

A Behaviorist Manifesto for the 21st Century

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Abstract — Observational assessment of behavior is a core measurement tool in modern psychological research and practice. Despite the importance of observational assessment and the tremendous amount of research devoted to refining and enhancing the methodological foundations of these tools, current best practices still bear a strong resemblance to those from three decades prior. The emergent field of behavioral signal processing, though relatively little known within the field of psychology, has the potential to revolutionize observational practice and resolve long-standing limitations of current methods. In this paper, we illustrate the need for and potential value of behavioral signal processing methods for observational practice by examining three current issues in the observational assessment of clinically distressed, married couples that are representative of challenges faced in numerous areas of clinical psychology.

I. INTRODUCTION

Clinical psychology and psychiatry are primarily concerned with the diagnosis and treatment of psychological disorders. The vast majority of psychological disorders are understood to arise from complex interactions between biological, psychological, and social factors, and a great deal of scholarly effort has been accordingly devoted to developing diagnostic tools in all three domains. Major advancements have been realized in measurement technology for biological variables (e.g., functional brain imaging [1]) and for subjective, internal experience (e.g., Item Response Theory for developing self-report instruments [2]). However, the technology available for measuring observable behavior has changed relatively little over time.

Manual annotation, often referred to as observational coding, is the current gold standard method for quantifying behavior in clinical psychology. Best practices for manual annotation have long been established and are widely accepted [3]. Generally speaking, best practices are designed to generate data that is as objective, reliable, and valid as possible while recognizing the limitations of human perception, information processing, and memory. For example, best practices include annotating a limited number of behaviors, conducting intensive annotator training at the beginning of a project, having multiple

annotators code each behavioral sample, and repeating inter-annotator reliability checks over the course of an annotation project.

Though a large body of exceedingly valuable work employs these practices, researchers and clinicians alike are frequently frustrated by the limitations imposed by these practices. The emerging field of behavioral signal processing (BSP [4]) is beginning to generate much needed solutions to three of the most troublesome limitations of gold standard methods for manual annotation:

1) Behavioral theories often have to be overly simplified when codified in an observational coding system.

2) The need to code a limited number of behaviors has slowed the pace of theoretical development.

3) Even the most efficient observational coding systems are too resource intensive for use in clinical practice.

We illustrate how BSP methods circumvent these previously intractable issues with examples from the study of clinically distressed, married couples and suggest how BSP methods could be extended to the study of similar behavioral phenomena that are important for bettering the field's understanding of psychopathology and clinical intervention.

II. BSP ANALYSIS OF MARITAL INTERACTION

Virtually every major theoretical model of intimate relationships considers interaction between husband and wife to be of vital importance for the overall well-being of a marriage. Marital interaction plays a similarly key role in theoretical models linking marital functioning to the physical and mental health of spouses. A wealth of empirical evidence supports these theoretical claims[5, 6], and observational assessment of spontaneous interactions between spouses remains a major area of focus in relationship science. Recent application of BSP methods to the study of distressed, married couples illustrates the tremendous potential of these methods for revolutionizing observational practice across clinical psychology as a whole.

A. BSP enables the study of complex behavioral phenomenon

“A special case in engineering is the usual in psychology, that a person's behavior affects the

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behavior of other persons... The complexities here are so refractory to quantitative decomposition that [experimental manipulation of simple stimuli] came to be used ... as a factual substitute for piecewise causal-dispositional analysis. In the human social case, [this approach] may be devastating.” – Paul Meehl [7]

“As our methods become better developed it will be possible to undertake investigations of more and more complex forms of behavior. Problems which are now laid aside will again become imperative, but they can be viewed as they arise from a new angle and in more concrete settings.” - John Watson [8].

Literally hundreds of specific behaviors have been studied during marital interaction. Of this panoply of candidates, behavioral feedback loops have emerged as one of the most important aspects of marital interaction for distinguishing clinically distressed couples from well-functioning couples. While it is well accepted that clinically distressed couples engage in longer feedback loops of more intense negative behaviors than satisfied couples[5], very little is known about how feedback loops unfold over time. One major impediment to furthering the field’s understanding of this important process is the complexity of measuring constituent behavioral components.

The demand/withdraw interaction pattern is one particularly destructive behavioral feedback loop that occurs at higher levels in distressed couples relative to satisfied couples[5]. The demand/withdraw interaction pattern occurs when one partner, the demander, nags, complains, and criticizes while pursuing change and the other partner, the withdrawer, refuses to discuss the problem and quickly ends any discussions of change in attempting to maintain the status quo. Numerous theories have been advanced to account for this behavioral phenomenon. The escape-conditioning model[9] suggests that some individuals are more sensitive to the distress of conflictual interaction and that they withdraw from particularly upsetting interactions (i.e., those likely to be characterized by strong demands from their spouses) as a means to lessen their acute distress. Numerous methodological approaches, including psychophysiology assessment and self-report instruments, have been used for assessing acute distress. However, many of these studies were unsuccessful in uncovering associations between acute distress and individual differences in demand/withdraw behavior. In contrast, a recent study[10] that employed BSP analysis of vocally encoded distress uncovered findings that helped to explain earlier null results and suggested important refinement of this theoretical model.

Though this study was valuable in its own right, it failed to fully leverage the power of BSP methods for the study of behavioral feedback loops. The major measurement challenges for marital researchers are that behavioral feedback loops likely occur on multiple timescales[11], involve expression across multiple modalities of communication[12], and are non-stationary over the course of an interaction[13]. Marital researchers are interested in questions such as, “Was there a critical moment during the interaction when things fell apart[14]?” and “Was either spouse responding to one form of expression but ignoring another[15]?”. These and other similar questions have awaited empirical examination for well over a decade if not substantially longer. However, to study such processes, it is imperative to have highly objective time series data that is continuously and precisely measured over small windows of time for multiple forms of behavior. It is simply not feasible to generate such data using manual annotation. In contrast, BSP methods can be used to reliably and efficiently extract features from all three modalities of human expression (verbal, vocal, and visual) for very small time scales. Lee and colleagues’[16] analysis of multivariate vocal entrainment during marital conflict represents an important first step in this direction.

Finely detailed features data derivable with BSP methods are likely to be valuable not only for the study of marital interactions but also for clinical psychology more broadly. Behavioral feedback loops are one particular form of operant conditioning, and operant conditioning is widely considered to be one of the most important psychological principles for understanding dysfunctional behavior. It is likely that BSP methods can and will be extended to the study of other forms of spontaneous interaction, such as between psychotherapist and client[17], with significance for clinical psychology.

B. BSP expedites theoretical development

“We sometimes hear people ask: Do you have a coding scheme I can borrow? This seems to us a little like wearing someone else’s underwear. Developing a coding scheme is very much a theoretical act, one that should begin in the privacy of one’s own study, and the coding scheme itself represents an hypothesis, even if it is rarely treated as such.” -Roger Bakeman and John Gottman[18]

“Often [plausible rival hypotheses stem] from the fact that other, prior studies have shown that a particular influence has an effect very much like the one produced in the study and explained by the investigator in some other way.” - Alan Kazdin [19]

Replication is one of the greatest strengths of research on marital interaction. Indeed, well over 300 published studies all generally find that engaging in more negative behaviors and fewer positive behaviors during marital interaction is

associated with increased risk for clinically significant marital distress across culture, length of relationship, and type of interaction[5]. One factor that contributes to the strength of these findings is that they have been generated using a wide array of different observational coding systems, each of which assesses a unique set of behaviors. As a group, these 300+ studies employ more than 20 distinct coding systems[20]. However, the use of so many different coding systems has also led to uncertainty when conflicting findings have emerged.

The main issue is that it is highly impractical to use more than one or two coding systems in a given study because it takes too much time and effort to do so. As a result, researchers typically code behaviors that are of most theoretical interest and omit behaviors that are less of interest even if they've been shown previously to be important. While this approach is reasonable given the limitations of manual annotation, it is unfortunate in that it has slowed the pace of theoretical development by limiting the number of studies that have pitted competing theoretical explanations against one another.

BSP methods offer a potential resolution for this dilemma by showing that it is possible to predict behavioral codes using features generated with unsupervised extraction methods. Importantly, Black and colleagues' work shows that these methods can be used with a wide range of behavioral codes, including even very abstract codes like acceptance[21]. As algorithms are created for predicting a larger number of behavioral codes, it will become increasingly possible for researchers to not only compare the value of existing codes against one another but also to examine the additive value of new behavioral codes. Such a tool will expedite the rate of theoretical refinement because it will allow researchers to measure well established behaviors using highly efficient, automated BSP methods while preserving their person hours for developing new codes.

BSP methods also expedite the rate of theoretical refinement by enabling researchers to conduct data driven, exploratory work to deconstruct behavioral processes. For example, Atkins and colleagues[22] used topic modeling to discover specific semantic content associated with blaming behavior. Other methods, such as Multiple Instance Learning and Salience Detection[23], will similarly allow researchers to obtain new insights about the specifics of why and how couples engage in behavioral processes. In this way, BSP methods may be used not only to solve known methodological issues but also to generate new knowledge.

C. *BSP facilitates clinical use of empirically supported observational assessment*

"In clinical practice, it is important (and becoming increasingly mandatory) to record a formal treatment plan that incorporates observable treatment goals ...

Observing communication during initial assessment and then during the course of treatment is necessary to assess the success in meeting the goals." – Richard Heyman [20]

A final, highly significant benefit of BSP methods is that they will make it much easier for clinicians to use empirically proven observational assessment methods in their everyday practices. The realities of modern clinical practice are such that the only viable option for clinicians has been to approximate the observational assessment methods used in research as closely as possible. However, no amount of clinical expertise or training in observational methods can overcome the limits of one person conducting observational assessment in the absence of a coding team, particularly when that person is also conducting the treatment. A major part of the value of observational assessment is that it can provide objective data about progress during therapy. However, observational data can hardly be considered objective if the person doing the manual annotation is fully informed about the progress of treatment. This limitation would be even more pronounced if a therapist wanted to manually annotate psychotherapy sessions that he or she had conducted.

The efficiency, objectivity, and portability of BSP methods have the potential to bridge the divide between observational assessment methods as used in clinical practice and in empirical research. In order for the potential benefit of BSP methods to be realized for clinical practice, three developments need to occur. First, automated methods for predicting observational codes from unsupervised, multimodal feature extraction need continued development. The vast majority of clinical practitioners consider their theoretical orientation to be integrative, meaning that they bring together aspects of multiple theoretical orientations. In order for BSP methods to be a reasonable option for integrative clinicians, algorithms for a large number of behaviors must be available. Second, standards need to be developed for acquisition of behavioral samples for BSP applications. In developing standards, it will be important to consider elements of the interaction itself (i.e., how long an interaction[24], methods for determining what content is discussed, etc.) as well as elements of the recording setup (i.e., far field vs. close talk microphones, orientation of cameras to interlocutors, etc.). Development of standards will require on-going collaboration between clinical practitioners and technology developers to ensure that standards are feasible given the modest resources available to most clinicians while also enabling the capture of high quality data. Third, algorithms will need to be packaged in very user friendly designs that are easily accessible and that incorporate appropriate privacy protections. Most clinicians will not have access to high end computing resources. Additionally, clinical records are subject to

numerous legal privacy requirements. Failure to consider the resources available to most clinicians or to incorporate privacy requirements into the distribution of BSP methods would almost guarantee that they will not be adopted by clinicians regardless of how well they work. Dissemination of BSP methods to clinical practice represents a very significant challenge. However, it is a challenge that is well worth confronting. The ultimate test of BSP methods is not what information they are capable of generating under well controlled, ideal recording settings but rather how they can be applied in the real world to improve the quality of mental health care services and the understanding of psychological disorders.

III. CONCLUSIONS

BSP methods have the potential to revolutionize observational assessment methods both in academic research and in clinical practice. Recent work demonstrates the vast potential of BSP methods to solve longstanding limitations of best practices for manual annotation as well as to serve as a generate novel and important findings with relevance for theoretical refinement. To date, much of this work has been conducted using spontaneous interactions of clinically distressed married couples discussing areas of disagreement. The benefits of BSP methods developed in this specific domain are relevant for many other areas of clinical psychology. Collaboration between clinical psychologists and BSP developers is vital to maximize the success of these efforts and the likelihood of their eventual adoption by clinical practioners.

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