M_{X4} \Diamond S_{X4-Y1} \Diamond I_{Y1} = 0.4 \Diamond 0.8 \Diamond 0.4 = 0.26$) assuming the values listed in Figure 2. A further step involves matching the most important functional relations with treatment mechanisms (Haynes, Kaholokua, and Nelson, 1999). Once the functional relations have been estimated, the treatment should be chosen that has the largest estimated impact on the behavior problems (Haynes and Williams, 2003).

FIGURE 3. Hypothetical functional model of the treatment effectiveness. The effectiveness is a function of the compatibility between treatment mechanisms (M_i) and causal variables (X_i), the strength of the relationship between causal variables and the behavioral problem (Y_i) and its modifiability. Within this framework second-order effects would be expectable as the causal variable intervened is functionally related with other behavior problems. As a result, reduced paranoid ideation, lesser avoidance of social situations and social skills improvements are expected. In this example only one behavioral problem is addressed (i.e., Y_1), an actual treatment program would benefit from modifying several causal variables. Nevertheless, other causal variables not addressed in the model are affected by the treatment mechanisms chosen (e.g., M_1 and M_3 will affect "low social reinforcement [X_7]" that in turn will reduce "depressive mood [Z_5]").
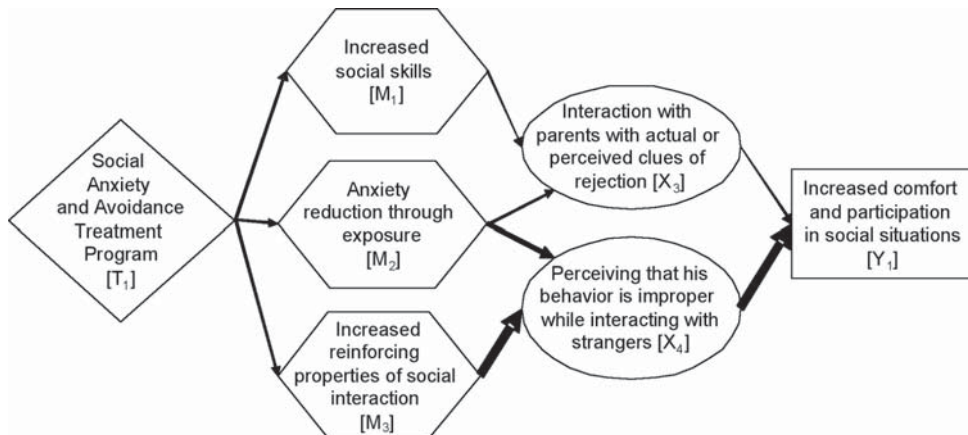
A hypothetical model considering the compatibility between treatment mechanisms and causal variables in Mr. Bernal's case is depicted in Figure 3. The clinical effectiveness of a particular treatment is assumed to be a function of the degree to which treatment mechanisms act on the causal variables, plus the estimated strength that links causal variables and behavioral variables, plus the estimated modifiability of the causal variables. Back to Mr. Bernal case, let's consider the effect of a social anxiety and avoidance treatment program with different mechanisms (M_1: increased social skills, M_2: anxiety reduction through exposure, M_3: increased reinforcing properties of social interaction) according to this framework (Figure 3). The estimated total treatment effect (TE) could be derived from this model:

$$TE = \sum TE_{Mi} = \sum (SM_{Mi,Xi} \times SX_{Xi,Yi} \times MX_{Yi})$$

TE is the sum of the effectiveness of each treatment mechanism involved (TE_{Mi}). In the formula, SM is the estimated strength of the relationship M_i,X_i between a treatment mechanism M_i and a causal variable X_i (high = 0.8, medium = 0.4, low = 0.2); SX is the estimated strength of the relationship X_i,Y_i between a casual variable X_i and a behavioral variable Y_i (high = 0.8, medium = 0.4, low = 0.2); and MX is the estimated modifiability of the causal variable X_i (high = 0.8, medium = 0.4, low = 0.2; for this example we will assume a high modifiability). The effectiveness of Mr. Bernal's treatment functional model for "anxiety responses [Y1]" would be:

$$TE = TE_{M1} + TE_{M2} + TE_{M3} = (SM_{M1,X3} \times SX_{X3,Y1} \times MX_{Y1}) + (SM_{M2,X3} \times SX_{X3,Y1} \times MX_{Y1}) + (SM_{M2,X4} \times SX_{X4,Y1} \times MX_{Y1}) + (SM_{M3,X4} \times SX_{X4,Y1} \times MX_{Y1}) = (0.2 \times 0.2 \times 0.8) + (0.2 \times 0.2 \times 0.8) + (0.4 \times 0.2 \times 0.8) + (0.8 \times 0.8 \times 0.8) = 0.64$$

The overall treatment effectiveness is the sum of the effectiveness of each treatment mechanism. This procedure may show the differential cost-benefits of different interventions. "Increased reinforcing properties of social interaction [TE_{M3} = 0.512]" is the treatment mechanism with the greatest impact on Mr. Bernal's behavior problem in this example. The estimated weight of a treatment mechanism can be used to adapt the effectiveness of a particular treatment to a particular case. As a result, not only the treatment, but its underlying mechanisms could be matched with the variables associated with the patient's problems or treatment goals.

Further considerations and limitations of a functional-analytic framework

Four decades after Kanfer and Saslow's (1965, 1969) classic papers, the presence of functional analysis as a case-formulation procedure is not widespread. For instance, Scotti, McMorrow, and Trawizki (1993) analyzed the studies published between 1963 and 1988 on behavioral treatment of chronic psychiatric patients. Only 9 studies among 272 reported the use of a pre-treatment functional analysis. In addition, Virués, Santolaya, Buela-Casal, and García-Cueto (2003, p. 43) studied the psychological assessment methods in 165 public mental health units in Spain finding that this procedure was absent or it

was very infrequently used (*Median* = 1 in a four-point ordinal scale, where 1 meant *non-used*; 2, *low use*; 3, *frequent use*; 4, *systematic use*). A more frequent application of functional analysis has been observed recently. Hanley *et al*. (2003) found that publications on the subject increased from 25 in the 1986-1990 period, to 150 reports during the 1996-2000 period. In adittion, Gresham, McIntyre, Olson-Tinker, Dolstra, McLaughlin, and Van (2004) reported that 48% out of 150 school-based interventions published in the *Journal of Applied Behavior Analysis* (1991-1999) used a functional behavioral assessment. Several factors may limit a wide dissemination of functional analysis in clinical case formulation: (a) a functional analysis approach to clinical-case formulation can be more time-consuming than diagnosis; (b) it is not always clear which domains to assess in the initial assessment phase, how to refine the data obtained in a preliminary analysis, and how to move from an analysis to treatment recommendations (Hayes and Follete, 1993, p. 185); and (c) the causal chain of events (i.e., mediating variables) that underlay the functional relations are not always known.

Although the functional analysis is designed to reduce judgment errors, there are still many opportunities for judgment error in the process of constructing a functional analysis (see reviews of clinical bias in Dumont and Lecompte, 1987; Haynes and O´Brien, 2000, Table 3-2; Kleinmutz, 1990). For instance, O'Brien (1995) found inaccurate estimates of covariation in experimental settings where the functional relation between behaviors and controlling factors was estimated. Furthermore Godoy and Gabino (2003) observed that in an estimation of antecedent-behavior and behavior-consequence relations, only 21% and 5% of the subjects respectively, considered both antecedent and consequent functional relations when gathering the information of a hypothetical clinical case.

Finally, it is often difficult to measure functional relations and to increase the reliability and validity of component judgments in a functional analysis. A few standardized assessment procedures are available to help the clinician detect functional relations (e.g., Behavior-Environment Taxonomy of Agitation, Fisher, u.d.; Functional Analysis Checklist, Sturmey, 2001; Functional Analysis Screening Tool, Goh, Iwata, and DeLeon, 1996; Motivation Assessment Scale, Durand, 1990). However, there are only a small number of assessment instruments available that focus on functional relations. Further study on their psychometric properties is still necessary. For instance, Zarcone, Rogers, Iwata, Rourke, and Dorsey (1991) examined the inter-rater agreement of the Motivational Assessment Scale and obtained 29.1% across independent assessors (N = 55). In addition, Sturmey (2001) reported a low reliability between raters in the Functional Analysis Checklist.

According to Cone (1997), it is likely that the hypothesis-generating process will be facilitated by clearly specified decision making sequences and guidelines. Guidelines for functional analysis elaboration have been proposed by Carr, Levin, McConnachie, Carlson, Kemp, and Smith (1994), and Groden (1989).

More research is needed to develop clinical guidelines and to shorten the time required to detect functional relations (Hayes and Follete, 1993). Partial reviews of the assessment strategies that can aid in the development of a empirically-driven functional analysis are available in Haynes *et al*. (1997), Sturmey (1996, pp. 21-52, Table 2.1) and Hanley *et al*. (2003). A comprehensive guide of empirically-supported functional relations,

matching topographical features with their probable functional counterparts will facilitate the functional analysis completion (Bisset and Hayes, 1999; Hayes and Follete, 1993; Tryon, 1996; Woods, 1974).

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