"That which is measured improves": A Theoretical and Empirical Review of Self-Monitoring in Self-Management and Adaptive Behavior Change

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Abstract:

Current psychological treatment approaches that rely on time-intensive, face-to-face psychotherapy are not capable of meeting the demand for mental health services. Mental health interventions that promote self-regulation and self-management of symptoms will play an increasingly important role in the well-being of millions of individuals. Self-monitoring is a core assessment and intervention component of many mental health interventions and an obligatory first step in the self-regulation process. The present paper reviews prominent theories of self-regulation and describes classic studies spanning clinical, social, cognitive, and personality psychology, which identify potential mechanisms underlying self-monitoring. At the empirical level, we describe the use of self-monitoring across a range of behavioral interventions directed at mental health and physical outcomes, identify factors that influence the effects of self-monitoring, and suggest ways in which technology can be incorporated into these interventions to improve the reach of psychological interventions.

Introduction

The vast majority of individuals with mental health needs who would benefit from efficacious psychological treatments do not receive them.[1] The failure of current one-on-one treatment modalities to meet existing mental health needs requires economically feasible, short-term and, in some cases, self-administered or web-based prescriptive treatments that exist outside specialized health care settings.[2] Health care is becoming increasingly patient-centered, moving away from provider-centric models of care to ones in which patients take increasing responsibility for lifestyle modifications, behavioral change, and self-regulation.[3,4] This may be particularly true for psychological health.[5] The focus of this theoretical and empirical review is the potential utility of self-monitoring for behavior change within the context of mental health interventions. An apocryphal quote often attributed to the mathematician and statistician Karl Pearson, "That which is measured improves," captures the seemingly self-evident and logical conclusion that systematic self-monitoring (the process of measurement) facilitates behavior change. The evidence for this conclusion will be discussed, first, in light of theoretical models of self-regulation, and then in the context of empirical findings, including recent literature on self-management techniques for mental health utilizing technology.

The review to follow will begin with a brief historical narrative of self-regulation theories. The purpose of the theoretical review is to provide a foundation for identifying potential mechanisms by which self-monitoring operates as a stand-alone intervention. It has been argued that, in an era of rapidly expanding technology, innovation development must be guided by theory.[6,7] Similar historical narrative reviews in the behavioral medicine literature have applied self-regulation theory to understanding the mechanisms underlying self-management of chronic health conditions.[8]

Following an overview of self-regulation theories, this review will discuss the origins of self-monitoring in the psychotherapy literature, with a focus on well-established psychotherapeutic interventions that prominently utilize self-monitoring as an intervention component. Observation of one's own behavior is considered crucial to most formalized psychotherapeutic interventions, including but not limited to self-management skills training, motivational enhancement, and behavioral activation.[9]

Finally, the present review will highlight recent empirical literature concerning the use of self-monitoring in formalized, technology-based (Internet- or smartphone-based) mental health interventions. Key features that affect the utility of self-monitoring will be highlighted, drawing on all areas of the broader health literature that are relevant to behavior change. The purpose of expanding the review to the broader health literature is to capture important information about moderators of treatment effect, as the mental health literature is nascent and therefore may benefit from principles derived from other areas of study.

Before proceeding, it should be noted that there exists a vast literature on the self-regulation of physical health behaviors, particularly with the use of technology in managing diabetes,[10,11] smoking cessation for individuals with chronic medical conditions[12], and weight management[13]. Although physical and mental health are intertwined, the health behavior literature is largely outside the scope of this review and has been extensively reviewed elsewhere[14–16]. This review will discuss the self-regulation of physical health behaviors (e.g., smoking) only when it is directly applicable to understanding the modifiers of self-monitoring effectiveness. Similarly, for quite some time educational researchers have been investigating the importance of self-monitoring in managing disruptive classroom behaviors and increasing on-task learning.[17–20] While educational performance is certainly relevant to mental

health, the education literature is outside the scope of the present review.

Self-Regulation

Self-regulation models[21–23] posit that systematic observation and assessment of one's current behavioral performance is a necessary, though not sufficient, first step in the process of self-regulation. Perceived discrepancies between one's current state and a goal or ideal are thought to prompt behavior change.

Theoretical models point to three chief mechanisms that may underlie the utility of self-monitoring in behavior change: a desire to change one's behavior that prompts movement or action towards one's goals (what could broadly be termed motivation); a behavioral goal, ideal or standard; and a means of measuring performance, often self-monitoring. In the following section, three theories will be discussed as prototypical examples of the behavioral, information-processing, and social-cognitive perspectives of self-regulation, with a focus on the indispensable role of self-monitoring within these models.

Theoretical Models

Behavioral Model A seminal early contribution is found in Kanfer and Karoly's behavioral model of "self-control"[23], defined as disengagement from habitual, automatic, or dominant action tendencies. Kanfer and Karoly highlight that self-regulatory processes are governed more strongly by psychological processes than by external stimuli or environmental contingencies. In the behavioral model, self-regulation is, at its core, acting "counter to the immediate contingencies,[23] or, simply put, not being merely reactive to the situation at hand.

The behavioral model posits that the primary mechanism of self-monitoring is to develop awareness of the controlling stimuli (environmental and psychological) and one's own responses. This is a necessary first step before an individual can choose to initiate a different behavior. Per Kanfer, "self-monitoring…serves as a precondition for [the] execution of new adaptive

behaviors" (p. 150)[24]. While the behavioral model was one of the first to propose that self-monitoring is necessary for self-regulation, the model does not provide clear explanations for why or under what conditions an individual would choose to enact a new behavior over an automatic or dominant reaction. An implicit assumption is that the dominant behavioral tendency is less adaptive than the alternative.

Information-Processing Model A highly influential model advanced by Carver[22] add to the behavioral model the notion of "discrepancy reduction." At the center of this model is the notion of a "negative feedback loop," a term borrowed from cybernetics and information processing. The negative feedback loop proposes four components of self-regulation: a goal or standard, input (from self-monitoring), comparison of the current state to a desired one (discrepancy monitoring), and feedback (behavioral change).[25]

In the information processing model, self-regulation functions as a hypothesized test-operate-test-exit (TOTE) unit. "Test" refers to the processes of self-monitoring, evaluation, and comparison to a goal. "Operate" corresponds to adjusting or changing one's actions as indicated by the test results. After behavioral adjustments have been made, testing occurs again to determine the success of one's efforts. If the new input matches the standard, the system is deactivated ("exit") until another discrepancy between goal and input is discovered.

Ultimately, self-monitoring in a negative feedback loop informs the persistence or adjustment of behaviors to match one's goals.

Social Cognitive Model Bandura's social cognitive model[21,26] built upon cognitive and behavioral principles by adding a motivational component to address the issue of goal-directed behavior. Bandura's model encompasses three components of self-regulation –self-monitoring, self-evaluation, and self-reinforcement. These are nearly identical to the processes described in Kanfer and Karoly's behavioral model.[23]

Per Bandura, "people cannot influence their own motivation and actions very well if they do not pay adequate attention to their own performances" (p. 250).[21]. In Bandura's model, self-monitoring provides information for two critical motivational processes: realistic goal setting and evaluation of one's progress towards one's goals. Similar to the information processing model, self-evaluation reveals a discrepancy between current performance and one's goal, which will lead to behavior change.

In daily life, others rarely provide systematic, explicit feedback about our own behavior. Therefore, self-observation and self-monitoring are two of the de facto methods by which we regulate our own behaviors.[27]

Comparison of Models. There are a few differences among the three self-regulation models presented here. Kanfer and Karoly's model[23] was developed with the closest ties to psychotherapy and is therefore more concerned with self-regulation in situations where there is a conflict between incompatible goals, or where one behavioral tendency is more habitual and another is more controlled.[28] Social cognitive[21] and learning models[23] emphasize the importance of affect for shaping behavior more so than do information processing models, which emphasize positive or negative evaluations of one's current state motivate behavior change.

Ultimately, some common threads also emerge among the three major theories of self-regulation discussed here. First, a goal or behavioral standard must exist to guide behavior. Second, and most relevant to this review, self-monitoring is a necessary first step for any self-regulation or behavior change because of the feedback it provides to the individual about his or her current performance.

The Origins of Self-Monitoring in Psychotherapeutic Interventions

Most psychotherapies aim to help the individual shift from more reactive to more purposeful behavior.

Self-monitoring aligns well with this goal because it asks clients to attend to the antecedents and consequences of behaviors. Self-monitoring has been described as "a temporary disengagement from automaticity, or a transition from 'mindlessness' to 'mindfulness'"[29].

Self-monitoring is used across many psychotherapeutic interventions for a multitude of purposes, from data gathering and reporting, to increasing self-awareness, to functioning as an active intervention that changes future thoughts and behaviors. In the following section, a brief overview will be provided of how self-monitoring has been used historically in psychotherapeutic interventions. The goal is to provide a foundation for the subsequent section, which describes more extensively recent technological adaptations to self-monitoring in psychotherapy.

Traditional Behavior Modification

The systematic collection of behavioral data has always been a hallmark of operant behavior modification. As it became apparent in the literature that self-monitoring of one's own behavior led to reactive effects[30], self-monitoring became a central treatment component in operant programs designed to enhance Self-monitoring self-regulation, such as smoking cessation programs.[31–33] By taking measurements of specific target behaviors (e.g., cigarette smoking), self-awareness was enhanced and this, in many cases, motivated behavior change assuming the person possessed the requisite behavior change skills. Self-monitoring also served as a self-reinforcer for behavior change when people observed objective evidence of improvement.[21]

Cognitive Behavioral Therapy

As the cognitive revolution evolved and psychological interventions transitioned from traditional behavioral modification to the cognitive behavioral therapy movement of the 1970s, self-monitoring was incorporated into these treatments as well. Psychothera-

py relies heavily on client introspection. Per Prochaska and Norcross, "verbal psychotherapies begin by working to raise the individual's level of observation" because "increasing consciousness…increase[s] the information available to individuals so that they can make the most effective response to stimuli impinging on them" (pp. 12-13).[34] Cognitive behavioral therapies (CBT), in particular, emphasize data gathering by the client. CBT has utilized self-monitoring so extensively that only a brief overview of common, evidence-based CBT methods will be discussed here.

Thought records are a central intervention component of cognitive therapies for depression and anxiety to help clients identify and challenge automatic thoughts.[35,36] For panic disorder, ongoing self-monitoring of panic attacks helps the client identify situations in which panic attacks are more likely to occur, understand how panic attacks are experienced (through recording of physical sensations, thoughts, behaviors), more accurately judge their varying levels of anxiety and panic than is possible with retrospective recall, and monitor ongoing progress.[37]

Other types of CBT involve worry records, daily mood records, and records of obsessions and compulsions.[38,39] CBT for bulimia and binge eating disorders utilizes a daily food diary for monitoring eating and planning meals, thus serving both a record keeping and self-regulation (planning) function. Dialectical behavior therapy employs a diary card for clients to track their skills use between sessions.[40,41] A cognitive-behavioral stress management program (C-ASMT) pilot tested the use of daily diaries that measured stress and coping to personalize the intervention to each individual client.[42–44]

Motivational Interviewing and Brief Alcohol Intervention

Another influential psychological intervention that systematically utilizes self-monitoring is motivational interviewing (MI).[45] MI is a nondirective intervention in which self-monitoring is used to provide concrete evidence of discrepancies between the client's current conceptions of self and their actual behavior, thereby motivating behavior change. Clients' current conceptions may involve biased estimates of how often a particular behavior occurs (e.g., an underestimation of how many drinks ones consume each week, or an overestimation of how much studying occurs during group study time). Self-monitoring may elucidate relations between a problem behavior and its consequences (e.g., measures of alcohol consumption with next-day mood and performance measures). MI conforms nicely to Carver's cybernetic negative feedback loop model,[22] in which discrepancies between the current state and some standard engages motivated change.

MI principles have been applied as brief interventions (BIs) for unhealthy alcohol use.[46] BIs often rely on the collection of personal data (e.g., recent drinking patterns) followed by the provision of normative feedback.[47] The goal of BIs is to provide corrective information to address some of the biases that may mediate unhealthy alcohol use.[48,49] The underlying mechanisms of BIs are similar to the functions of feedback and goal-setting in Bandura's social-cognitive model.[50]

Retrospective Self-Monitoring

Although most self-monitoring in CBT focuses on prospective monitoring of behavior, an intervention from the stress literature, written disclosure, takes a retrospective form and involves the processing of a previous significant event. Pennebaker and colleagues have demonstrated that writing about emotionally significant memories has positive mental and physical health benefits.[51–53] According to Pennebaker and Segal,[52] the act of remembering and organizing autobiographical events to create a "personal story" allows individuals to integrate thoughts and feelings and derive meaning from their experiences. In doing so, personal experiences take on structure and a sense of predictability, which render the emotional impact of a traumatic life event more manageable. Self-monitoring involves becoming aware of one's patterns of thoughts,

emotions, and behaviors and then constructing hypotheses about why certain behaviors occur under certain conditions. Similar to more traditional, formalized CBT interventions, the therapeutic effects of written disclosure paradigms are thought to be mediated through the cognitive processes of awareness and insight.

Technological Applications of Self-Monitoring

Self-monitoring interventions are poised to become more prominent with the rise of Internet and smartphone technology. Technology-based interventions, whether they are stand-alone treatments or techniques that augment existing empirically-supported therapies, are not labor-intensive and are conducive to widespread dissemination. Even if the incremental effect sizes of these interventions are small, as stated by Sobell and colleagues,[54] cumulative per capita gains can translate into large benefits for society. Furthermore, individual, face-to-face therapy cannot work as the only model of treatment delivery if our aim is to meet the existing demand for psychological services.[1] The following section discusses the overall trend in health care towards greater self-management through new technologies and reviews empirical studies that have examined the efficacy of these technologies within psychotherapeutic interventions.

Self-Diagnosis

Internet and mobile technologies have enabled new methodologies for self-monitoring, building upon established research techniques such as ecological momentary assessment (EMA)[55], the experience sampling method (ESM)[56], web-based daily diaries[57]. These technologies make frequent and event-specific assessment much more feasible.

One possible application of such technologies is self-diagnosis. For example, Groot[58] notes that in the "flow of life," the difference between a bad mood or difficult period of time and depression may not be

apparent to the individual until a depressive episode is quite severe. Many people may be unaware that their mood is significantly more negative than their baseline. Groot proposes that continuous, longitudinal self-monitoring, combined with the appropriate data analysis software, could allow individuals to diagnose the "phenotype" of depression in themselves earlier than would be possible without regular self-monitoring. Furthermore, repeated sampling of environmental variations may allow the individual to identify triggering or sensitive events that could be handled differently in the future.

Consistent with this proposal, there already exist a number of popular commercial websites and mobile applications that allow individuals to track moods and events to see the warning signs of emerging psychological or relationship problems. Consumers desire increased self-awareness and insight, and new technologies empower them to find the information for themselves. Some technology-based mental health interventions focus on diagnostic self-monitoring,[59,60] such as for unhealthy alcohol use[61] or eating disordered behavior.[62]

Unobtrusive Self-Monitoring

Individuals vary in their adherence to recommended self-monitoring protocols.[63] At times, the very target of measurement (i.e., mental health symptoms) may limit or impair individuals' cognitive and functional capabilities to engage in consistent self-monitoring.[64] This has led some to advocate for more "passive" or unobtrusive methods of self-monitoring that can gather data without active involvement from the participant.

Technology is uniquely outfitted to gather data in an automatic, continuous fashion. Smartphones are often equipped with features that allow for unobtrusive monitoring of behavioral indicators or correlates of mental health. Examples include accelerometers and Global Positioning Systems to track movement and activity, light sensors to provide inferences about sleep/wake patterns, and microphones and software to detect

the quantity and quality of human speech.[64] Emerging research has found that these unobtrusive measurements are correlated with self-report of mental health symptoms, which suggests they may useful for continuous symptom monitoring.[64] Studies that have combined data from active self-monitoring and passive or unobtrusive measures, such as geographically explicit ecological momentary assessment (GEMA), found that certain mental health-relevant phenomena (e.g., substance use craving) can be predicted by geospatial location.[65] Additionally, one small trial that tested unobtrusive self-monitoring as an intervention itself, combined with personalized feedback and tailored interventions delivered via smartphone, found promising reductions in depression symptoms.[66]

Substance Use

Technology-based self-monitoring programs have been tested for the purposes of, reducing alcohol, marijuana, and tobacco use.[67] These interventions target different aspects of the recovery process, from unhealthy use to maintenance of treatment gains. Technology-based interventions have the potential to overcome barriers associated with traditional substance use treatment, such as stigma, privacy concerns, and time constraints. Technology-based interventions may offer a means for overcoming some of these barriers by minimizing patient commitment and maximizing privacy.

Alcohol use Technology-based interventions for alcohol management have shown varying results depending on the intervention and target population. Brief intervention (BI) using normative feedback has been shown to be effective for reducing drinking among those with unhealthy alcohol use[46], and when BIs are provided online, the results seem to be equivalent to face-to-face methods.[68,69]

However, the literature is more mixed when examining psychotherapy treatment for alcohol use disorders that involve self-monitoring. Rose and colleagues[70] found significant increases in abstinence, self-efficacy, and coping skills with the Alcohol

Therapeutic Interactive Voice Response (ATIVR) intervention, during which participants reported substance use and mood daily to an automated phone service. At the study's conclusion, participants reported the program was helpful because they were accountable for tracking their alcohol use and because they received personalized feedback.

Surprisingly, Helzer and colleagues[71] found that participants using an interactive voice response (IVR) program reported drinking more than those in the control group, although they suggested this could be the result of the control group's retrospective reports being less accurate. Studies that have compared ecological momentary assessment[72] or daily reporting[73] to retrospective recall of drinking confirm the notion that people tend to underreport their drinking in retrospective reports. A noteworthy and promising result is that technology-based assessment methods tend to improve adherence. For instance, in the study by Helzer and colleagues,[71] those using the IVR program were calling 95% of the time.

A test of the Internet-based application Moderate Drinking,[74] which was designed for heavy drinkers, showed reduced consumption rates post-intervention; however, the application utilized numerous treatment components, including self-monitoring and goal setting, and it was unclear which components were essential mechanisms of change.

Smoking. Technology-based self-monitoring interventions for smoking have been more promising than those for alcohol management. MOMENT, a self-monitoring smartphone intervention for teens who are heavy marijuana users, reduced desire and use.[75] The authors posit that receiving feedback directly after submitting self-monitoring data may have been critical to the intervention's efficacy.

Another promising smartphone application ("app") for smoking cessation is SmartQuit[76], which is based on the behavior change principles of Acceptance and Commitment Therapy (ACT).[77] As its name implies,

ACT focuses on increasing the willingness to experience aversive events, such as physical cravings for tobacco, while committing to behaviors that are in accordance with important goals and values, such as improved health outcomes). One of the most effective features of the SmartQuit program is a self-monitoring component that involves the tracking of urges to smoke, tracking of urges experienced without smoking, and the number of smoke-free days.[78,79] Positive feedback (badges) that are earned by experiencing urges without smoking is assumed to reinforce smoking cessation and enhance self-efficacy. Among smokers who completed the program, 88% reduced their cigarettes and 33% quit completely.[76] This research also showed the importance of inducing participants to engage in active self-monitoring for a sufficient period of time to complete the program.[79] Other research on smoking cessation apps (e.g., SmokefreeVET80 for U.S. military veterans) have found similar results regarding the effect of engagement on outcome, namely that users who use the app with greater frequency also achieve better outcomes.

Affect, Stress, and Anxiety

Researchers have hypothesized that mobile technologies could be especially useful for tracking affective instability and disorders because of the opportunity for in-the-moment assessment of emotional states.[81] Real-time assessment, as compared with retrospective recall, may better capture affect and therefore increase accurate self-awareness.[59,60] This hypothesis is supported by Harrison and colleagues[82] who tested "myCompass," a mobile phone tool that involves real-time self-monitoring, messaging prompts, and online CBT education modules, The tool was associated with reductions in symptoms of anxiety, depression, and stress. Reid and colleagues[19] reported a significant reduction anxiety, depression, and stress for adolescents using mobiletype, a mobile phone app designed to track affective states, among other. A systematic review[83] of the utility of electronic self-monitoring of mood for patients with bipolar disorder

determined that the evidence for self-monitoring as a stand-alone intervention was inconclusive. Some studies lacked sufficient internal validity to draw conclusions about the effect of self-monitoring, and one randomized clinical trial actually found potentially harmful effects for self-monitoring of depressive symptoms, although this finding has yet to be replicated. The authors suggest a thoughtful and critical approach to the use of electronic self-monitoring of mood symptom in bipolar disorder.

In stress management programs, online assessment has great potential for elucidating the situations, events, and emotions that comprise a broad experience such as "stress." An example is an Internet-based stress and coping daily diary that is used with Cognitive-Affective Stress Management Training.[42,44] The daily diary assesses the characteristics of stressful situations, cognitive appraisals, potential stress-reducing reappraisals, affective responses, and extent-use and perceived effectiveness of a dozen possible coping strategies. It allows clients to discover relationships between situations, thoughts, and feelings and is used to provide idiographic administration of a brief manualized cognitive-behavioral intervention.[42,43] In this program, the potential effects of stand-alone self-monitoring on stress-related clinical outcomes remains untested.

Autism Spectrum Disorder

For children diagnosed with autism spectrum disorder (ASD), technology-based interventions that facilitate self-monitoring have demonstrated promising results as well. Personal prompting devices have been found to decrease stereotypy in middle school aged boys[84] and increase on-task behaviors in boys between the ages of eight and thirteen.[85,86] These prompting devices have the advantage of being inconspicuous, and they have been found to facilitate independence in children with ASD by reducing the number of adult cues needed.[85,87]

Deitchman and colleagues[88] suggest that video feedback (VFB) is useful in helping boys with ASD

between the ages of five and seven employ learned social skills in a naturalistic setting. In comparing two technologies, State and colleagues[89] found that self-monitoring with a vibrating watch, which acted as a personal prompting device, was even more effective than VFB. In a study comparing the efficacy of paper-and-pencil to iPad self-monitoring, Bouck and colleagues[87] found that the number of tasks adolescents with ASD completed and the number of prompts they needed was only slightly improved with the iPad. Although each of these studies had samples of four or fewer participants, results suggest that technologies that facilitate self-monitoring may help address a range of symptoms associated with ASD.

Eating Disorders

Studies investigating the efficacy of treatment maintenance for eating disorders (ED) using text message technology have shown mixed results. Bauer and colleagues[90] asked patients discharged from inpatient ED treatment to send in weekly symptom reports for 16 weeks via text message, and study investigators sent patients weekly tailored feedback. The authors suggest that the feedback may have been viewed as supportive, acted as a helpful reminder of CBT skills, and encouraged participants to seek outpatient treatment when needed. However, results should be interpreted with caution as remission rates between the intervention and control group did not differ in a clinically significant way. Similarly, Shapiro and colleagues[91] found reduced symptomology for binging and purging at the conclusion of a 12-week intervention during which participants texted symptoms nightly. However, despite the high adherence rate for completers, the study had a slightly higher attrition rate than non-technology based studies for treating bulimia nervosa.

Schizophrenia

Schizophrenia is refractory to most traditional treatment modalities and has therefore been targeted with technology-based interventions for specific component symptoms. Preliminary efficacy trials suggest that a symptom self-management smartphone application, FOCUS, might help those with schizophrenia and schizoaffective disorder in reducing symptoms of depression, psychosis, and general psychopathology.[92] The FOCUS smartphone intervention consists of symptom self-monitoring through brief assessment and self-management resources for mood regulation, medication adherence, social functioning, and improved sleep. The outcomes of the self-monitoring assessment were used to inform which self-management resources patients would have access to in the app. For instance, reports of anxiety in social interactions might lead to a suggestion to use cognitive restructuring ("test your thinking"), whereas reports of auditory hallucinations would prompt a suggestion to listen to music. The authors found high rates of acceptability among participants based on app usage, which was in part attributed to including patients in the app development phase to refine use, design, and functionality.[93]

Summary

There has been a recent proliferation in the number of technology-based interventions that rely on Internet and smartphone app technology, but the majority of these interventions are commercial products that are not well researched. Those that are researched have demonstrated mixed findings even within the same target condition.[59,60,62]

As such, at this point, providers should be cautious in recommending online tools to patients without sufficient informed consent about the potential drawbacks or null effects associated with these tools. Given the paucity of sufficiently-powered randomized control trials (RCTs) in the research literature and the presence of conflicting information based on the RCTs that are published, it is difficult to determine whether

technology-based self-monitoring interventions contribute over and above the efficacy of other types of self-monitoring.

If researchers have noted advantages of technology-based self-monitoring over other forms of self-monitoring, the primary benefits have been the ubiquity of mobile technology,[82,94] improved data validity compared to retrospective reports in some cases (e.g., alcohol use)[73], and timely feedback[91,95].

Variables that Influence the Effects of Self-Monitoring

Although self-monitoring has become an important component in many behavior change interventions, it is not uniformly associated with positive outcomes[96–99], as the recent literature on technological innovations makes clear. Information or awareness alone does not necessarily produce behavior change. The inconsistency of positive effects has led some to ask, which variables affect the utility of self-monitoring as an intervention?[100] Understanding the features that promote or limit the effects of self-monitoring is critical when considering the development of innovative interventions rooted in self-management principles. A summary of the features discussed in the following section is included in Table 1.

theories advanced by Bandura[26] and Mischel.[101] Karoly and Doyle[102] manipulated outcome expectancies for self-monitoring, telling half of their smoking cessation clients that self-recording had been proven effective for smoking cessation in the past, while the remaining clients were told that the self-recording technique was still under investigation. The positive outcome expectancy groups showed greater reductions in smoking than the negative expectancy groups, which suggests that providing a clear treatment rationale and positive expectations for the utility of self-monitoring can improve treatment outcome. The authors proposed that positive outcome expectancies increase motivation and treatment compliance, which in turn lead to better outcomes.

Complexity and Detail One obvious drawback of self-monitoring is the time or energy burden it can place on the client if monitoring is detail-intensive. One smoking cessation study found significantly lower rates of returning to a second treatment session among groups who were assigned to record daily cigarette consumption compared to groups asked only to pay attention to the situations in which they smoked (40-60% vs. 90%).[103] Complex or detailed self-monitoring may be

Table 1. Features Affecting the Reactivity of Self-Monitoring

Feature	Definition	Predicted Effect
Outcome expectancies	Beliefs concerning the likely outcome of a behavior	Positive outcome expectancies, namely believing that self-monitoring will effect change, increases the likelihood of seeing an effect.
Complexity and detail	The number of different items being monitored and the level of detail required for each item	Increasing levels of complexity and detail seem to have a negative effect on adherence and outcome.
Sufficiency and	The level of detail needed to make	Only one study has found that a minimum level of
Timing	Whether self-monitoring occurs before or after the target behavior	Monitoring immediately before a behavior is about to occurs is thought to be either better or equivalent to post-behavior monitoring in terms of reactivity effects.

Outcome Expectancies Expectancies concerning the likely outcome of a behavior is an important determinant of whether or not that behavior will occur. Outcome expectancies are a major component of social cognitive

intimidating early in treatment, particularly if the psychotherapist does not provide a clear rationale for its utility.[102]

In a non-clinical study with undergraduate social psychology students, Hayes and Cavior[104] found that

including self-monitoring more than one behavior reduced the reactivity of the procedure. Similarly, several treatment studies have found that more intensive self-monitoring does not necessarily lead to better outcomes. Le Grange and colleagues[105] tested whether adding a detailed ecological momentary assessment method that involved recording thoughts, mood, events, and eating behaviors multiple times throughout the day would enhance CBT for binge eating disorder. They found no advantage for the more intensive self-monitoring in terms of treatment outcome.

Helsel and colleagues[106] found that weight loss patients who transitioned to an abbreviated self-monitoring method halfway through treatment returned more food and exercise diaries than those who continued with a traditional detailed method, and the two groups had comparable outcomes. The authors conclude that it may be the engagement with self-monitoring, rather than the level of detail, that is important for behavior change. This parallels the research from smoking cessation apps that suggests that engagement with self-monitoring, as measured by the number of times that it occurs, is one of the most significant predictors of treatment outcome.[79] Thus, while a minimal level of self-monitoring is necessary to promote behavior change, intensive or highly detailed self-monitoring has the potential to burden the client and detract from treatment adherence.

Sufficiency and Quality On the other hand, some research suggests that the quality or thoroughness of self-monitoring may matter at least some of the time. These findings seemingly contradict the notion that mere engagement, as measured by number of recordings, is the best predictor for self-monitoring reactivity.

In one study of 18 adolescents in a behavioral weight control treatment[107], the only aspect of self-monitoring associated with post-treatment and three-month follow-up body mass index (BMI) was what the

authors termed "recording sufficiency," defined as recording five or more food or beverage items in a day. By contrast, there was no significant association between BMI and the number of days recorded, which suggests that merely submitting more recordings was not enough to effect change in weight. While this finding on recording sufficiency is suggestive, it has yet to be replicated. Future research should consider whether a minimum level of quality or sufficiency is necessary to make self-monitoring useful.

Timing From the perspective of self-regulation, the timing of self-monitoring may affect behavior change efforts. Awareness that a behavior is going to occur is likely to be more useful than awareness of a behavior after it has already happened, under the assumption that earlier awareness allows for a disruption of the habitual behavior chain and an initiation of an alternate response.[23] However, there have been inconsistent findings regarding whether the reactivity of self-monitoring varies as a function of its timing.

In the weight loss literature, one study[108] found that monitoring planned food intake before eating led to greater weight loss than monitoring the amount of food consumed. In contrast, Karoly and Doyle[102] used a between-subjects design with undergraduate students to compare pre- and post-behavior monitoring and found that monitoring smoking urges (pre-behavior) did not lead to better outcomes than monitoring cigarettes consumed (post-behavior). Because both groups were equally successful in decreasing cigarette consumption, it may be that pre-behavior monitoring aided the self-motivating and directive functions of self-regulation, whereas post-behavior monitoring exerted its effects through self-punishment.[21] Ultimately, there is no clear conclusion about whether the timing of self-monitoring matters, and most treatment protocols continue to utilize post-behavior recording.

Conclusions

Over fifteen years ago, Febbraro and Clum[109] conducted a meta-analysis on the effectiveness of self-regulation techniques (e.g., self-monitoring, self-reinforcement) as primary treatment interventions. Compared to no intervention at all, self-monitoring (SM) yielded a small but significant effect size (d = .29). When interventions utilizing other self-regulation techniques (e.g., self-reinforcement) were added, the comparison of SM-alone and SM-plus to waitlist/minimal contact control groups yielded a medium effect size (d = .45), suggesting that self-regulation interventions that combine self-monitoring and other treatment modalities are effective. The somewhat modest effect sizes of these techniques as stand-alone interventions must be counterbalanced with the fact that they are often far more efficient than one-on-one psychotherapies. They may lend themselves to well-designed self-administered interventions, perhaps aided by therapist consultation and monitoring. Notably, this meta-analysis was conducted prior to the recent proliferation of self-management smartphone apps and other Internet-based interventions rooted in self-regulation theory.

While research on self-monitoring showed notable decline in the 1980s, self-monitoring remains an unquestioned central component of many psychotherapies.[100] Future research should more closely examine what contribution or additive effect, if any, self-monitoring has within an already empirically supported treatment.

One important area of research and application is the increasing use of technology in behavior change programs. As Kazdin and Blasé[1] have noted, traditional models of mental health service delivery are simply incapable of addressing existing demand. Recent innovations, such as self-administered interventions and "big data" methods that utilize built-in features of our existing technologies to gather more data than a single individual can track[64], have positioned the field of mental health care to expand access to services in an unprecedented way. Virtually all of these innovations rely, in part, on technology-enabled self-monitoring of situations, behaviors, emotions, and consequences.

Limitations

One unanswered question about self-monitoring reactivity is the degree to which observed behavior change is the result of self-monitoring specifically, or whether those effects could be due to individual differences, such as trait conscientiousness. An important future direction for research on self-monitoring interventions is to assess individual difference variables to identify whether the intervention effects remain after taking into account possible personality traits related to differential outcome.

Another limitation to be addressed in future studies is the reliance on the self-monitoring records themselves or other self-reported outcome measures. The evidence for self-monitoring effects would be greatly strengthened by multitrait-multimethod assessment approaches, such as by including objective behavioral measures when available (e.g., blood alcohol level) and other methods of assessment (e.g., clinical interview as well as self-report).

Future Directions

The theoretical and empirical literature suggest that self-monitoring is necessary for behavioral regulation and is indispensable to many psychotherapies. Internet and mobile technologies have allowed individuals to conveniently access self-monitoring methods throughout their daily lives with the tap of a finger. Given the ubiquity of smartphones around the world, in both rich and poor countries, there is tremendous potential for population impact with the use of mobile mental health technologies.

The empirical literature suggests that technological innovations can make consistent and accurate self-monitoring more feasible. The benefits of this may be particularly pronounced in areas such as emotional

disorders, where cognition is most likely to be skewed by the very processes one means to better understand, e.g., depression or anxiety.[110,111]

Given the exponential capacity of computers to encode and process information, technology-based self-monitoring programs also have the potential to personalize medicine in novel and unprecedented ways. By utilizing an individual's own data in real-time, computerized interventions have the potential to adapt and personalize assessment measures and coping tools. Technology opens up the possibility for rapid, responsive, iterative adjustments in assessment and treatment, and it is able to do this on a scale that would be impossible in a traditional, face-to-face health care delivery model.

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