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Does Monitoring Goal Progress Promote Goal Attainment?

A Meta-Analysis of the Experimental Evidence

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Abstract

Control Theory and other frameworks for understanding self-regulation suggest that monitoring goal progress is a crucial process that intervenes between setting and attaining a goal, and helps to ensure that goals are translated into action. However, the impact of progress monitoring interventions on rates of behavioral performance and goal attainment has yet to be quantified. A systematic literature search identified 138 studies (N = 19,951) that randomly allocated participants to an intervention designed to promote monitoring of goal progress versus a control condition. All studies reported the effects of the treatment on (a) the frequency of progress monitoring and (b) subsequent goal attainment. A random effects model revealed that, on average, interventions were successful at increasing the frequency of monitoring goal progress (d_+ = 1.98, 95% CI: 1.71 to 2.24) and promoted goal attainment (d_+ = 0.40, 95% CI: 0.32 to 0.48). Furthermore, changes in the frequency of progress monitoring mediated the effect of the interventions on goal attainment. Moderation tests revealed that progress monitoring had larger effects on goal attainment when the outcomes were reported or made public, and when the information was physically recorded. Taken together, the findings suggest that monitoring goal progress is an effective self-regulation strategy, and that interventions that increase the frequency of progress monitoring are likely to promote behavior change.

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A Meta-Analysis of the Experimental Evidence

The present review investigates the impact of monitoring goal progress on rates of goal attainment. Goals are mental representations of desired outcomes (Austin & Vancouver, 1996) – such as to run a marathon or to be happy – and goal intentions are self-instructions to act towards those outcomes (Sheeran & Webb, 2011; Triandis, 1980). Goal intentions capture both the nature of the set goal (e.g., the number of exercise sessions that one intends to engage in this week) and how committed one is to attaining it (e.g., the strength of one's intention to exercise five times this week). Intentions are the starting point for the willful control of action (Gollwitzer & Moskowitz, 1996). However, evidence indicates that intentions have only a modest impact on performance. A meta-analysis of 47 experimental studies found that a medium-to-large-sized change in intentions had a small-to-medium-sized effect on subsequent behavior (Webb & Sheeran, 2006). Evidence indicates that people who intend to exercise do not necessarily do so (Rhodes & de Bruijn, 2013), that most people want to be happier than they are (Oishi, Diener, & Lucas, 2007), and that it has become almost as traditional to fail to achieve New Year's resolutions as it is to form them in the first place (Marlatt & Kaplan, 1972; Norcross & Vangarelli, 1988). In short, forming a goal intention is not, on its own, sufficient to ensure goal attainment (for reviews, see Gollwitzer & Sheeran, 2006; Sheeran, Milne, Webb, & Gollwitzer, 2005; Sheeran & Webb, 2011; Webb, 2006).

This 'gap' between intention and action (Sheeran, 2002) has led researchers to investigate which factors determine intention-behavior consistency. For instance, properties of intentions such as temporal stability (Cooke & Sheeran, 2004; Sheeran & Abraham,

2003), the extent of actual control over performance (Sheeran, Trafimow, & Armitage, 2003), and the operation of habits (Neal, Wood, Wu, & Kurlander, 2011; Ouellette & Wood, 1998) have each been shown to moderate the relationship between intention and behavior (for reviews, see Sheeran & Webb, 2011; Webb & Sheeran, 2006). There is also evidence concerning the cognitive processes that support the translation of goals into action. For example, adopting a goal heightens the activation of goal-relevant information (Aarts, Dijksterhuis, & De Vries, 2001) and inhibits alternative goals (Shah, Friedman, & Kruglanski, 2002; for a review, see Johnson, Chang, & Lord, 2006). However, these findings raise the question: what do people actually do between setting and getting a goal?

Many theories in social and health psychology accord goal intentions the key role in determining behavior, including the Theory of Reasoned Action (Fishbein, 1980; Fishbein & Ajzen, 1975), the Theory of Planned Behavior (Ajzen, 1991), Social Cognitive Theory (Bandura, 1986; 1991; 1999), the Model of Interpersonal Behavior (Triandis, 1977, 1980), Protection Motivation Theory (Rogers, 1983), the Prototype–Willingness Model (Gibbons, Gerrard, Blanton, & Russell, 1998; Gibbons, Gerrard, & Lane, 2003), and Locke and Latham's (1990) theory of goal setting. However, for the most part, these theories do not specify the processes that intervene between intention formation and goal attainment (de Bruin et al., 2012). An important exception is Control Theory (Carver & Scheier, 1982; Powers, 1973). According to Control Theory, goal setting simply reflects the adoption of a reference value or standard for performance. For example, someone who decides to try to lose weight might aim to lose 2lb a week. The crucial activity of goal striving, however, is monitoring goal progress – that is, evaluating one's ongoing performance relative to the standard – and responding accordingly.

Monitoring goal progress involves periodically noting qualities of the target behavior (e.g., how much one has eaten) and/or outcome (e.g., how much weight one has lost) and comparing these perceptions with the desired standard (e.g., lose 2lb) (Baumeister & Vohs, 2007; Carver & Scheier, 1982; Webb, Chang, & Benn, 2013). Progress monitoring should promote goal attainment because it serves to identify discrepancies between the current state and the desired state, and thus enables people to recognize when additional effort or self-control is needed (Fishbach, Touré-Tillery, Carter, & Sheldon, 2012; Myrseth & Fishbach, 2009). For example, dieters who monitor their intake of calories can better decide whether they should allow themselves to have an extra helping of food. Expending effort or exerting self-control serves to bring behavior in line with a standard. However, progress monitoring precedes efforts to reduce discrepancies – discrepancies must first be identified before people can adjust their behavior appropriately.

A number of models posit a central role for progress monitoring, including Feedback Intervention Theory (Kluger & DeNisi, 1996), Goal Setting Theory (Latham & Locke, 1991), Field Theory (Lewin, 1951), models of self-awareness (e.g., Duval & Wicklund, 1972), Kanfer and Karoly's (1972) account of self-regulation, the Test-Operate-Test-Exit system (Miller, Galanter, & Pribram, 1960), the 'living systems perspective' (Ford, 1987), and the Model of Multiple-Goal Pursuit (Louro, Pieters, & Zeelenberg, 2007). Like Control Theory, these models suggest that the real 'work' of goal striving involves monitoring goal progress and acting on discrepancies. Prompting the self-monitoring of goal progress is also frequently deployed as a technique for promoting behavior change. A recent review reported that 38% of interventions designed to promote healthy eating and physical activity incorporated progress monitoring (Michie, Whittington,

McAteer, & Gupta, 2009). Monitoring goal progress is also an important component of clinical practice (for reviews, see Febbraro & Clum, 1998; Korotitsch & Nelson-Gray, 1999) and interventions designed to reduce energy usage (for a review, see Abrahamse, Steg, Vlek, & Rothengatter, 2005).

Despite the theoretical and empirical prominence of progress monitoring, however, the field lacks an empirical synthesis of its impact on goal attainment. There are numerous meta-analytic reviews of the impact of goal intentions on goal attainment (e.g., Albarracín, Johnson, Fishbein, & Muellerleile, 2001; McEachan, Conner, Taylor, & Lawton, 2011; Ouellette & Wood, 1998; Sheeran, 2002; Webb & Sheeran, 2006) and the factors that influence people's ability to act on discrepancies such as trait self-control (De Ridder, Lensvelt-Mulders, Finkenhauer, Stok, & Baumeister, 2012), ego-depletion (Hagger, Wood, Stiff, & Chatzisrantis, 2010), and if-then planning (Gollwitzer & Sheeran, 2006). However, it is not yet clear whether, or to what extent, monitoring goal progress promotes goal attainment. The present review therefore quantifies the impact of progress monitoring on rates of behavioral performance and goal attainment. In so doing, the review both tests Control Theory (and related theories) and assesses the utility of progress monitoring as a behavior change technique (Abraham & Michie, 2008).

Available Evidence Concerning the Relation Between Progress Monitoring and Goal Attainment

The available evidence offers a mixed picture of the impact of progress monitoring on goal attainment. Some studies have observed that progress monitoring promotes goal attainment. For example, Polivy, Herman, Hackett, and Kuleshnyk (1986, Study 1) investigated the effect of being able to monitor consumption on unhealthy eating. Female

dieters were asked to taste some chocolates and to eat as many as they needed to evaluate them accurately. Polivy et al. manipulated how easy it was for participants to monitor their consumption; some participants were asked to leave their chocolate wrappers on the table, while others were asked to place them in a wastebasket that was already half full of wrappers. The main finding was that participants who were asked to leave their wrappers on the table ate fewer chocolates than participants who were asked to put their wrappers in the wastebasket, presumably because leaving the wrappers on the table made it easier for participants to monitor how many chocolates they had eaten.

Evidence also points to a relationship between the ability to identify discrepancies (between the current state and desired state) and self-control. For example, Skoranski et al. (2013) found that, relative to normal weight children, obese children were poorer at monitoring their performance on a variant of the Stroop task, as indicated by blunted error-related negativity in their neural activation. This finding suggests that problems identifying when actions deviate from goals may hamper self-regulation and could have contributed to their obesity (Smith & Mattick, 2013, reported a similar relationship among heavy drinkers). Similarly, Chambers and Swanson (2012) found that people who were successful in maintaining weight loss tended to monitor their weight and have a clearly defined upper limit (a 'trigger point', such as an increase in dress size or gaining 10lbs) at which they would take action to reduce their weight.

Other studies have observed no effects of progress monitoring on outcomes, however. For example, DeWalt et al. (2006) randomly allocated patients with heart failure to receive usual care or an intervention emphasizing the importance of daily self-weighing. Although patients who were exposed to the intervention reported monitoring their weight

daily, there was no difference in quality of life at 12 months. A review by Michie et al. (2009) also reported no significant bivariate association between the use of progress monitoring as an intervention technique and effect sizes obtained in physical activity and dietary interventions (see Table S5 in the Supplementary Materials; http://dx.doi.org/10.1037/a0016136.supp). Some studies have even found that progress monitoring has detrimental outcomes. For instance, Carli et al. (2008) reported that participants who were asked to monitor their sun exposure using a UV-meter actually spent more time in the sun, used fewer sun protective measures, and experienced greater sunburn than participants who were not asked to use a UV-meter. In short, the impact of progress monitoring on goal attainment differs across primary studies.

Extant reviews of the literature also have not clarified the role of progress monitoring in goal attainment. Narrative reviews have been criticized as being subjective, scientifically unsound, and inefficient (Light & Pillemer, 1984). Furthermore, these reviews do not permit inferences about the magnitude of the effect of progress monitoring on outcomes (e.g., Abrahamse et al., 2005; Korotitsch & Nelson-Gray, 1999). Previous quantitative syntheses of the impact of progress monitoring exhibit three important limitations. First, some reviews include only a relatively small number of studies (e.g., Richardson, Newton, Abraham, Sen, Jimbo, & Swartz, 2008, could locate only 9 studies examining the impact of pedometers on weight loss) or focus on specific contexts (e.g., Febbraro & Clum's, 1998, review focused on the effects of self-monitoring on adult problem behaviors), and so preclude generalizations. Second, previous reviews have not computed the effect of interventions on the frequency of progress monitoring, and so we do not know whether interventions designed to promote progress monitoring actually

succeeded in doing so. This is particularly problematic as many interventions incorporate progress monitoring alongside other behavior change techniques (BCTs). For example, Burke, Giangiulio, Gillam, Beilin, and Houghton (2003) provided participants with a 16-week program designed to promote physical activity and healthy eating. Completing activity diaries was just a small part of the larger intervention program (that, according to Michie et al., 2009, included 14 other BCTs). Without examining the effects of such interventions on the frequency of progress monitoring, it is difficult to isolate the effects of progress monitoring on goal attainment. Finally, some reviews have merely assessed the correlation between progress monitoring and outcomes. For instance, Michie et al. (2009) regressed effect sizes on the presence versus absence of a progress monitoring component in relevant interventions (respectively coded 0 and 1 by the researchers). Thus, a meta-analytic integration of the experimental evidence is needed to draw firm conclusions about whether, and to what extent, progress monitoring promotes rates of behavioral performance and goal attainment.

Moderators of the Impact of Progress Monitoring on Goal Attainment

Several variables could influence the impact of progress monitoring on goal attainment. The present review delineates three broad classes of moderator variables pertaining to the characteristics of the intervention, study methodology, and sample, respectively.

Intervention Characteristics. To answer both conceptual and practical questions about when and how progress monitoring influences goal attainment, it is important to examine the nature of progress monitoring prompted by the intervention. Drawing upon conceptual frameworks for understanding the nature of progress monitoring, (e.g., Anseel,

Beatty, Shen, Lievens, & Sackett, 2015; Ashford & Cummings, 1983; Wilde & Garvin, 2007) and careful examination of extant interventions designed to promote progress monitoring (i.e., a combined 'top-down' and 'bottom-up' approach, as advocated by Koole, 2009; Skinner, Edge, Altman, & Sherwood, 2003; Webb, Miles, & Sheeran, 2012), we identified six key dimensions that could be used to code how goal progress was monitored in each of the interventions identified in the present review (see Table 1).

The first dimension is the focus of monitoring, which distinguishes between monitoring behavior versus monitoring the outcomes of behavior (e.g., Michie, Ashford, Sniehotta, Dombrowski, Bishop, & French, 2011; Michie et al., 2013). For example, people seeking to lose weight could keep track of their snacking behavior, or they could keep track of their weight (a likely outcome of snacking behavior). We predict that a match between the focus of monitoring (behavior vs. outcome) and the dependent variable (behavior vs. outcome) will improve performance. Thus, we expect that monitoring behavior (e.g., snack intake) will have a larger impact on subsequent behavior (e.g., the number of snacks consumed) than on outcomes (e.g., weight loss), whereas focusing on outcomes will have a larger impact on subsequent outcomes than on behavior. This is because behavioral discrepancies are informative about the need to adjust the specific behavior but may say little about outcomes that are likely determined by multiple behaviors. Outcome discrepancies, on the other hand, may suggest the need to increase effort on multiple behaviors in order to reach the desired outcome but may say little about any particular behavior (as substitute behaviors could serve the same ends; Kruglanski, Shah, Fishbach, Friedman, Chun, & Sleeth-Keppler, 2002).

The second dimension concerned whether interventions asked participants to monitor their progress in public or in private. Protocols that require participants to monitor their progress in public (e.g., weigh themselves during a weight loss class, Samuel-Hodge et al., 2009) or to submit reports on their goal progress (e.g., step counts, De Cocker, De Bourdeaudhuij, & Cardon, 2008; diaries of peak flow or symptoms related to asthma, Buist, Vollmer, Wilson, Frazier, & Hayward, 2006) may engender a greater sense of public commitment to the goal (Cialdini, 2001; Kiesler, 1971), accountability (e.g., Stuckey et al., 2011), presentational concerns (Schlenker, Dlugolecki, & Doherty, 1994) or experimenter demand (Zizzo, 2010), each of which could serve to promote goal attainment.

The third dimension involved whether or not participants were asked to physically record the information obtained from monitoring (e.g., write the information in a diary). This form of monitoring has been termed 'self-recording' (Korotitsch & Nelson-Gray, 1999). Physical logs, even if kept private, can provide the opportunity for the person to examine and reflect on their progress toward the goal over time, and potentially identify actions that promote or hamper goal progress. We therefore expected that interventions that prompted participants to physically record the information that they obtain from monitoring their goal progress would obtain larger effects on goal attainment than interventions that did not have this requirement.

Assessing goal progress involves comparing the current state with a reference value (Carver & Scheier, 1982; 1990). The effects of progress monitoring on goal attainment might, therefore, also be influenced by the nature of the reference value against which participants evaluate their progress. The fourth dimension of progress monitoring examined here concerned whether reference values took the form of: (i) a desired target or goal (e.g.,

target blood sugar levels, Bell, Fonda, Walker, Schmidt, & Vigersky, 2012); (ii) a reference value in the past (e.g., with respect to previously abnormal HBA1C levels; Farmer et al., 2007); or (iii) comparison to others (e.g., comparing level of exercise with that of others; Hurling et al., 2007).

The fifth dimension on which approaches to progress monitoring can differ distinguished between monitoring distance from a goal versus rate of progress toward the goal. Goal setting theory (Locke & Latham, 1990) proposed that the absolute size of the discrepancy between current and desired states (i.e., the distance from the goal) determines subsequent effort. According to Carver and Scheier (1982; 1990), however, it is not only the absolute discrepancy between the current state and the reference value that matters, but also the rate with which progress is being made (or not made). For example, a dieter may be a long way from their goal of losing 30lbs, but if they have lost 4lbs over the preceding week then they are likely to feel pleased with their rate of progress, which could galvanize effort.

The final dimension of progress monitoring examined the distinction between passive versus active monitoring. This distinction originated in organizational psychology (e.g., Anseel, Beatty, Shen, Lievens, & Sackett, 2015; Ashford & Cummings, 1983) and the literature on information seeking (e.g., Berger, 2002). Passive monitoring involves obtaining information about progress without having to make deliberate efforts to seek out and scrutinize that information. For example, passive monitoring of progress toward a weight loss goal could involve noticing that clothes feel looser than before (Chambers & Swanson, 2012), or realizing that friends have commented on how slim one looks. In

contrast, active monitoring involves actively seeking out and attending to information about goal progress (e.g., deliberately weighing oneself).

In addition to the six dimensions of progress monitoring outlined in Table 1, we also examined the method used to promote progress monitoring. For example, Acharya, Elci, Sereika, Styn, and Burke (2011) compared the effects of monitoring dietary and exercise behavior using a personal digital assistant (PDA) versus a written diary and observed no significant differences in weight loss. Given the range of methods that can be used to monitor goal progress and the increasing availability of technology to support self-monitoring (Conroy, Yang, & Maher, 2014), it is important to compare the effects of different methods on both the frequency of progress monitoring and goal attainment.

We also considered whether the source and the duration of the intervention influenced effect sizes. Research on persuasion suggests that the source of the message has an important influence on its impact (Chaiken, 1980; Maddux & Rogers, 1980, see Wilson & Sherrell, 1993, for a review). It is possible that interventions designed to promote progress monitoring that are delivered by credible or expert sources (e.g., health professionals) improve adherence and goal attainment compared to interventions delivered by other parties (e.g., researchers) (for reviews of the effects of source credibility, see Eisend, 2004; Kumkale & Albarracin, 2004; Latimer, Brawley, & Bassett, 2010; Pornpitakpan, 2004). It is less clear how the duration of the intervention might be expected to influence effect sizes. On the one hand, monitoring progress over a longer period of time could provide more extensive and useful information, and afford greater opportunity to change behavior and outcomes. Thus, we might expect a ‘dose-response’ relationship such that the length of time over which participants monitor their goal progress is related to the

size of the change in goal attainment. On the other hand, monitoring progress may become less informative over time, or the person may habituate to the information obtained from progress monitoring (Ashford & Cummings, 1998; Webb, Chang, & Benn, 2014). Therefore, longer periods of monitoring may not confer additional benefit.

The final intervention characteristic concerns the use of additional BCTs alongside progress monitoring (Abraham & Michie, 2008). Michie et al. (2009) found that combining progress monitoring with one of four other BCTs (intention formation, specific goal setting, feedback on performance, and review of behavioral goals) was associated with larger effects of interventions on physical activity and diet. Similar findings have been reported in systematic reviews of behavioral interventions for weight control (Dombrowski et al., 2012), physical activity and healthy eating (Greaves et al., 2011), and problem behaviors (Febbraro & Clum, 1998). The present meta-analysis therefore coded the use of additional BCTs alongside monitoring of behavior and/or outcomes. We also separated immediate from delayed feedback (on behavior vs. outcomes, respectively) because previous research has shown that immediate feedback is more beneficial than delayed feedback (e.g., in learning contexts, Dihoff, Brosvic, Epstein, & Cook, 2004; Opitz, Ferdinand, & Mecklinger, 2011).

Methodological Characteristics. The second category of moderator variables relates to methodological characteristics of the primary studies, and includes: (a) The nature of the comparison group, (b) the nature of the focal goal, (c) how key variables were measured (e.g., self-report vs. objective assessment), (d) study quality, (e) publication status, and (f) participant characteristics. Progress monitoring interventions have been compared to control conditions that do not involve monitoring (e.g., Spence et al., 2009,

asked participants in the intervention condition, but not the control condition, to return a diary of their step counts as recorded by a pedometer), control conditions where participants monitor their progress but in a different manner to the treatment condition (e.g., Beasley et al., 2008, compared the use of PDAs with paper diaries for monitoring food intake), and control conditions where participants monitor their progress to a lesser extent than do participants in the treatment condition (e.g., Gokee LaRose, Gorin, & Wing, 2009, had participants in the control condition weigh themselves only once a week, whereas participants in the treatment were asked to weigh themselves daily). Reviews in other domains have shown smaller effects for interventions when compared to active control conditions than when compared to passive control conditions (e.g., Portnoy, Scott-Sheldon, Johnson, & Carey, 2008), and so we expected that the effect of interventions designed to promote progress monitoring would be larger if the control conditions did not involve progress monitoring.

We also anticipated that the effects of progress monitoring might vary for different goals. For example, self-monitoring of blood glucose levels could be an effective way to manage diabetes (Allemann, Houriet, Diem, & Stettler, 2009; Coster, Gulliford, Seed, Powrie, & Swaminathan, 2000), while self-weighing may have a smaller impact on weight loss (Burke, Wang, & Sevick, 2011; VanWormer, French, Pereira, & Welsh, 2008). The methodological rigor of the primary studies might also influence the validity of estimated effect sizes (Juni, Altman, & Matthias, 2001; Moher, Cook, Eastwood, Olkin, Rennie, & Stroup, 1999; Moja, Telaro, D'Amico, Moschetti, Coe, & Liberati, 2005; Oxman & Guyatt, 1988). We therefore rated aspects of study quality including participant blinding, experimenter blinding, and the type, quality, and success of randomization. As unpublished

studies may use less rigorous methods than published studies, publication status was also coded. Finally, **t**he type of sample (e.g., general public vs. people with particular health conditions), and the mean age and gender composition of the sample was also coded.

The Present Review

The foregoing discussion indicates that progress monitoring constitutes a key component of Control Theory and other leading models of goal-directed behavior, and is a crucial process that intervenes between intention formation and goal attainment. However, despite the conceptual significance of progress monitoring, and its increasing deployment as a technique for promoting behavior change, empirical evidence concerning the role of progress monitoring is equivocal. A meta-analytic review is needed to quantify the impact of progress monitoring on rates of behavioral performance and goal attainment.

The present meta-analysis includes only studies that randomly allocated participants to a treatment condition designed to promote progress monitoring versus a control condition. The review assesses the impact of interventions on both the frequency of progress monitoring and rates of goal attainment. We also test the predictions that: (i) The effect of the interventions on goal attainment are mediated by changes in progress monitoring, and (ii) intervention effects on outcomes are mediated by changes in behavior among participants who monitored their goal progress. Finally, we assess whether dimensions of progress monitoring and other intervention, methodological, and sample characteristics influence effect sizes.

Method

Selection of Studies

There were three inclusion criteria for the review. First, studies had to randomly assign (adult, human) participants to a treatment condition that received an intervention designed to promote monitoring of goal progress, or a control condition that received either an active, comparison intervention (e.g., an intervention that also prompted progress monitoring, but in a different manner or to a lesser degree than the treatment condition) or a no-intervention group (e.g., a waiting list control group). Interventions were deemed to have prompted progress monitoring if participants were invited to monitor their behavior (e.g., to use a pedometer) and/or the outcomes of their behavior (e.g., to weigh themselves). Second, studies had to measure the frequency of progress monitoring following the intervention. Finally, studies had to include a measure of behavior(s) (e.g., step count) or outcome(s) (e.g., levels of glycated haemoglobin [HbA1c], weight) in the wake of the intervention.[1]

The sample of studies was generated via a computerized search of social scientific databases (those accessed by Web of Knowledge[2], as well as UMI Dissertation Abstracts). Three search filters were used, one for randomized control trials (random* AND intervention or random* AND experiment*)[3], one for progress monitoring designed to reflect different terms for self-monitoring and methods that interventions might use to invoke progress monitoring (monitor* OR progress OR track OR diary OR website OR Personal Digital Assistant OR Phone OR pedometer OR meter OR self-weigh*), and one filter for the dependent variable (goal OR behav* OR outcome OR perform* OR consum*). Articles had to include at least one term from each of the filters in the title, abstract, or

keywords. We also: (a) Considered all of the articles that cited Carver and Scheier's (1982) paper on Control Theory, (b) searched the reference lists of reviews of self-monitoring in other domains (e.g., pro-environmental behavior, Abrahamse et al., 2005; clinical practice, Korotitsch & Nelson-Gray, 1999; educational, Webber, Scheuermann, McCall, & Coleman, 1993; and organizational settings, Anseel et al., 2015; Ashford, 2003), (c) examined the reference lists in each article that was deemed suitable for inclusion (ancestry approach; Johnson, 1993), and (d) sent emails requesting published and unpublished data to the distribution lists of the European Association of Social Psychology, European Health Psychology Society, Society for Personality and Social Psychology, and the British Psychological Society (Social Psychology Section).

Figure 1 shows the flow of information through the review. Of the 22,054 articles that were initially identified, 21,556 were obtained from the database search and 498 from citations of Carver and Scheier (1982); 9,753 duplicates were removed. During initial screening, the title, abstract and keywords were considered. The majority of papers rejected at this stage did not randomly assign participants to conditions. For example, Poirier and Cobb (2012) examined engagement with a web-based intervention. However, the impact of engagement (on the frequency of progress monitoring and goal attainment) was not evaluated with respect to a control condition, which did not receive the intervention. Of the 12,301 articles screened in this manner, 636 studies were identified as potentially eligible for inclusion. These studies were then evaluated in detail. Two hundred and nineteen studies (34%) were excluded because they did not include a measure of progress monitoring following the intervention (e.g., Gillis, Lumley, Mosley-Williams, Leisen, & Roehrs, 2006; Levy, Xu, Daly, & Ely, 2013). A further 141 studies (22%) did include a

measure, but did not report sufficient data for us to be able to compute an effect size and this information could not be obtained by emailing the author(s) (e.g., Reijonsaari et al., 2012). Eighty one studies (13%) were excluded because they did not randomly assign adult participants to an intervention condition designed to promote self-monitoring of goal progress (e.g., Graham, Cha, Cobb, Fang, Niaura, & Mushro, 2013; Te Velde, Wind, Perez-Rodrigo, Klepp, & Brug, 2008). Nineteen studies (3%) were excluded as they outlined a method for a future study (e.g., described the protocol for an RCT) (e.g., Focht et al., 2011; Ma et al., 2013). Seventeen studies (3%) were excluded because they reported additional effects of data already included in the review (e.g., Farmer et al., 2009, and French, Wade, Yudkin, Neil, Kinonth, & Farmer 2008, reported findings from the same dataset as Farmer et al., 2007). Nine studies (1%) were excluded because they focused on children (e.g., Belzer et al., 2014; Brown, Dunn, & Budney, 2014), and five studies (1%) were excluded as they did not measure goal attainment in the wake of the intervention (e.g., Olson, Schmidt, Winkler, & Wipfii, 2011). Finally, we rejected four duplicate studies, along with two studies where the measure of progress monitoring was not sufficiently distinct from the measure of goal attainment (Williams et al., 2006; Carr et al., 2013) and one study that was not written in English (Wang, Kueffer, Wang, & Maercker, 2014). Table 2 presents the characteristics and effect sizes for each included study. (An asterisk precedes each of these papers in the reference list.)

Data Extraction

Coding of Study Characteristics. For each study, we coded the following methodological characteristics: (a) Bibliographic information (e.g., publication status); (b) the nature of the focal behavior or outcome (e.g., weight, HbA1c levels, steps taken); (c)

the nature of the measures of progress monitoring and goal attainment (i.e., self-report or objective); and (d) aspects of study quality as defined by Chalmers et al. (1990) (e.g., participant and experimenter blinding, randomization success, method of randomization, quality of randomization). We also coded the following characteristics of the focal sample: (a) The type of sample (i.e., general public, university students, specific sample); (b) the average age of participants in the treatment condition; and (c) the proportion of females in the treatment condition. Finally, we coded the following characteristics of each intervention: (a) Whether participants were prompted to monitor behavior or the outcomes of behavior; (b) whether progress was monitored in public or in private (the latter category was further divided into monitoring in private and not reported versus monitoring in private and the information was reported to at least one other person); (c) whether the information obtained from monitoring was physically recorded or not; (d) the nature of the reference value against which the information derived from monitoring was compared (e.g., past performance, a desired target, or others' performance); (e) whether participants were prompted to monitor their rate of progress or their distance from the reference value; (f) whether monitoring was active or passive; (g) the method used to promote progress monitoring (e.g., diary, personal digital assistant, pedometer); (h) the source of the intervention (i.e., health professionals, researchers/study interventionists, or a mixed team); and (i) the duration of the intervention (in days).

We also coded whether the interventions included any BCTs in addition to progress monitoring. We coded for the presence versus absence of 8 BCTs identified by Michie et al. (2009) using the definitions provided by Michie et al. (2013): (a) Goal setting (behavior); (b) goal setting (outcome); (c) review of behavioral goals; (d) review of

outcome goals; (e) action planning; (f) prompt identification of a discrepancy between current behavior and goal; (f) feedback on behavior (immediate vs. delayed); and (g) feedback on outcomes (immediate vs. delayed). Immediate feedback was defined as that provided immediately following the performance of a behavior. Where there was a gap between the behavior and the feedback, the feedback was defined as delayed (e.g., participants posted information on their dietary behaviors to which a dietitian returned handwritten feedback). Only BCTs that differed between the treatment and control conditions (and so could account for differences between the conditions) were coded.

All of the studies were coded by the first and third authors. There was a high level of agreement (for categorical characteristics, median kappa = 0.95, range = 0.48 to 1.00; for continuous characteristics, median r = 0.99, range = 0.94 to 1.00) and disagreements were resolved jointly by discussion.

Computing Effect Sizes. Effect sizes (representing the effect of interventions on the frequency of progress monitoring and behavior and/or outcomes) were calculated as the standardized mean difference between the treatment and comparison conditions divided by their pooled standard deviation (Hedges & Olkin, 1985). Whenever possible, effect sizes were calculated using the means and standard deviations. However, if the means and standard deviations were not reported, then the metric that was available (e.g., F ratio, chi-square) was converted to an effect size. When effect sizes could not be computed precisely on the basis of information in the report or correspondence with authors (10 effects on progress monitoring, 7%, 13 effects on goal attainment, 9%), then we estimated values based on the significance levels reported. For example, if the effect was non-significant, then we assumed zero difference ($d = 0.00$). If the effect was significant at $p < .05$, then we

used the smallest value of d (given the sample size) that was significant at this level of alpha.[4]

When multiple intervention conditions used the same method to promote progress monitoring, and there were no differences in the frequency of progress monitoring between the conditions, the conditions were combined and compared to relevant comparison condition(s) (3 studies or 2%, e.g., Nanchahal, Townsend, Latley, Haslam, Wellings, & Haines, 2009). Where there were multiple intervention conditions that used the same method to promote progress monitoring, but differed in the frequency of progress monitoring (10 studies or 7%, e.g., Hellerstedt & Jeffrey, 1997), the intervention conditions were treated as separate tests and the sample size for the comparison condition was divided by the number of intervention conditions (as recommended by Higgins & Green, 2011). When there were multiple comparison conditions (e.g., in Andrews et al., 2011, either usual care or the intervention without a pedometer could be treated as the comparison condition), we selected the comparison condition that most closely matched the treatment condition, in an effort to isolate the effect of progress monitoring (6 studies or 4%). If studies did not clearly define which conditions were the treatment versus control (e.g., Pellegrini, Verba, Otto, Helsel, Davis, & Jakicic, 2012, compared standard behavioral weight loss, a technology-based system, and a combined intervention), we prioritized conditions for which there was information on the frequency of progress monitoring, and treated the condition that reported the most frequent progress monitoring as the treatment condition, and the condition that reported the least frequent progress monitoring as the comparison condition (7 studies or 5%). This strategy was designed to maximize our ability to test the effect of changes in the frequency of progress monitoring on goal attainment.

When there were multiple measures of behavior and/or outcomes, effect sizes were computed separately for each measure and then meta-analyzed in their own right before inclusion in the main dataset. Where studies reported baseline and follow-up measures of behavior or outcomes, we computed effect sizes based on change scores (83 studies or 60%). If change scores were not reported (45 studies or 33%), then follow-up scores were converted to change scores, using the method described by Higgins and Green (2008).

Meta-Analytic Strategy

Effect size computations were undertaken using STATA version 11 and the revised metan command (StataCorp, 2009). This provided effect sizes, weighted by sample size, with a 95% confidence interval, and an estimate of heterogeneity. A random effects model was employed as we expected that effect sizes from the primary studies were likely to be too complex to be accurately captured by a few study factors (Cooper, 1986). Three studies used cluster randomization and effect sizes were corrected using the procedures described by Higgins and Green (2011).[5] Outlying effect sizes (defined as effect sizes that were three standard deviations larger or smaller than the mean) were winsorized and replaced with the next most extreme value (Dixon, 1960; Tukey, 1962). Following Cohen's (1992) recommendations, d = 0.20 was taken to represent a 'small' effect size, d = 0.50 a 'medium' effect size, and d = 0.80 a 'large' effect size and we used these qualitative indexes to interpret the findings.

Results

Effect of the Interventions on Frequency of Progress Monitoring and Goal Attainment

We first computed the effect size for the difference in the frequency of progress monitoring between the treatment and control conditions following the intervention (see

Figure 2). The sample-weighted average effect size was $d_+ = 1.98$ with a 95% confidence interval from 1.72 to 2.24, based on 138 studies and a total sample size of 19,951. This indicates that the interventions had, on average, a (very) large effect on the frequency of progress monitoring according to Cohen's (1992) criteria. Our sample of studies, therefore, is suitable for testing whether progress monitoring promotes rates of behavioral performance and goal attainment. There was, however, significant heterogeneity in effect sizes across the primary studies, $Q(137) = 7490.15$, $p < .001$, and it is worth noting that interventions had a larger effect on the frequency of progress monitoring when the comparison condition involved no monitoring ($d_+ = 3.34$) than when the comparison condition involved some progress monitoring ($d_+ = 0.68$), $Q(1) = 5252.05$, $p < .001$ (see Table 3).

Next, we computed the average effect of the interventions on goal attainment (see Figure 3). The sample-weighted average effect size was $d_+ = 0.40$ with a 95% confidence interval from 0.32 to 0.48 ($k = 138$; $N = 18,398$). Effect sizes were heterogeneous, $Q(137) = 837.77$, $p < .001$. The sample-weighted average effect of the interventions on studies that only measured behavior was $d_+ = 0.37$ ($k = 35$, $N = 5,518$, 95% CI: 0.25 to 0.49), and among those that focused on outcomes was $d_+ = 0.44$ ($k = 86$, $N = 10,593$, 95% CI: 0.33 to 0.55). There was significant variability in effect sizes in both cases, $Q(34) = 116.77$, $p < .001$ and $Q(85) = 581.76$, $p < .001$, respectively. In summary, interventions that engendered large-sized changes in the frequency of progress monitoring, on average, led to small-to-medium-sized changes in goal attainment.

To check this conclusion, we conducted a mediation analysis using data from the 21 studies ($N = 1,995$) where the correlation between the frequency of progress monitoring

and goal attainment could be retrieved.[6, 7] In line with Kenny, Kashy, and Bolger's (1998) recommendations, four multiple regressions were conducted to establish mediation (d values were converted to effect size r for this purpose, and the sample-weighted average correlations between intervention, frequency of progress monitoring, and goal attainment were used in the matrix input function for multiple regression). Regression analyses showed that intervention (the independent variable) predicted both changes in goal attainment (the dependent variable) and changes in the frequency of progress monitoring (the proposed mediator; see Figure 4). Changes in the frequency of progress monitoring also predicted changes in goal attainment. Most important, however, changes in the frequency of progress monitoring attenuated the effect of the interventions on goal attainment in a simultaneous regression analysis. This conclusion was confirmed by a significant value on Kenny et al.'s (1998) modification of the Sobel (1982) test ($Z = 13.09$, $p < .001$), which shows that changes in the frequency of progress monitoring significantly reduced the association between interventions and goal attainment.

Tests for Potential Bias

Three analyses tested for publication and small sample bias. First, we compared effect sizes for published (k = 129, 93%) versus unpublished studies (k = 9, 7%). No significant difference in effect sizes was observed for the frequency of progress monitoring ($d_+ = 1.99$ vs. 1.86, for published and unpublished studies, respectively) or goal attainment ($d_+ = 0.40$ vs. 0.42, respectively) suggesting a lack of publication bias. Second, we computed Egger's regression (Egger, Davey-Smith, Schneider, & Minder, 1997) to test for asymmetry in the distribution of effect sizes. The regression coefficients were significant for progress monitoring ($p < .001$) and goal attainment ($p < .01$). We therefore used Duval

and Tweedie's (2000) trim and fill analysis to estimate adjusted effect sizes. The trim and fill analysis imputed 37 and 31 additional effect sizes and produced adjusted estimates of d_+ =1.16 (95% CI = 0.89 to 1.44) and d_+ = 0.19 (95% CI = 0.10 to 0.28) for the frequency of progress monitoring and goal attainment, respectively. Peters, Sutton, Jones, Abrams and Rushton (2007) pointed out that "[w]hen there is large between-study heterogeneity the trim and fill method can underestimate the true positive effect when there is no publication bias" (p. 4544). Both of these conditions were met in the present data. Our interpretation, therefore, is that: (a) The influence of publication bias in the current meta-analysis is modest rather than severe (Rothstein, Sutton, & Borenstein, 2005), and (b) the magnitude of effects on frequency of progress monitoring and goal attainment can be deemed large and small-to-medium, respectively. This interpretation is also supported by findings from tests for small sample bias. Coyne, Thombs, and Hagedoorn (2010) recommended that researchers compute effect sizes separately for studies that have at least 55% power to detect a medium-sized effect (i.e., $n \geq 35$ per condition). Seventy studies in the present review (51%) met this criterion. The effect sizes among these, adequately powered, interventions was $d_+ = 2.05$ for frequency of progress monitoring and $d_+ = 0.33$ for goal attainment.

Does Behavior Change Mediate the Impact of Progress Monitoring on Outcomes?

Next, we investigated whether changes in behavior mediated the effect of interventions designed to promote progress monitoring on outcomes (e.g., whether interventions improved dietary and exercise behavior which, in turn, explained weight loss). Mediation analyses were undertaken using data from the 6 studies (N = 473) where the correlation between changes in behavior and changes in outcomes could be retrieved.[8]

Intervention (the independent variable) predicted changes in outcomes (the dependent variable), and in behavior (the proposed mediator; see Figure 5). Changes in behavior also predicted changes in outcomes. Most important, however, simultaneous regression analysis showed that changes in behavior attenuated the effect of intervention on outcomes. This conclusion was confirmed by a significant value on Kenny et al.'s (1998) modification of the Sobel (1982) test ($Z = 3.54$, $p < .01$). Thus, changes in behavior mediated the relationship between interventions and outcomes.

Moderators of Intervention Effects on Progress Monitoring and Goal Attainment

The effects of the interventions on the frequency of progress monitoring and goal attainment were heterogeneous, which encourages the search for moderator variables. The sample-weighted effect size (d_+) and homogeneity statistic (Q) were therefore calculated separately for each level of the moderator, and Schwarzer's (1988) META programme was used to test whether effect sizes differed significantly (see Table 3). The impact of continuous moderators (i.e., duration of the intervention) on effect sizes was examined using meta-regression (via the metareg command in STATA, see Table 4).

Intervention Characteristics. We began by examining moderation by intervention characteristics. Several dimensions of progress monitoring influenced the frequency with which participants monitored their progress and the effects of so doing on goal attainment. Below, we focus on the effects on goal attainment, but the effects on the frequency of progress monitoring were broadly similar (see Table 3). The focus of progress monitoring (behavior versus outcomes) did not appear to influence effect sizes for goal attainment (see Table 3). However, we observed the predicted 'matching effect', such that monitoring behavior had a large, reliable effect on behavior ($d_+ = 0.79$, 95% CI: 0.50 to 1.07, $k = 17$, N

= 2,565), but no reliable effect on outcomes (d_+ = 0.14, 95% CI: -0.18 to 0.46, k = 8, N = 1,175), Q for comparison = 82.91, $p < .001$. In contrast, monitoring outcomes had a medium-to-large, reliable effect on outcomes (d_+ = 0.62, 95% CI: 0.26 to 0.98, k = 30, N = 4,199), but did not reliably affect behavior (d_+ = 0.17, 95% CI: -0.01 to 0.36, k = 4, N = 975), Q for comparison = 39.59, $p < .001$.[9]

Prompting participants to monitor their progress in public or to report the information that they obtained via monitoring had larger effects on goal attainment (d_+ = 0.55 and 0.47, respectively) than did monitoring in private (d_+ = 0.19), Q(1) = 6.17 and 48.91, respectively, $p < .05$ and $< .001$. Physically recording the information derived from monitoring led to larger effects on goal attainment (d_+ = 0.43) compared to not recording this information (d_+ = 0.29), Q(1) = 12.71, $p < .001$), and this was also the case when goal attainment was measured objectively (d_+ = 0.57 vs. 0.23). The nature of the reference value did not influence effect sizes. Comparing the current state to a desired (future) target had comparable effects on goal attainment (d_+ = 0.41) as comparing the current state to a reference value in the past (d_+ = 0.43), Q(1) = 0.14, p = 0.71. Finally, whether participants monitored their rate of goal progress or distance from the goal, or used passive versus active forms of monitoring, did not influence the impact of monitoring on goal attainment, Q(1) = 0.19 and 0.49 for the two comparisons, respectively.

The method used to promote progress monitoring influenced the frequency with which participants monitored their progress, Q(6) = 826.86, $p < .001$, and the effect of the interventions on goal attainment, Q(6) = 102.38, $p < .001$. Interventions that asked participants to monitor their progress using a phone (d_+ = 2.67), blood pressure monitor (d_+ = 3.31), or pedometer (d_+ = 3.02) showed the largest differences in the frequency of

progress monitoring (relative to comparison conditions). The largest effects on goal attainment were observed among participants using a blood pressure monitor or blood glucose monitor to assess their goal progress (d_+ = 0.64 and 0.60, respectively). The source of the intervention also significantly influenced the frequency of progress monitoring, $Q(3) = 213.40$, $p < .001$, and (marginally) goal attainment, $Q(3) = 7.13$, $p = .07$. Pairwise comparisons revealed that interventions that were delivered by health professionals were associated with larger changes in the frequency of progress monitoring ($d_+ = 2.31$) than interventions delivered by researchers ($d_+ = 1.63$), mixed teams ($d_+ = 1.97$), or interventions that were not delivered face-to-face ($d_+ = 2.06$). For goal attainment, the only significant difference was that interventions delivered by researchers tended to have smaller effects ($d_+ = 0.35$) than interventions that were not delivered face-to-face ($d_+ = 0.54$). The duration of the intervention had no impact on the frequency of progress monitoring, $\beta = 0.00$, $t = 0.08$, $p < .94$, or on goal attainment, $\beta = -0.00$, $t = -0.15$, $p = .88$ (see Table 4).

The inclusion of additional BCTs – notably, goal setting, highlighting the discrepancy between current behavior and the goal, immediate feedback on behavior, delayed feedback on behavior or outcomes, or action planning – increased the effect of the interventions designed to promote progress monitoring on goal attainment, relative to interventions that did not incorporate these BCTs (see Table 5). Interestingly, providing immediate feedback on behavior alongside progress monitoring engendered larger effects on goal attainment than each of the other types of feedback ($p < .05$ for all comparisons). Prompting review of behavioral or outcome goals was not associated with a significant increase in the impact of interventions on goal attainment (see Table 5).

Methodological Characteristics. Finally, we examined the impact of methodological characteristics on effect sizes. The nature of the focal behavior or target outcome had a significant impact on the effect of interventions on the frequency of progress monitoring, $Q(1) = 452.48$, $p < .001$, and goal attainment, $Q(1) = 114.43$, $p < .001$. As Table 3 shows, prompting progress monitoring had medium-sized effects on goal attainment among studies focusing on depression ($d_+ = 0.66$), blood pressure ($d_+ = 0.63$), the management of asthma ($d_+ = 0.60$), physical activity ($d_+ = 0.59$), and blood glucose levels ($d_+ = 0.51$), and small effects among studies focusing on weight ($d_+ = 0.30$) and diet ($d_+ = 0.23$). Prompting progress monitoring did not promote goal attainment among studies focusing on heart care behaviors ($d_+ = 0.14$) or the use of healthcare systems ($d_+ = 0.01$). Effect sizes also differed as a function of the measure of progress monitoring, $Q(1) = 564.86$, $p < .001$, and goal attainment, $Q(1) = 10.33$, $p < .01$. Interventions had larger effects when the frequency of progress monitoring and goal attainment were measured objectively ($d_+ = 2.32$ and 0.44, respectively) rather than by self-reports ($d_+ = 1.50$ and 0.34, respectively).

Effect sizes were influenced by indicators of the quality of the primary studies such as the type, success, and quality of randomization procedures, and whether participants and experimenters were blind to condition (see Table 3). In general, and as might be expected, smaller effects tended to be observed in better quality studies. The type of sample also influenced effect sizes for frequency of progress monitoring, $Q(2) = 88.41$, $p < .001$, and goal attainment, $Q(2) = 10.15$, $p < .01$. Interventions had smaller effects on the frequency of progress monitoring and goal attainment among participants with particular medical

conditions (d_+ = 1.91 and 0.39) than among the general public (d_+ = 2.20 and 0.52). Participants' age or gender was not associated with effect sizes (see Table 4).

Discussion

Control Theory and other frameworks for understanding self-regulation propose that monitoring goal progress is crucial for effective goal striving and promotes goal attainment. Whereas other 'core' self-regulatory processes such as goal setting and responding to discrepancies have been the subject of meta-analytic reviews (e.g., De Ridder et al., 2012; Gollwitzer & Sheeran, 2006; Hagger et al., 2010; Locke, Shaw, Saari, & Latham, 1981; McEachan et al., 2011; Ouellette & Wood, 1998; Sheeran, 2002; Webb & Sheeran, 2006), the impact of interventions on the frequency of progress monitoring and rates of goal attainment has not been quantified. As a result, it has been difficult to evaluate the role of progress monitoring in shaping goal attainment. The present review provided this evaluation and observed a large-sized effect of interventions on the frequency of progress monitoring and a small-to-medium-sized effect on goal attainment.

Interventions designed to promote progress monitoring were highly effective at increasing monitoring frequency, and generated an effect size that was more than twice the magnitude of a conventional 'large' effect (d_+ = 1.98). This finding raises the question, why were interventions designed to promote progress monitoring so effective? One answer may be 'the ostrich problem', or peoples' motivated avoidance of information concerning goal progress (Webb et al., 2013). Webb et al. suggested that relatively few people spontaneously monitor their household energy consumption, check their bank balance, keep track of their food intake, or generally take stock of their current standing relative to their

goals (see also Liberman & Dar, 2009). The present findings thus indicate that there is considerable scope for improving monitoring frequency.

Prompting progress monitoring had a small-to-medium-sized effect on rates of goal attainment. Furthermore, changes in frequency of progress monitoring mediated the relationship between interventions and goal attainment. These findings confirm the importance of progress monitoring as a key mechanism by which people strive for goals (Burnette, Burnette, O'Boyle, Vanepps, Pollack, & Finkel, 2012; Carver & Scheier, 1982; Carver, Johnson, Joormann, & Scheier, 2015; de Bruin et al., 2012; Ford, 1987; Louro et al., 2007; Miller et al., 1960; Powers, 1973; Powers, Clark, & McFarland, 1960a, 1960b), and have both conceptual and practical importance. At the conceptual level, the findings suggest that models of behavior that posit a direct relationship between intentions and behavior (e.g., the Theory of Planned Behavior, Protection Motivation Theory) neglect a key volitional process that intervenes between goal setting and goal attainment – namely, monitoring goal progress (for reviews, see Gollwitzer & Sheeran, 2006; Sheeran et al., 2005; Sheeran & Webb, 2011). It is notable that progress monitoring had an impact on goal attainment ($d_+ = 0.40$) that is comparable to that reported for goal intentions ($d_+ = 0.36$ according to Webb & Sheeran, 2006), suggesting that effective goal striving requires that people not only decide upon an appropriate goal (e.g., "what is it that I want to achieve?"), but also that they compare ongoing behavior or the current status of the outcome to that goal (e.g., "where do I currently stand with respect to this goal?"). Monitoring goal progress serves to identify discrepancies between the current and desired state, which enables people to decide how best to allocate effort among salient goals (Carver & Scheier, 1982; Louro et al., 2007), and when and how to exercise restraint or initiate corrective

action (Fishbach et al., 2012; Myrseth & Fishbach, 2009). In light of the present review, we contend that models concerned with specifying the determinants of intentions such as the Theory of Planned Behavior might profitably be extended to integrate the important role of monitoring goal progress. Such integration holds the promise of a more complete understanding of goal-directed behavior. At the practical level too, the present findings could serve to improve behavior change interventions by affording new targets for intervention beyond behavioral intentions (see also de Bruin et al., 2012).

The Impact of Dimensions of Progress Monitoring on Goal Attainment

By identifying the key dimensions on which efforts to monitor progress may differ (Table 1), we were able to code these features of interventions and compute associations with both the frequency of monitoring and goal attainment. These analyses revealed support for our hypotheses concerning the match between the focus of progress monitoring and the dependent variable. Specifically, prompting participants to monitor their behavior had a significant impact on rates of behavioral performance but not on outcomes, whereas prompting participants to monitor outcomes had a significant impact on outcomes, but not on behavior. This finding can be explained by a goal systems perspective (Kruglanski et al., 2002), which suggests that goals can be achieved via a range of behavioral means. For example, the goal to reduce household energy bills could be achieved by taking shorter showers, by replacing light bulbs with low energy alternatives, or by fitting solar panels. Therefore, monitoring outcomes could prompt a range of corrective actions, and so is more likely to influence outcomes than the performance of any specific behavior. In contrast, monitoring behavior (e.g., the length of a shower) is likely to influence the performance of that behavior, but may not influence the outcome, particularly if the outcome can be

influenced by a variety of behaviors. Monitoring behavior versus outcomes could also differentially influence commitment such that people who monitor outcomes become more committed to the goal and are prepared to substitute different means to attain relevant outcomes, whereas people who monitor a particular behavior become committed only to that particular means of goal attainment (Kruglanski, Pierro, & Sheveland, 2011).

Progress monitoring had larger effects on goal attainment when the information gleaned from monitoring was reported or made public, than when it was kept private. This finding may indicate that monitoring progress in public increases the amount of effort that people put into striving for the goal – due to a sense of public commitment (Cialdini, 2001; Kiesler, 1971), personal accountability (e.g., Stuckey et al., 2011), presentational concerns (Schlenker et al., 1994), or experimenter demand (Zizzo, 2010). Future research might directly compare reported versus not reported forms of progress monitoring in order to assess whether these mechanisms mediate the effects of monitoring in public on outcomes.

We also observed larger effects of progress monitoring on goal attainment when the information obtained from monitoring was physically recorded than when it was not. There are a number of possible explanations for this effect. First, recording progress may increase the likelihood that the information is remembered, both in terms of strengthening the encoding of information and also facilitating retrieval. Second, given that information on goal progress may reflect badly on the self (Carlson, 2013; Karlsson, Loewenstein, & Seppi, 2009; Northcraft & Ashford, 1990; Tuckey, Brewer, & Williamson, 2002; Zuckerman, Brown, Fox, Lathin, & Minasian, 1979) or demand undesired action (Sweeny, Melnyk, Miller, & Shepperd, 2010), people may ignore or reject such information (for a review, see Webb et al., 2013). Thus, it is not enough merely to monitor progress – the

person must also face up to what the information shows (akin to self-confrontation, Bailey & Sowder, 1970; Schoutrop, Lange, Hanewald, Davidovich, & Salomon, 2002). Information may be more difficult to ignore or reject when it has been recorded (Roggeveen & Johar, 2002), thereby reducing the scope for self-deception (Greenwald, 1997). Finally, recording information may increase goal commitment because evidence suggests that people feel more committed and certain about decisions that are expressed via action (Cioffi & Garner, 1996). Future research should examine the mechanisms that underlie the utility of the recording information on progress , and the circumstances in which such recording is likely to be particularly beneficial.

The nature of the reference value generally did not influence the effect of interventions on goal attainment. Although there was some evidence that participants prompted to evaluate their progress with respect to a past state did so more frequently than those prompted to evaluate their progress with respect to a desired future state, both effect sizes were very large and the use of these different reference values did not influence the effect of the interventions on goal attainment. One intriguing hypothesis that we were unable to test here is that different reference values are suited to different stages of goal striving. Research by Bonezzi, Brendl, and De Angelis (2011) suggests that people tend to adopt their past state as a reference value in the early stages of goal pursuit (i.e., people ask themselves "how far have I gone?") and adopt the desired end state as their reference point when nearing the goal (i.e., people ask themselves "how far do I have to go?"). It was also the case that there were insufficient studies to examine the use of others' performance as a reference value. Given the pervasiveness of social comparison (e.g., Collins, 1996; Pinkus, Lockwood, Schimmack, & Fournier, 2008; Suls, Martin, & Wheeler, 2002) and evidence

attesting to the substantive impact that others' performance can have on self-regulatory processes (e.g., Aarts, Gollwitzer, & Hassin, 2004; Fitzsimons & Finkel, 2010; Shah, 2003a; 2003b), studies investigating the effects of monitoring goal progress with respect to others' performance are a priority for future research.

Although participants prompted to actively monitor their progress did so more frequently than those who passively monitored progress, both active and passive forms of monitoring influenced goal attainment, and there was no difference in their relative efficacy. Similarly, although participants who were prompted to monitor distance from the goal did so more frequently than those prompted to monitor their rate of progress toward their goal, both forms of monitoring were equally effective in promoting goal attainment. However, only three primary studies prompted participants to consider their rate of goal progress and so further tests are needed to draw firm conclusions, especially as small samples tend to bias the effect size upward (Coyne et al., 2010). Indeed, few empirical studies have explicitly investigated whether people are sensitive to the rate of discrepancy reduction (see, however, Gollwitzer & Rohloff, 1999; Hsee & Abelson, 1991, for notable exceptions).

Taken together, our findings provide some of the first tests of theoretical distinctions that have been drawn between different types of progress monitoring (e.g., Anseel et al., 2015; Ashford & Cummings, 1983; Wilde & Garvin, 2007) and information seeking (e.g., Berger, 2002), and make it clear that monitoring is not a unitary process. Rather, there are multiple ways in which people can assess their goal progress. The dimensions identified here may provide a useful impetus for examining the impact of specific forms of progress monitoring on goal attainment. In particular, there is a need for

studies that directly compare the efficacy of different forms of progress monitoring and identify the mechanisms by which they influence goal attainment.

The present review found that, while all of the techniques and tools for promoting progress monitoring were effective, some were more effective than others. Ideally, studies should compare the effects of different methods of progress monitoring for the same goal (e.g., Helsel et al., 2007, compared the impact of completing detailed diaries versus abbreviated diaries on monitoring food intake). Indeed, we intended to conduct such analyses in the present review; however, there were insufficient studies to permit meaningful comparisons. Even for the most frequently studied goal (weight loss; k = 50, 36% of studies), only three methods of progress monitoring (written diaries, websites, or PDAs) were used in at least three studies. Thus, caution is warranted in drawing conclusions about the effectiveness of different methods of progress monitoring. Research that explicitly compares different methods of monitoring goal progress will lead to more conclusive findings.

Previous reviews have found that interventions that incorporated additional BCTs alongside monitoring goal progress tended to have larger effects than interventions that prompted progress monitoring alone (e.g., Dombrowski et al., 2012; Febbraro & Clum, 1998; Greaves et al., 2011; Michie et al., 2009). Our findings support this idea – interventions that included goal setting, action planning, and some forms of feedback (namely, immediate feedback on behavior) alongside progress monitoring engendered larger effects than interventions that did not incorporate these additional BCTs. These findings could arise because additional BCTs target different self-regulatory processes that serve to bolster the impact of progress monitoring. That is, goal setting may help people to

set appropriate reference values (Bandura, 1991; Carver & Scheier, 1982), immediate feedback on behavior facilitates attention to and reinforces ongoing performance (Ashford, 1986; Della Libera & Chlazzi, 2006; Kluger & DeNisi, 1996), and planning helps people to act on discrepancies (for reviews, see Carraro & Gadreau, 2013; Gollwitzer & Sheeran, 2006). More generally, these findings underline the idea that theoretically supported combinations of BCTs can be particularly effective in promoting goal attainment (Michie et al., 2009; Prestwich, Webb, & Conner, 2015).

The Role of Methodological Factors

The nature of the focal goal had a substantial impact on the size of the effects observed in the present review. Progress monitoring appeared to have larger effects on goal attainment when it was used to manage specific medical conditions (e.g., asthma, Bateman et al., 2008; blood pressure, Imai et al., 2003; diabetes, Alleman et al., 2009; Norris, Engelgau, & Narayan, 2001), compared with other health goals (e.g., weight loss or dieting). It was notable that most of the studies that met our inclusion criteria focused on health goals. In fact, only one study could be included in the present review that asked participants to monitor in a domain unrelated to health (time spent doing different activities, Runyan, Steenbergh, Bainbridge, Daugherty, Oke, & Fry, 2013), despite reviews attesting to the benefits of self-monitoring in clinical, educational, and environmental domains (e.g., Abrahamse et al., 2005; Febbraro & Clum, 1998; Korotitsch & Nelson-Gray, 1999). One reason why studies in these domains could not be included in the present review is that they tended not to examine the impact of interventions on the frequency of progress monitoring (one of the key criteria for inclusion in the present review) meaning that it is difficult to

attribute the effects of such interventions to changes in the frequency of progress monitoring. Such measures should be included in future studies in these domains.

Effect sizes in the present review were not influenced by the age or gender of the sample, but were influenced by the type of sample. Specifically, effect sizes tended to be smaller for participants with particular medical conditions compared to members of the general public. It is possible that chronic health conditions make it harder to monitor progress or change behavior, or alter the impact of behavior on health outcomes because of genetic or physiological factors. In either case, it is worth noting that the interventions still had substantive effects on progress monitoring and goal attainment even for participants with chronic health conditions.

Measurement features and indicators of study quality also influenced effect sizes. Effect sizes were larger when progress monitoring and goal attainment were measured objectively, rather than by self-report. This finding may suggest caution in using self-report measures as interventions can influence outcomes in ways that are not amenable to self-report (cf. Maidment, Jones, Webb, Hathway, & Gilbertson, 2014). Consistent with previous meta-analyses (e.g., Wood et al., 2008), interventions had smaller effects when participants and experimenters were blind to conditions. This finding suggests that expectations about the benefits of progress monitoring can influence both the frequency of monitoring and goal attainment. Success and quality of randomization were associated with larger effects. Fortunately, studies with poor randomization procedures were in the minority and effect sizes remained robust across different types of randomization.[10] Finally, publication bias had a modest influence in the present review and effect sizes remained

substantively unaltered in studies that had adequate power according to Coyne et al.'s (2010) criterion.

Limitations

Conclusions drawn from the present meta-analysis must be mindful of the evidence base upon which it stands. After a search that started with over 22,000 records, 138 tests provided data on the effect of interventions prompting progress monitoring on goal attainment and could be included in the meta-analysis. These tests provided a robust evidence base for answering our key research questions, but we acknowledge the paucity of data concerning effects in particular domains (e.g., behaviors not related to health), the impact of particular types of monitoring (e.g., only three studies examined the effect of monitoring the rate of progress), and how moderators combine to influence effect sizes (e.g., how different dimensions of progress monitoring can best be combined to promote goal attainment). It is also worth noting that our analyses of moderators did not correct for the increased Type I error rate associated with conducting multiple tests. This was because most of the effects did not derive from the same sample and our focus was on determining the magnitude of effects, rather than significance testing. Finally, we acknowledge that some moderators examined here are likely to be correlated (e.g., studies that prompt participants to monitor the outcomes of their behavior may also be more likely to also ask participants to physically record this information). Future research might address such potential multicollinearity by independently manipulating features of progress monitoring and examining the effects on goal attainment.

We also recognize that the nature of the control condition had an important influence on the effect size observed for the frequency of progress monitoring. Arguably,

control conditions in which participants are not prompted to monitor their progress provide the clearest test of the impact of monitoring goal progress on outcomes. However, such studies rarely measured frequency of progress monitoring among participants in the control condition, and so we had to assume zero progress monitoring when computing effect sizes. An alternative approach would have been to substitute the mean frequency of progress monitoring from studies where these data were available. Unfortunately, the primary studies differed in too many substantive respects to permit this imputation strategy. We acknowledge that assuming zero levels of progress monitoring in the no-progress-monitoring control conditions may be suboptimal. However, in the absence of a viable alternative strategy, and in the light of evidence that people rarely monitor their progress unless prompted to do so (Liberman & Dar, 2009; Webb et al., 2013), we consider that the approach adopted here best captures the nature of the target processes. Further observational studies would be valuable, however, to confirm the validity of this approach.

We found that changes in the frequency of progress monitoring mediated the impact of interventions on goal attainment, suggesting that progress monitoring is a key process by which people strive for goals. We also found that changes in behavior mediated the effect of the interventions on outcomes. However, both of these mediation analyses were conducted at the level of the study, rather than the participant. Although mediation analyses using meta-analytic data are useful for building theory, they do have a number of limitations (for a review, see Viswesvaran & Ones, 1995). For example, aggregating across characteristics of the intervention, different methodologies, and samples can influence effect sizes. One solution to this problem would be to be even more selective about which studies to include in the mediation analyses (e.g., focusing only on studies that target

particular behaviors and that test the effect of similar interventions). However, the relatively small number of primary studies that reported relevant correlations in the present review meant that this it was not possible to be this selective. It is notable, however, that empirical studies that conducted mediation analyses using participants as the unit of analysis reached similar conclusions. For example, Wang et al. (2012) found that adherence to self-monitoring of diet and physical activity mediated the effect of a behavioral intervention on weight loss (see also Webber, Tate, Ward, & Bowling, 2010). In sum, notwithstanding its limitations, there are some grounds for thinking that the mediation analyses reported here accurately represent the processes under consideration.

Directions for Future Research

The present review observed that progress monitoring has an important role in shaping goal attainment, and thus raises a number of questions that might be addressed in future research. First, it will be important to better understand the factors influence the likelihood that people will monitor their goal progress. Although experimental studies that manipulate progress monitoring provide the best test of the effect of progress monitoring on goal attainment, these studies say little about the nature and determinants of spontaneous progress monitoring (i.e., what influences people to monitor in the first place, and how they go about doing so). Including measures of cognitions pertaining to monitoring (e.g., whether so doing is perceived as worthwhile or informative) could help to identify when and why people monitor their goal progress (for an illustrative approach, see Webb et al., 2014). Recent reviews (e.g., Anseel, Lievens, & Levy, 2007; Anseel et al., 2015; Webb et al., 2013) have adopted a self-motives framework (Sedikides & Strube, 1997) to propose that interactions among four different motives – self-assessment, self-improvement, self-

enhancement, and self-verification – determine the nature and extent of self-initiated progress monitoring. For example, the desire to accurately assess progress may increase progress monitoring, whereas the desire to protect or enhance the self may inhibit progress monitoring, especially if one suspects that progress is poor. Although there is some empirical support for this perspective (e.g., Tuckey et al., 2002), the evidence to date has been limited to organizational contexts. Further research is needed to understand the determinants of monitoring outside these contexts and, in particular, how features of the focal goal, the situation, and the person combine to influence progress monitoring.

It will also be important to identify the most effective way to monitor goal progress in various contexts. The present review goes some way towards answering this question by showing that monitoring behavior is more likely to lead to changes in behavior than is monitoring outcomes, whereas changes in outcomes are more likely to occur when people monitor outcomes rather than behaviors. We also found that monitoring progress in public and physically recording progress had larger effects on goal attainment than monitoring that was done in private and not recorded. However, future research might also consider the optimum time to initiate progress monitoring and the optimum reference values to use at different time-points. Finally, it will be important to compare different methods for monitoring goal progress as the primary evidence base expands and technologies for supporting progress monitoring develop (e.g., diaries vs. electronic devices), and to examine how the different methods might be augmented by prompting relevant self-motives.

Conclusion

The present review of 138 interventions designed to promote progress monitoring suggests that (a) it is possible to engender large increases in the frequency of progress

monitoring, and (b) increasing progress monitoring engenders a meaningful improvement in rates of behavioral performance and goal attainment. Our conclusion is that progress monitoring has a robust effect on goal attainment and constitutes a key component of effective self-regulation. Theoretical accounts of goal setting and intention formation should therefore be extended to embrace the role of progress monitoring in goal striving, and behavior change practitioners should consider this technique in future interventions. There is much to be done to unravel the conceptual significance and exploit the practical benefits of progress monitoring. However, we hope that the present review will spark further research to these ends.

References

Aarts, H., Dijksterhuis, A, & De Vries, P. (2001). On the psychology of drinking: being thirsty and perceptually ready. British Journal of Psychology, 92, 631–642.

Aarts, H., Gollwitzer, P. M., & Hassin, R. R. (2004). Goal contagion: Perceiving is for pursuing. Journal of Personality and Social Psychology, 87, 23-37. doi:10.1037/0022-3514.87.1.23

Abraham, C., & Michie, S. (2008). A taxonomy of behavior change techniques used in interventions. Health Psychology, 27(3), 379-387. doi:10.1037/0279-6133.27.3.379

* Abrahams, N., Jewkes, R., Lombard, C., Mathews, S., Campbell, J., & Meel, B. (2010). Impact of telephonic psycho-social support on adherence to post-exposure prophylaxis (PEP) after rape. Aids Care, 22(10), 1173-1181. doi:10.1080/09540121003692185

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. A. (2005). Review of intervention studies aimed at household energy conservation. Journal of Environmental Psychology, 25, 273-291. doi:10.1016/j.jenvp.2005.08.002

* Abraira, C., Colwell, J. A., Nuttall, F. Q., Sawin, C. T., Nagel, N. J., Comstock, J. P., … Lee, H. S. (1995). Veterans affairs cooperative study on glycemic control and complications in Type-II Diabetes (VA CSDM) - results of the feasibility trial. Diabetes Care, 18(8), 1113-1123. doi:10.2337/diacare.18.8.1113

* Acharya, S. D., Elci, O. U., Sereika, S. M., Styn, M. A., & Burke, L. E. (2011). Using a personal digital assistant for self-monitoring influences diet quality in comparison to a standard paper record among overweight/obese adults. Journal of the American Dietetic Association, 111(4), 583-588. doi:10.1016/j.jada.2011.01.009

Ajzen, I. (1991). The theory of planned behavior. Organisational Behavior and Human Decision Processes, 50, 179–211.

* Akers, J. D., Cornett, R. A., Savla, J. S., Davy, K. P., & Davy, B. M. (2012). Daily self-monitoring of body weight, step count, fruit/vegetable intake, and water consumption: A feasible and effective long-term weight loss maintenance approach. Journal of the Academy of Nutrition and Dietetics, 112(5), 685-692. doi:10.1016/j.jand.2012.01.022

Albarracín, D., Johnson, B. T., Fishbein, M., & Muellerleile, P. A. (2001). Theories of reasoned action and planned behavior as models of condom use: A meta-analysis. Psychological Bulletin, 127, 142-161. doi:10.1037//0033-2909.127.1.142

Allemann, S., Houriet, C., Diem, P., & Stettler, C. (2009). Self-monitoring of blood glucose in non-insulin treated patients with type 2 diabetes: a systematic review and meta-analysis. Current Medical Research and Opinion, 25(12), 2903-2913. doi:10.1185/03007990903364665

* Allen, J. K., Stephens, J., Dennison Himmelfarb, C. R., Stewart, K. J., & Hauck, S. (2013). Randomized controlled pilot study testing use of smartphone technology for obesity treatment. Journal of Obesity, Article ID 151597. doi:10.1155/2013/151597

* Amsberg, S., Anderbro, T., Wredling, R., Lisspers, J., Lins, P-E., Adamson, U., & Johansson, U-B. (2009). A cognitive behavior therapy-based intervention among poorly controlled adult type 1 diabetes patients-A randomized controlled trial. Patient Education and Counseling, 77(1), 72-80. doi:10.1016/j.pec.2009.01.015

* An, L. C., Perry, C. L., Lein, E. B., Klatt, C., Farley, D. M., Bliss, R. L., … Ehlinger, E. P. (2006). Strategies for increasing adherence to an online smoking cessation intervention for college students. Nicotine & Tobacco Research, 8, S7–S12. doi:10.1080/14622200601039881

* Anderson, J. W., Raymond Reynolds, L., Bush, H. M., Rinsky, J. L., & Washnock, C. (2011). Effect of a behavioral/nutritional intervention program on weight loss in obese adults: A randomized controlled trial. Postgraduate Medicine, 123, 205-213. doi:10.3810/pgm.2011.09.2476

* Andrews, R. C., Cooper, A. R., Montgomery, A. A., Norcross, A. J., Peters, T. J., Sharp, D. J., . . . Dayan, C. M. (2011). Diet or diet plus physical activity versus usual care in patients with newly diagnosed type 2 diabetes: the Early ACTID randomised controlled trial. Lancet, 378(9786), 129-139. doi:10.1016/s0140-6736(11)60442-x

Anseel, F., Beatty, A., Shen, W., Lievens, F., & Sackett, P.R. (2015). How are we doing after 30 years? A meta-analytic review of the antecedents and outcomes of feedback-seeking behavior. Journal of Management, 41, 318-348. doi:10.1177/0149206313484521

Anseel, F., Lievens, F., & Levy, P. E. (2007). A self-motives perspective on feedback-seeking behavior: Linking organizational behavior and social psychology research. International Journal of Management Reviews, 9, 211–236. doi:10.1111/j.1468-2370.2007.00210.x

* Antypas, K., & Wangberg, S. C. (2014). An Internet- and mobile-based tailored intervention to enhance maintenance of physical activity after cardiac rehabilitation: Short-term results of a randomized controlled trial. Journal of Medical Internet Research, 16, e77. doi:10.2196/jmir.3132

* Arbour, K. P., & Martin Ginis, K. A. (2008). Improving body image one step at a time: Greater pedometer step counts produce greater body image improvements. Body Image, 5(4), 331-336. doi:10.1016/j.bodyim.2008.05.003

* Aronson, B. S. (2006). Assessing the feasibility of a theory-driven self-management intervention to promote short-term antibiotic adherence in college students. Unpublished doctoral dissertation, University of Massachusetts, Worcester.

Ashford, S. J. (1986). Feedback-seeking in individual adaptation: A resource perspective. The Academy of Management Journal, 29(3), 465-487. doi:10.2307/256219

Ashford, S. J. (2003). Reflections on the looking glass: A review of research on feedback-seeking behavior in organizations. Journal of Management, 29(6), 773–799. doi:10.1016/S0149-2063(03)00079-5

Ashford, S. J., & Cummings, L. L. (1983). Feedback as an individual resource: Personal strategies of creating information. Organizational Behavior and Human Performance, 32, 370-398.

* Atienza, A. A., King, A. C., Oliveira, B. M., Ahn, D. K., & Gardner, C. D. (2008). Using hand-held computer technologies to improve dietary intake. American Journal of Preventive Medicine, 34(6), 514-518. doi:10.1016/j.amepre.2008.01.034

Austin, J. T., & Vancouver, J. B. (1996). Goal constructs in psychology: Structure, process, and content. Psychological Bulletin, 120(3), 338–375.

Bailey, K. G., & Sowder, W. T. (1970). Audiotape and videotape self-confrontation in psychotherapy. Psychological Bulletin, 74, 127-137. doi:10.1037/h0029633

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1991). Social cognitive theory of self-regulation. Organizational Behavior and Human Decision Processes, 50, 248–287.

Bandura, A. (1999). A social cognitive theory of personality. In L. Pervin & O. John (Ed.), Handbook of personality (2nd ed., pp. 154-196). New York: Guilford Publications.

Bateman, E. D., Hurd, S. S., Barnes, P. J., Bousquet, J., Drazen, J. M., FitzGerald, M. … Zar, H. J. (2008). Global strategy for asthma management and prevention: GINA executive summary. European Respiratory Journal, 31, 143-178. doi:10.1183/09031936.00138707

Baumeister, R. F., & Vohs, K. D. (2007). Self-regulation, ego depletion, and motivation. Social and Personality Psychology Compass, 1, 1-14.

* Beasley, J. M., Riley, W. T., Davis, A., & Singh, J. (2008). Evaluation of a PDA-based dietary assessment and intervention program: A randomized controlled trial. Journal of the American College of Nutrition, 27(2), 280-286.

* Bell, A. M., Fonda, S. J., Walker, S., Schmidt, V., & Vigersky, R. A. (2012). Mobile phone-based video messages for diabetes self-care support. Journal of Diabetes Science and Technology, 6, 310-319. doi:10.1177/193229681200600214

Belzer, M. E., Naar-King, S., Olson, J., Sarr, M., Thornton, S., Kahana, S. Y., … Adolescent Medicine Trials Network for HIV/AIDS Interventions (2014). The use of cell phone support for non-adherent HIV-infected youth and young adults: An initial randomized and controlled intervention trial. Aids and Behavior, 18(4), 686-696. doi:10.1007/s10461-013-0661-3

* Berg, J., Dunbar-Jacob, J., & Sereika, S. M. (1997). An evaluation of a self-management program for adults with asthma. Clinical Nursing Research, 6, 225-238. doi:10.1177/105477389700600304

Berger, C. R. (2002). Strategic and nonstrategic information acquisition. Human Communication Research, 28, 287-297. doi:10.1111/j.1468-2958.2002.tb00869x

* Blasco, A., Carmona, M., Fernández-Lozano, I., Salvador, C. H., Pascual, M., Sagredo, P. G., … & Alonso-Pulpón (2012). Evaluation of a telemedicine service for the secondary prevention of coronary artery disease. Journal of Cardiopulmonary Rehabilitation and Prevention, 32, 25-31. doi:10.1097/HCR.0b013e31e3182343aa7

Bonezzi, A., Brendl, C. M., & De Angelis, M. (2011). Stuck in the middle: The psychophysics of goal pursuit. Psychological Science, 22(5), 607–612. doi:10.1177/0956797611404899

* Boutelle, K. N., Kirschenbaum, D. S., Baker, R. C., & Mitchell, M. E. (1999). How can obese weight controllers minimize weight gain during the high risk holiday season? By self-monitoring very consistently. Health Psychology, 18(4), 364-368. doi:10.1037/0278-6133.18.4.364

* Brindal, E., Hendrie, G., Freyne, J., Coombe, M., Berkovsky, S., & Noakes, M. (2013). Design and pilot results of a mobile phone weight-loss application for women starting a meal replacement programme. Journal of Telemedicine and Telecare, 19, 166-174. doi: 10.1177/1357633X13479702

Brown, P. C., Dunn, M. E., & Budney, A. J. (2014). Development and initial evaluation of a web-based program to increase parental awareness and monitoring of underage alcohol use: A brief report. Journal of Child & Adolescent Substance Abuse, 23(2), 109-115. doi:10.1080/1067828x.2012.750553

* Buist, A. S., Vollmer, W. M., Wilson, S. R., Frazier, E. A., & Hayward, A. D. (2006). A randomized clinical trial of peak flow versus symptom monitoring in older adults with asthma. American Journal of Respiratory and Critical Care Medicine, 174(10), 1077-1087. doi:10.1164/rccm.200510-1606OC

Burke, L. E., Wang, J., & Sevick, M. A. (2011). Self-monitoring in weight loss: a systematic review of the literature. Journal of the American Dietetic Association, 111(1), 92-102. doi:10.1016/j.jada.2010.10.008

Burke, V., Giangiulio, N., Gillam, H. F., Beilin, L. J., & Houghton, S. (2003). Physical activity and nutrition programs for couples: a randomized controlled trial. Journal of Clinical Epidemiology, 56(5), 421-432. doi:10.1016/50895-4356(02)00610-8

Burnette, J. L., O'Boyle, E. H., Vanepps, E. M., Pollack, J. M., & Finkel, E. J. (2012). Mind-sets matter: A meta-analytic review of implicit theories and self-regulation. Psychological Bulletin, 139(3), 655–701. doi:10.1037/a0029531

* Caldwell, M. A., Peters, K. J., & Dracup, K. A. (2005). A simplified education program improves knowledge, self-care behavior, and disease severity in heart failure patients in rural settings. American Heart Journal, 150(5), 983.

* Carli, P., Crocetti, E., Chiarugi, A., Salvini, C., Nardini, P., Zipoli, G., & Simeone, E. (2008). The use of commercially available personal UV-meters does cause less safe tanning habits: A randomized-controlled trial. Photochemistry and Photobiology, 84(3), 758-763. doi:10.1111/j.1751-1097.2007.00256.x

Carlson, E. N. (2013). Overcoming the barriers to self-knowledge: Mindfulness as a path to seeing yourself as you really are. Perspectives on Psychological Science, 8, 173–186. doi:10.1177/1745691612462584

Carr, L. J., Dunsiger, S. I., Lewis, B., Ciccolo, J. T., Hartman, S., Bock, B., & Marcus, B. H. (2013). Randomized controlled trial testing an internet physical activity intervention for sedentary adults. Health Psychology, 32(3), 328-336. doi:10.1037/a0028962

Carraro, N., & Gaudreau, P. (2013). Spontaneous and experimentally induced action planning and coping planning for physical activity: A meta-analysis. Psychology of Sport and Exercise, 14, 228-248. doi:10.1016/j.psychsport.2012.10.004

* Carter, M. C., Burley, V. J., Nykjaer, C., & Cade, J. E. (2013). Adherence to a smartphone application for weight loss compared to website and paper diary: pilot randomized controlled trial. Journal of Medical Internet Research, 15, e32. doi:10.2196/jmir.2283

Carver, C. S., Johnson, S. L., Joormann, J., & Scheier, M. F. (2015). An evolving view of the structure of self-regulation. In G. H. E. Gendolla, M. Tops, & S. L. Koole (Eds.), Handbook of biobehavioral approaches to self-regulation (pp. 9-23). Springer: New York. doi:10.1007/978-1-4939-1236-0_2

Carver, C. S., & Scheier, M. F. (1982). Control theory: A useful conceptual framework for personality, social, clinical and health psychology. Psychological Bulletin, 92(1), 111-135. doi:10.1037//0033-2909.92.1.111

Carver, C. S., & Scheier, M. F. (1990). Origins and functions of positive and negative affect: a control-process view. Psychological Review, 97, 19-35.

Cash, T. F., Counts, B., & Huffine, C. E. (1990). Current and vestigial effects of overweight among women: Fear of fat, attitudinal body image, and eating behaviors. Journal of Psychopathology and Behavioral Assessment, 12, 157-167.

Chaiken, S. (1980). Heuristic versus systematic information-processing and the use of source versus message cues in persuasion, Journal of Personality and Social Psychology, 39, 752-766, doi:10.1037/0022-3514.39.5.752

Chalmers, I., Adams, M., Dickersin, K., Hetherington, J., Tarnow-Mordi, W., Meinhert, C. … Chalmers, T. C. (1990). A cohort study of summary reports of controlled trials. Journal of the American Medical Association, 263(10), 1401-1405.

Chambers, J. A., & Swanson, V. (2012). Stories of weight management: Factors associated with successful and unsuccessful weight maintenance. British Journal of Health Psychology, 17, 223-243. doi:10.1111/j.2044-8287.2011.02030.x

* Chambliss, H. O., Huber, R. C., Finley, C. E., McDoniel, S. O., Kitzman-Ulrich, H., & Wilkinson, W. J. (2011). Computerized self-monitoring and technology-assisted feedback for weight loss with and without an enhanced behavioral component. Patient Education and Counseling, 85(3), 375-382. doi:10.1016/j.pec.2010.12.024

* Chao, P. J. (2010). A group randomized trial to examine the feasibility and effects of pedometer use and self-monitoring of daily walking in people with severe and persistent mental illnesses. Unpublished doctoral thesis, University of Hawaii at Manoa, US.

* Chau, J, P-C., Lee, D. T-F., Yau, D. S-F., Chow, A. Y-M., Yu, W-C., Chair, S-Y., … Chick, Y-L. (2012). A feasibility study to investigate the acceptability and potential effectiveness of a telecare service for older people with chronic obstructive pulmonary disease. International Journal of Medical Informatics, 81, 674–682. doi:10.1016/j.ijmedinf.2012.06.003

* Cho, J-H., Chang, S-A., Kwon, H-S., Choi, Y-H., Ko, S-H., Moon, S-D., … Yoon, K-H. (2006). Long-term effect of the internet-based glucose monitoring system on HbA(1c) reduction and glucose stability. Diabetes Care, 29(12), 2625-2631. doi:10.2337/dc05-2371

Cialdini, R. B. (2001). Influence: Science and practice. Allyn & Bacon, Boston.

Cioffi, D., & Garner, R. (1996). On doing the decision: Effects of active versus passive choice on commitment and self-perception. Personality and Social Psychology Bulletin, 22, 133-147. Doi:10.1177/0146167296222003

* Clarke, G., Kelleher, C., Hornbrook, M., DeBar, L., Dickerson, J., & Gullion, C. (2009). Randomized effectiveness trial of an Internet, pure self-help, cognitive behavioral intervention for depressive symptoms in young adults. Cognitive Behavior Therapy, 38, 222–234. doi:10.1080/16506070802675353

Cohen, J. (1992). A power primer. Psychological Bulletin, 112, 155–159.

Collins, R. L. (1996). For better or worse: The impact of upward social comparison on self-evaluations. Psychological Bulletin, 119, 51-69. doi:10.1037//0033-2909.119.1.51

Conroy, D. E., Yang, C-H., & Maher, J. P. (2014). Behavior change techniques in top-ranked mobile apps for physical activity. American Journal of Preventive Medicine, 46, 649-652. doi:10.1016/j.amepre.2014.01.010.

Cooke, R., & Sheeran, P. (2004). Moderation of cognition-intention and cognition-behaviour relations: A meta-analysis of properties of variables from the theory of planned behaviour. British Journal of Social Psychology, 43(2), 159–187.

Cooper, H. M. (1986). Integrating research: A guide for literature reviews. London, England: Sage.

Coster, S., Gulliford, M. C., Seed, P. T., Powrie, J. K., & Swaminathan, R. (2000). Self-monitoring in Type 2 diabetes mellitus: a meta-analysis. Diabetic Medicine, 17(11), 755-761. doi:10.1046/j.1464-5491.2000.00390.x

* Coughlin, J. W., Gullion, C. M., Brantley, P. J., Stevens, V. J., Bauck, A., Champagne, C. M., … Appel, L. J. (2013). Behavioral mediators of treatment effects in the weight loss maintenance trial. Annals of Behavioral Medicine, 46, 369–381. doi:10.1007/s12160-013-9517-3

Coyne, J., Thombs, B. D., & Hagedoorn, M. (2010). Ain't necessarily so: Review and critique of recent meta-analyses of behavioral medicine interventions in health psychology. Health Psychology, 29, 107-116. doi:10.1037/a0017633; PMID: 20230082

* Cussler, E. C., Teixeira, P. J., Going, S. B., Houtkooper, L. B., Metcalfe, L. L., Blew, R. M., … Lohman, T. G. (2008). Maintenance of weight loss in overweight middle-aged women through the Internet. Obesity, 16(5), 1052-1060. doi:10.1038/oby.2008.19

* D'Eramo, G. A. (1987). A comparison of intensity of educational intervention on knowledge, attitude, weight and metabolic control in obese individuals with Type II non-insulin dependent diabetes mellitus. Unpublished doctoral dissertation, Columbia University Teachers College, New York.

* De Blok, B. M. J., De Greef, M. H. G., Ten Hacken, N. H. T., Sprenger, S. R., Postema, K., & Wempe, J. B. (2006). The effects of a lifestyle physical activity counseling program with feedback of a pedometer during pulmonary rehabilitation in patients with COPD: A pilot study. Patient Education and Counseling, 61(1), 48-55. doi:10.1016/j.pec.2005.02.005

de Bruin, M., Sheeran, P., Kok, G., Hiemstra, A., Prins, J. M., Hospers, H. J., & van Breukelen, G. J. P. (2012). Self-regulatory processes mediate the intention-behavior relation for adherence and exercise behaviors. Health Psychology, 31, 695-703. doi:10.1037/a0027425

* De Cocker, K. A., De Bourdeaudhuij, I. M., & Cardon, G. M. (2008). The effect of pedometer use in combination with cognitive and behavioral support materials to promote physical activity. Patient Education and Counseling, 70(2), 209-214. doi:10.1016/j.pec.2007.10.008

* De Cocker, K. A., Spittaels, H., Cardon, G., De Bourdeaudhuij, I., & Vandelanotte, C. (2012). Web-based, computer-tailored, pedometer-based physical activity advice: development, dissemination through general practice, acceptability, and preliminary efficacy in a randomized controlled trial. Journal of Medical Internet Research, 14(2), e53. doi:10.2196/jmir.1959

Della Libera, C., & Chelazzi, L. (2006). Visual selective attention and the effects of monetary rewards. Psychological Science, 17, 222-227.

* Dennis, E. A., Potter, K. L., Estabrooks, P. A., & Davy, B. M. (2012). Weight gain prevention for college freshmen: comparing two social cognitive theory-based interventions with and without explicit self-regulation training. Journal of Obesity, Article ID 803769. doi:10.1155/2012/803769

* Dennison, L., Morrison, L., Lloyd, S., Phillips, D., Stuart, B., Williams, S., … Yardley, L. (2014). Does brief telephone support improve engagement with a web-based weight management intervention? Randomized controlled trial. Journal of Medical Internet Research, 16, e95. doi:10.2196/jmir.3199

De Ridder, D. T. D., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2012). Taking stock of self-control: A meta-analysis of how trait self-control relates to a wide range of behaviors. Personality and Social Psychology Review, 16, 76–99. doi:10.1177/1088868311418749

* DeWalt, D. A., Malone, R. M., Bryant, M. E., Kosnar, M. C., Corr, K. E., Rothman, R. L., … Pignone, M. P. (2006). A heart failure self-management program for patients of all literacy levels: A randomized, controlled trial ISRCTN11535170. BMC Health Services Research, 6, 30. doi:10.1186/1472-6963-6-30

Dihoff, R. E., Brosvic, G. M., Epstein, M. L., & Cook, M. J. (2004). Provision of feedback during preparation for academic testing: Learning is enhanced by immediate but not delayed feedback. Psychological Record, 54 (2), 207-231.

Dixon, W. J. (1960). Simplified estimation from censored normal samples. The Annals of Mathematical Statistics, 31, 385–391.

Dombrowski, S. U., Sniehotta, F. F., Avenell, A., Johnston, M., MacLennan, G., & Araújo-Soares, V. (2012). Identifying active ingredients in complex behavioural interventions for obese adults with obesity-related co-morbidities or additional risk factors for co-morbidities: a systematic review. Health Psychology Review, 6, 7–32. doi:10.1080/17437199.2010.513298

* Domingo, M., Lupon, J., Gonzalez, B., Crespo, E., Lopez, R., Ramos, A., … Bayes-Genis, A. (2011). Noninvasive remote telemonitoring for ambulatory patients with heart failure: Effect on number of hospitalizations, days in hospital, and quality of life. CARME (CAtalan Remote Management Evaluation) study. Revista Espanola De Cardiologia, 64(4), 277-285. doi:10.1016/j.rec.2010.10.032

* Duran, A., Martin, P., Runkle, I., Perez, N., Abad, R., Fernandez, M., … Calle-Pascual, A. L. (2010). Benefits of self-monitoring blood glucose in the management of new-onset Type 2 diabetes mellitus: the St Carlos Study, a prospective randomized clinic-based interventional study with parallel groups. Journal of Diabetes, 2(3), 203-211. doi:10.1111/j.1753-0407.2010.00081.x

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. Biometrics, 56(2), 455–463. doi:10.1111/j.0006-341X.2000.00455.x

Duval, S., & Wicklund, R. (1972). A theory of objective self-awareness. New York: Academic Press.

Egger, M., Davey Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple graphical test. British Medical Journal, 315(7109), 629-634. doi:10.1136/bmj.315.7109.629

Eisend, M. (2004). Is it still worth to be credible? A meta-analysis of temporal patterns of source credibility effects in marketing. Advances in Consumer Research, 31, 352-357.

* Farmer, A., Wade, A., Goyder, E., Yudkin, P., French, D., Craven, A., … Neil, A. (2007). Impact of self monitoring of blood glucose in the management of patients with non-insulin treated diabetes: open parallel group randomised trial. British Medical Journal, 335(7611), 132-136. doi:10.1136/bmj.39247.447431.BE

Farmer, A. J., Wade, A. N., French, D. P., Simon, J., Yudkin, P., Gray, A., … DiGEM Trial Group. (2009). Blood glucose self-monitoring in type 2 diabetes: a randomised controlled trial. Health Technology Assessment, 13(15), 1-50. doi:10.3310/hta13150.

Febbraro, G. A. R., & Clum, G. A. (1998). Meta-analytic investigation of the effectiveness of self-regulatory components in the treatment of adult problem behaviors. Clinical Psychology Review, 18, 143-161. doi:10.1016/S0272-7358(97)00008-1

Fishbach, A., Touré-Tillery, M., Carter, T. J., & Sheldon, O. J. (2012). The problem with self-control. Paper presented at the Society for Personality and Social Psychology Conference, San Diego, California.

Fishbein, M. (1980). A theory of reasoned action: Some applications and implications. In H. Howe & M. Page (Eds.), Nebraska Symposium on Motivation (Vol. 27, pp. 65–116). Lincoln, NB: University of Nebraska Press.

Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention and behavior: An introduction to theory and research. Reading, MA: Addison Wesley.

Fitzsimons, G. M., & Finkel, E. J. (2010). Interpersonal influences on self-regulation. Current Directions in Psychological Science, 19, 101-105. doi:10.1177/0963721410364499

Focht, B. C., Garver, M. J., Devor, S. T., Dials, J., Rose, M., Lucas, A. R., ... Rejeski, W. J. (2011). Improving maintenance of physical activity in older, knee osteoarthritis patients trial-pilot (IMPACT-P): Design and methods. Contemporary Clinical Trials, 33(5), 976-982.

Ford, D. H. (1987). Humans as self-constructing living systems: A developmental perspective on behavior and personality. Hillsdale, NJ: Erlbaum.

French, D. P., Wade, A. N., Yudkin, P., Neil, H. A. W., Kinmonth, A. L., & Farmer, A. J. (2008). Self-monitoring of blood glucose changed non-insulin-treated Type 2 diabetes patients' beliefs about diabetes and self-monitoring in a randomized trial. Diabetic Medicine, 25(10), 1218-1228. doi:10.1111/j.1464-5491.2008.02569.x

* Gajecki, M., Berman, A. H., Sinadinovic, K., Rosendahl, I., & Andersson, C. (2014). Mobile phone brief intervention applications for risky alcohol use among university students: a randomized controlled study. Addiction Science & Clinical Practice, 9, 11. doi:10.1186/1940-0640-9-11

Gibbons, F. X., Gerrard, M., Blanton, H., & Russell, D. W. (1998). Reasoned action and social reaction: Willingness and intention as independent predictors of health risk. Journal of Personality and Social Psychology, 74, 1164–1180. doi:10.1037/0022-3514.74.5.1164

Gibbons, F. X., Gerrard, M., & Lane, D. J. (2003). A social-reaction model of adolescent health risk. In J. J. Suls & K. A. Wallston (Eds.), Social psychological foundations of health and illness (pp. 107–136). Oxford, England: Blackwell.

Gillis, M. E., Lumley, M. A., Mosley-Williams, A., Leisen, J. C. C., & Roehrs, T. (2006). The health effects of at-home written emotional disclosure in fibromyalgia: A randomized trial. Annals of Behavioral Medicine, 32(2), 135-146. doi:10.1207/s15324796abm3202_11

* Gokee LaRose, J., Gorin, A. A., & Wing, R. R. (2009). Behavioral self-regulation for weight loss in young adults: a randomized controlled trial. International Journal of Behavioral Nutrition and Physical Activity, 6, 10. doi:10.1186/1479-5868-6-10

* Gokee LaRose, J., Tate, D. F., Gorin, A. A., & Wing, R. R. (2010). Preventing weight gain in young adults: A randomized controlled pilot study. American Journal of Preventive Medicine, 39, 63–68. doi:10.1016/j.amepre.2010.03.011

* Gold, B. C., Burke, S., Pintauro, S., Buzzell, P., & Harvey-Berino, J. (2007). Weight loss on the web: A pilot study comparing a structured behavioral intervention to a commercial program. Obesity, 15, 155-164. doi:10.1038/oby.2007.520

Gollwitzer, P. M., & Moskowitz, G. B. (1996). Goal effects on action and cognition. In E. T. Higgins & A. W. Kruglanski (Eds.), Social psychology: Handbook of basic principles (pp. 361–399). New York: Guilford Press.

Gollwitzer, P. M., & Rohloff, U. B. (1999). The speed of goal pursuit. In R. S. Wyer (Ed.), Advances in social cognition (Vol. 12, pp. 147-159). Hillsdale, NJ: Erlbaum.

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. Advances in Experimental Social Psychology, 38, 69–120. doi:10.1016/50065-2601(06)38002

* Goto, M., Takedani, H., Naga, N., Kubota, M., Ishiyama, M., Ito, S., & Nitta, O. (2014). Self-monitoring has potential for home exercise programmes in patients with haemophilia. Haemophilia, 20, e121–e127. doi:10.1111/hae.12355

* Goulis, D. G., Giaglis, G. D., Boren, S. A., Lekka, I., Bontis, E., Balas, E. A., … Avramides, A. (2004). Effectiveness of home-centered care through telemedicine applications for overweight and obese patients: a randomized controlled trial. International Journal of Obesity, 28(11), 1391-1398. doi:10.1038/sj.ijo.0802773

Graham, A. L., Cha, S., Cobb, N. K., Fang, Y., Niaura, R. S., & Mushro, A. (2013). Impact of seasonality on recruitment, retention, adherence, and outcomes in a web-based smoking cessation intervention: Randomized controlled trial. Journal of Medical Internet Research, 15(11), e249. doi:10.2196/jmir.2880

Greaves, C. J., Sheppard, K. E., Abraham, C., Hardeman, W., Roden, M., Evans, P. H., … The Image Study Group. (2011). Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. BMC Public Health, 11, 119. doi:10.1186/1471-2458-11-119

Greenwald, A. G. (1997). Self-knowledge and self-deception: Further consideration. In M. S. Myslobodsky (Ed.), The Mythomanias: The nature of deception and self-deception (pp. 51–72). Mahwah, NJ: Lawrence Erlbaum Associates.

* Haapala, I., Barengo, N. C., Biggs, S., Surakka, L., & Manninen, P. (2009). Weight loss by mobile phone: a 1-year effectiveness study. Public Health Nutrition, 12, 2382 – 2391. doi:10.1017/S1368980009005230

* Haddock, C. K., Poston, W. S. C., LaGrotte, C., Klotz, A. A., Oliver, T. L., Vander Veur, S. S., … Forey, J. P. (2014). Findings from an online behavioural weight management programme provided with or without a fortified diet beverage. British Journal of Nutrition, 111, 372–379 doi:10.1017/S0007114513002377

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: A meta-analysis. Psychological Bulletin, 136, 495-525. doi:10.1037/a0019486

* Hannum, S. M., Carson, L., Evans, E. M., Canene, K. A., Petr, E. L., Bui, L., & Erdman, J. W. (2004). Use of portion-controlled entrees enhances weight loss in women. Obesity Research, 12(3), 538-546. doi:10.1038/oby.2004.61

Haynes, R. B., McKibbon, K. A., Wilczynski, N. L., Walter, S. D., & Werre, S. R. (2005). Optimal search strategies for retrieving scientifically strong studies of treatment from Medline: analytical survey. British Medical Journal, 330, 1179-1182. doi:10.1136/bmj.38446.498542.8F

Hedges, L. V., & Olkin, I. (1985). Statistical methods for meta-analysis. Orlando, FL: Academic Press.

* Hellerstedt, W. L., & Jeffery, R. W. (1997). The effects of a telephone-based intervention on weight loss. American Journal of Health Promotion, 11(3), 177-182. doi:10.4278/0890-1171-11.3.177

* Helsel, D. L., Jakicic, J. M., & Otto, A. D. (2007). Comparison of techniques for self-monitoring eating and exercise behaviors on weight loss in a correspondence-based intervention. Journal of the American Dietetic Association, 107(10), 1807-1810. doi:10.1016/j.jada.2007.07.014

Higgins, J. P. T., & Green, S. (2008). Special topics in statistics. In J. Higgins, J. Deeks & D. Altman (Eds.), Cochrane Handbook for Systematic Reviews of Interventions. Version 5.0.1 [updated September 2008].

Higgins, J. P. T., & Green, S. (2011). Special topics in statistics. In J. Higgins, J. Deeks & D. Altman (Eds.), Cochrane Handbook for Systematic Reviews of Interventions. Version 5.1.0 [updated March 2011].

* Homko, C. J., Deeb, L. C., Rohrbacher, K., Mulla, W., Mastrogiannis, D., Gaughan, J., … Bove, A. A. (2012). Impact of a telemedicine system with automated reminders on outcomes in women with gestational diabetes mellitus. Diabetes Technology & Therapeutics, 14(7), 624-629. doi:10.1089/dia.2012.0010

Hsee, C. K., & Abelson, R. P. (1991). Velocity relation: Satisfaction as a function of the first derivative of outcome over time. Journal of Personality and Social Psychology, 60, 341-347. doi:10.1037/0022-3514.60.3.341

* Hurling, R., Catt, M., Boni, M. D., Fairley, B. W., Hurst, T., Murray, P., ... Sodhi, J. S. (2007). Using Internet and mobile phone technology to deliver an automated physical activity program: Randomized controlled trial. Journal of Medical Internet Research, 9(2). doi:10.2196/jmir.9.2.e7

* Hyman, D. J., Ho, K. S. I., Dunn, J. K., & Simons-Morton, D. (1998). Dietary intervention for cholesterol reduction in public clinic patients. American Journal of Preventive Medicine, 15(2), 139-145. doi:10.1016/s0749-3797(98)00038-5

Imai, Y Otsuka, K Kawano, Y Shimada, K; Hayashi, H (Hayashi, H); Tochikubo, O … Fukiyama, K (2003). Japanese society of hypertension (JSH) guidelines for self-monitoring of blood pressure at home. Hypertension Research, 26, 771-782. doi: 10.1291/hypres.26.771

* Janson, S. L., Fahy, J. V., Covington, J. K., Paul, S. M., Gold, W. M., & Boushey, H. A. (2003). Effects of individual self-management education on clinical, biological, and adherence outcomes in asthma. American Journal of Medicine, 115(8), 620-626. doi:10.1016/j.amjmed.2003.07.008

* Janson, S. L., McGrath, K. W., Covington, J. K., Cheng, S-C, & Boushey, H. A. (2009). Individualized asthma self-management improves medication adherence and markers of asthma control. Journal of Allergy and Clinical Immunology, 123(4), 840-846. doi:10.1016/j.jaci.2009.01.053

* Jefferson, M. L. (2005). The effects of self-monitoring psychological states on behavioral weight management treatment. Unpublished doctoral dissertation, Ohio State University, Ohio.

* Jennings, C. A., Vandelanotte, C., Caperchione, C. M., & Mummery, W. K. (2014). Effectiveness of a web-based physical activity intervention for adults with Type 2 diabetes—A randomised controlled trial. Preventive Medicine 60 (2014) 33–40. doi:10.1016/j.ypmed.2013.12.011

Johnson, B. T. (1993). DSTAT. Software for the meta-analytic review of research literatures (rev. ed.). [Computer software]. Hillsdale, NJ: Erlbaum.

Johnson, R. E., Chang, C. H., & Lord, R. G. (2006). Moving from cognition to behavior: What the research says. Psychological Bulletin, 132(3), 381–415. doi:10.1037/0033-2909.132.3.381

Juni, P., Altman, D. G., & Matthias, E. (2001). Assessing the quality of randomised controlled trials. In: M. Egger, G. Davey Smith, & D. G. Altman (Eds.), Systematic reviews in health care: meta-analysis in context (2nd ed). London: BMJ Books.

* Jurgens, C. Y., Lee, C. S., Reitano, J. M., & Riegel, B. (2013). Heart failure symptom monitoring and response training. Heart & Lung, 42, 273-280. doi:10.1016/j.hrtlng.2013.03.005

Kanfer, F. H., & Karoly, P. (1972). Self-control: A behavioristic excursion into the lions den. Behavior Therapy, 3, 398-416.

Karlsson, N., Loewenstein, G., & Seppi, D. (2009). The ostrich effect: Selective attention to information. Journal of Risk and Uncertainty, 38, 95–115. doi:10.1007/s11166-009-9060-6

* Kempf, K., Tankova, T., & Martin, S. (2013). ROSSO-in-praxi-international: Long-term effects of self-monitoring of blood glucose on glucometabolic control in patients with Type 2 diabetes mellitus not treated with insulin. Diabetes Technology & Therapeutics, 15, 89-96. doi:10.1089/dia.2012.0213

Kenny, D. A., Kashy, D. A., & Bolger, N. (1998). Data-analysis in social psychology. In D. Gilbert, S. Fiske, & G. Lindzey (Eds.), The handbook of social psychology (Vol. 4, pp. 233–265). New York: Oxford University Press.

Kiesler, C. A. (1971). The psychology of commitment: Experiments linking behavior to belief. Academic Press, New York.

* Kim, C., Draska, M., Hess, M. L., Wilson, E. J., & Richardson, C. R. (2012). A web-based pedometer programme in women with a recent history of gestational diabetes. Diabetic Medicine, 29(2), 278-283. doi:10.1111/j.1464-5491.2011.03415.x

* King, A. C., Ahn, D. K., Oliveira, B. M., Atienza, A. A., Castro, C. M., & Gardner, C. D. (2008). Promoting physical activity through hand-held computer technology. American Journal of Preventive Medicine, 34(2), 138-142. doi:10.1016/j.amepre.2007.09.025

* Kirwan, M., Vandelanotte, C., Fenning, A., & Duncan, M. J.. (2013). Diabetes self-management smartphone application for adults with Type 1 diabetes: Randomized controlled trial. Journal of Medical Internet Research, 15, e235. doi:10.2196/jmir.2588

Kluger, A. N., & DeNisi, A. (1998). Feedback interventions: Toward the understanding of a double-edged sword. Current Directions in Psychological Science, 7(3), 67–72. doi:10.1111/1467-8721.ep10772989

* Kobulnicky, C. J. H. (2002). The behavioral impact of teaching patients to monitor side effects of chemotherapy: An intervention study. Unpublished doctoral dissertation, University of Wisconsin, Madison.

Koole, S. (2009). The psychology of emotion regulation: An integrative review. Cognition & Emotion, 23, 4–41. doi:10.1080/02699930802619031

Korotitsch, W. J., & Nelson-Gray, R. O. (1999). An overview of self-monitoring research in assessment and treatment. Psychological Assessment, 11, 415-425. doi:10.1037/1040-3590.11.4.415

* Kraschnewski, J. L., Stuckey, H. L., Rovniak, L. S., Lehman, E. B., Reddy, M., Poger, J. M., … Sciamanna, C. N. (2011). Efficacy of a weight-loss website based on positive deviance: A randomized trial. American Journal of Preventive Medicine, 41, 610–614. doi:10.1016/j.amepre.2011.08.012

* Kristal, A. R., Curry, S. J., Shattuck, A. L., Feng, Z., & Li, S. (2000). A randomized trial of a tailored, self-help dietary intervention: The Puget Sound Eating Patterns study. Preventive Medicine, 31, 380–389. doi:10.1006/pmed.2000.0711

* Kroenke, K., Theobald, D., Wu, J., Norton, K., Morrison, G., Carpenter, J., & Tu, W. (2010). Effect of telecare management on pain and depression in patients with cancer a randomized trial. Journal of the American Medical Association, 304(2), 163-171. doi:10.1001/jama.2010.944.

Kruglanski, A. W., Pierro, A., & Sheveland, A. (2011). How many roads lead to Rome? Equifinality set-size and commitment to goals and means. European Journal of Social Psychology, 41(3), 344-352. doi:10.1002/ejsp.780

Kruglanski, A. W., Shah, J. Y., Fishbach, A., Friedman, R., Chun, W. Y. & Sleeth-Keppler, D. (2002). A theory of goal systems. Advances in Experimental Social Psychology, 34, 331-378. doi:10.1016/S0065-2601(02)80008-9

Kumkale, G. T., & Albarracin, D. (2004). The sleeper effect in persuasion: A meta-analytic review. Psychological Bulletin, 130, 143-172. doi:10.1037/0033-2909.130.1.143

* Kwon, H. S., Cho, J. H., Kim, H. S., Song, B. R., Ko, S. H., Lee, J. M., … Yoon, K. H. (2004). Establishment of blood glucose monitoring system using the Internet. Diabetes Care, 27(2), 478-483. doi:10.2337/diacare.27.2.478

Latham, G. P., & Locke, E. A. (1991). Self-regulation through goal setting. Organizational Behavior and Human Decision Processes, 50, 212-247. doi:10.1016/0749-5978(91)90021-K

Latimer, A. E., Brawley, L. R., & Bassett, R. L. (2010). A systematic review of three approaches for constructing physical activity messages: What messages work and what improvements are needed? International Journal of Behavioral Nutrition and Physical Activity, 7, 36. doi:10.1186/1479-5868-7-36

Levy, B. T., Xu, Y., Daly, J. M., & Ely, J. W. (2013). A randomized controlled trial to improve colon cancer screening in rural family medicine: An Iowa Research Network (IRENE) study. Journal of the American Board of Family Medicine, 26(5), 486-497. doi:10.3122/jabfm.2013.05.130041

Lewin, K. (1951). Field theory in social science. New York: Harper.

Liberman, N., & Dar, R. (2009). Normal and pathological consequences of encountering difficulties in monitoring progress towards goals. In Moskowitz, G. B., & Grant, H. (Eds.). The psychology of goals (pp. 277-303). New York: Guilford Press.

Light, R. J., & Pillemer, D. B. (1984). Summing up. The science of reviewing research. Cambridge: Harvard University Press.

* Ligibel, J. A., Meyerhardt, J., Pierce, J. P., Najita, J., Shockro, L., Campbell, N., … Shapiro, C. (2012). Impact of a telephone-based physical activity intervention upon exercise behaviors and fitness in cancer survivors enrolled in a cooperative group setting. Breast Cancer Research and Treatment, 132, 205–213. doi:10.1007/s10549-011-1882-7.

* Linde, J. A., & Jeffrey, R. W. (2011). Testing a brief self-directed behavioral weight control program. Behavioral Medicine, 37, 47-53. doi:10.1080/08964289.2011.568992

Locke, E. A., & Latham, G. P. (1990). A theory of goal-setting and task performance. Englewood Cliffs, NJ: Prentice Hall.

Locke, E. A., Shaw, K. N., Saari, L. M., & Latham, G. P. (1981). Goal-setting and task performance 1969-1980. Psychological Bulletin, 90, 125–152.

* Logan, A. G., Irvine, M. J., McIsaac, W. J., Tisler, A., Rossos, P. G., Easty, A., … Cafazzo, J, A. (2012). Effect of home blood pressure telemonitoring with self-care support on uncontrolled systolic hypertension in diabetics. Hypertension, 60(1), 51-57. doi:10.1161/hypertensionaha.111.188409

Louro, M. J., Pieters, R., & Zeelenberg, M. (2007). Dynamics of multiple-goal pursuit. Journal of Personality and Social Psychology, 93, 174-193. doi:10.1037/0022-3514.93.2.174

Ma, J., Strub, P., Lavori, P. W., Buist, S., Camargo, C. A., Jr., Nadeau, K. C., . . . Xiao, L. (2013). DASH for asthma: A pilot study of the DASH diet in not-well-controlled adult asthma. Contemporary Clinical Trials, 35(2), 55-67. doi:10.1016/j.cct.2013.04.008

Maddux, J. E., & Rogers, R. W. (1980). Effects of source expertness, physical attractiveness, and supporting arguments on persuasion - a case of brains over beauty. Journal of Personality and Social Psychology, 39, 235-244. doi:10.1037/0022-3514.39.2.235

Maidment, C. D., Jones, C. R., Webb, T. L., Hathway, E. A., & Gilbertson, J. M. (2014). The impact of household energy efficiency measures on health: A meta-analysis. Energy Policy, 65, 583-593. doi:10.1016/j.enpol.2013.10.054

* Maljanian, R., Grey, N., Staff, I., & Conroy, L. (2005). Intensive telephone follow-up to a hospital-based disease management model for patients with diabetes mellitus. Disease Management, 8, 15-25. doi:10.1089/dis.2005.8.15.

* Marquez-Contreras, E., Martell-Claros, N., Gil-Guillen, V., de la Figuera-Von Wichmann, M., Casado-Martinez, J. J., … Compliance Group of the Spanish Society of Hypertension (2006). Efficacy of a home blood pressure monitoring programme on therapeutic compliance in hypertension: the EAPACUM-HTA study. Journal of Hypertension, 24(1), 169-175.

Marlatt, G. A., & Kaplan, B. E. (1972). Self-initiated attempts to change behavior: A study of New Year's resolutions. Psychological Reports, 30, 123–131.

* Maruyama, C., Kimura, M., Okumura, H., Hayashi, K., & Arao, T. (2010). Effect of a worksite-based intervention program on metabolic parameters in middle-aged male white-collar workers: A randomized controlled trial. Preventive Medicine, 51(1), 11-17. doi:10.1016/j.ypmed.2010.04.008

McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the Theory of Planned Behaviour: a meta-analysis. Health Psychology Review, 5(2), 97-144. doi:10.1080/17437199.2010.521684

* McKinstry, B., Hanley, J., Pagliari, C., Paterson, M., Lewis, S., Sheikh, A., … Padfield, P. (2013). Telemonitoring based service redesign for the management of uncontrolled hypertension: multicenter randomised controlled trial. British Medical Journal, 346, f3030. doi:10.1136/bmj.f3030

* McManus, R., Mant, J., Bray, E. P., Holder, R., Jones, M. I., Greenfield, S., … Hobbs, F. D. R. (2010). Telemonitoring and self-management in the control of hypertension (TASMINH2): a randomised controlled trial. Lancet, 376(9736), 163-172. doi:10.1016/s0140-6736(10)60964-6

* McMurdo, M. E. T., Sugden, Ja., Argo, I., Boyle, P., Johnston, D. W., Sniehotta, F. F., & Donnan, P. T. (2010). Do pedometers increase physical activity in sedentary older women? A randomized controlled trial. Journal of the American Geriatrics Society, 58(11), 2099-2106. doi:10.1111/j.1532-5415.2010.03127.x

* Mehos, B. M., Saseen, J. J., & MacLaughlin, E. J. (2000). Effect of pharmacist intervention and initiation of home blood pressure monitoring in patients with uncontrolled hypertension. Pharmacotherapy, 20(11), 1384-1389. doi:10.1592/phco.20.17.1384.34891

Michie, S., Abraham, C., Whittington, C., McAteer, J., & Gupta, S. (2009). Effective techniques in healthy eating and physical activity interventions: A meta-regression. Health Psychology, 28(6), 690-701. doi:10.1037/a0016136

Michie, S., Ashford, S., Sniehotta, F. F., Dombrowski, S. U., Bishop, A., & French, D. P. (2011). A refined taxonomy of behaviour change techniques to help people change their physical activity and healthy eating behaviours: The CALO-RE taxonomy. Psychology and Health, 26(11), 1479–1498. doi:10.1080/08870446.2010.540664

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., … Wood. C. E. (2013). The behavior change techniques taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. Annals of Behavioral Medicine, doi:10.1007/S12160-013-9486-6

Miller, G. A., Galanter, E., & Pribram, K. H. (1960). Plans and the structure of behavior. New York: Holt, Rinehart, & Winston.

Moher, D., Cook, D. J., Eastwood, S., Olkin, I., Rennie, D., & Stroup, D. F. (1999). Improving the quality of reports of meta-analyses of randomised controlled trials: the QUOROM statement. Lancet, 354, 1896-1900. doi:10.1016/S0140-6736(99)04149-5

Moja, L. P., Telaro, E., D'Amico, R., Moschetti, I., Coe, L., & Liberati, A. (2005). Assessment of methodological quality of primary studies by systematic reviews: results of the metaquality study cross sectional study. British Medical Journal, 330(7499), 1053-1055. doi:10.1136/bmj.38414.515938.8F

* Moreland, E. C., Volkening, L. K., Lawlor, M. T., Chalmers, K. A., Anderson, B. J., & Laffel, L. M. B. (2006). Use of a blood glucose monitoring manual to enhance monitoring adherence in adults with diabetes - A randomized controlled trial. Archives of Internal Medicine, 166(6), 689-695. doi:10.1001/archinte.166.6.689

* Morgan, P. J., Lubans, D. R., Collins, C. E., Warren, J. A., & Callister, R. (2009). The SHED-IT randomized controlled trial: Evaluation of an Internet-based weight-loss program for men. Obesity, 17(11), 2025-2032. doi:10.1038/oby.2009.85

* Muchmore, D. B., Springer, J., & Miller, M. (1994). Self-monitoring of blood-glucose in overweight Type-2 diabetic patients. Acta Diabetologica, 31(4), 215-219. doi:10.1007/BF00571954

Myrseth, K. O. R., & Fishbach, A. (2009). Self-control: A function of knowing when and how to exercise restraint. Current Directions in Psychological Science, 18, 247-252. doi:10.1111/j.1467-8721.2009.01645.x

* Nanchahal, K., Townsend, J., Letley, L., Haslam, D., Wellings, K., & Haines, A. (2009). Weight-management interventions in primary care: a pilot randomised controlled trial. The British Journal of General Practice, 59(562), e157-166. doi:10.3399/bjgp09X420617

Neal, D. T., Wood, W., Wu, M., & Kurlander, D. (2011). The pull of the past: when do habits persist despite conflict with motives? Personality & Social Psychology Bulletin, 37(11), 1428–37. doi:10.1177/0146167211419863

* Nguyen, H. Q., Gill, D. P., Wolpin, S., Steele, B. G., & Benditt, J. O. (2009). Pilot study of a cell phone-based exercise persistence intervention post-rehabilitation for COPD. International Journal of Chronic Obstructive Pulmonary Disease, 4, 301-313. doi:10.2147/COPD.56643

Norcross, J. C., & Vangarelli, D. J. (1988). The resolution solution: longitudinal examination of New Year's change attempts. Journal of Substance Abuse, 1, 127-134. doi:10.1016/S0899-3289(88)80016-6

Norris, S. L., Engelgau, M. M., & Narayan, K. M. V. (2001). Effectiveness of self management training in type 2 diabetes - A systematic review of randomized controlled trials. Diabetes Care, 24, 561-587. doi:10.2337/diacare.24.3.561

Northcraft, G. B., & Ashford, S. J. (1990). The preservation of self in everyday life: The effects of performance expectations and feedback context on feedback inquiry. Organizational Behavior and Human Decision Processes, 47, 42–64. doi:10.1016/0749-5978(90)90046-C

* O'Kane, M. J., Bunting, B., Copeland, M., Coates, V. E., & the ESMON Study Group (2008). Efficacy of self-monitoring of blood glucose in patients with newly diagnosed Type 2 diabetes (ESMON study): Randomised controlled trial. British Medical Journal, 336(7654), 1174. doi:10.1136/bmj.39534.571644.BE

Oishi, S., Diener, E., & Lucas, R. E. (2007). The optimum level of well-being: Can people be too happy? Perspectives on Psychological Science, 2, 346-360. doi:10.1111/j.1745-6916.2007.00048.x

Olson, R., Schmidt, S., Winkler, C., & Wipfii, B. (2011). The effects of target behavior choice and self-management skills training on compliance with behavioral self-monitoring. American Journal of Health Promotion, 25(5), 319-324. doi:10.4278/ajhp.090421-QUAN-143

Opitz, B., Ferdinand, N. K., & Mecklinger, A. (2011). Timing matters: the impact of immediate and delayed feedback on artificial language learning. Frontiers in Human Neuroscience, 5, 8. doi:10.3389/fnhum.2011.00008

* Ornes, L. L. (2006). A theory-based, Web-mediated physical activity intervention for college women. Unpublished doctoral thesis, The University of Utah, US.

* Orsama et al. (2013). Active assistance technology reduces glycosylated hemoglobin and weight in individuals with Type 2 diabetes: Results of a theory-based randomized trial. Diabetes Technology and Therapeutics, 16, 662-669. doi:10.1089/dia.2013.0056

* Oshima, Y., Matsuoka, Y., Sakane, N. (2013). Effect of weight-loss program using self-weighing twice a day and feedback in overweight and obese subject: A randomized controlled trial. Obesity Research & Clinical Practice, 7, e361-e366. doi:10.1016/j.orcp.2012.01.003

Ouellette, J. A., & Wood, W. (1998). Habit and intention in everyday life: The multiple processes by which past behavior predicts future behavior. Psychological Bulletin, 124, 57-74. doi:10.1037//0033-2909.124.1.54

Oxman, A. D., & Guyatt, G. H. (1988). Guidelines for reading literature reviews. Canadian Medical Association Journal, 138, 697-703.

* Pellegrini, C. A., Verba, S. D., Otto, A. D., Helsel, D. L., Davis, K. K., & Jakicic, J. M. (2012). The comparison of a technology-based system and an in-person behavioral weight loss intervention. Obesity, 20(2), 356-363. doi:10.1038/oby.2011.13

Peters, J. L., Sutton, A. J., Jones, D. R., Abrams, K. R., & Rushton, L. (2007). Performance of the trim and fill method in the presence of publication bias and between-study heterogeneity. Statistics in Medicine, 26, 4544-4562. doi:10.1002/sim.2889

* Petersen, C. B., Severin, M., Hansen, A. W., Curtis, T., Gronbaek, M., & Tolstrup, J. S. (2012). A population-based randomized controlled trial of the effect of combining a pedometer with an intervention toolkit on physical activity among individuals with low levels of physical activity or fitness. Preventive Medicine, 54(2), 125-130. doi:10.1016/j.ypmed.2011.12.012

* Petrella, R. J., Stuckey, M. I., Shapiro, S., & Gill, D. P. (2014). Mobile health, exercise and metabolic risk: a randomized controlled trial. BMC Public Health, 14, 1082. doi: 10.1186/1471-2458-14-1082

* Phelan, S., Phipps, M. G., Abrams, B., Darroch, F., Grantham, K., Schaffner, A., & Wing, R. R. (2014). Does behavioral intervention in pregnancy reduce postpartum weight retention? Twelve-month outcomes of the Fit for Delivery randomized trial. American Journal of Clinical Nutrition, 99, 302–311. doi: 10.3945/ajcn.113.070151

* Piette, J. D., Richardson, C., Himle, J., Duffy, S., Torres, T., Vogel, M., … Valenstein, M. (2011). A randomized trial of telephonic counseling plus walking for depressed diabetes patients. Medical Care, 49(7), 641-648. doi:10.1097/MLR.0b013e318215d0c9

Pinkus, R. T., Lockwood, P., Schimmack, U., & Fournier, M. A. (2008). For better and for worse: Everyday social comparisons between romantic partners. Journal of Personality and Social Psychology, 95, 1180-1201. doi:10.1037/0022-3514.95.5.1180

Poirier, J., & Cobb, N. K. (2012). Social influence as a driver of engagement in a web-based intervention. Journal of Medical Internet Research, 14, e36. doi:10.2196/jmir.1957

Polivy, J., Herman, C. P., Hackett, R., & Kuleshnyk, I. (1986). The effects of self-attention and public attention on eating in restrained and unrestrained subjects. Journal of Personality and Social Psychology, 50, 1253-1260. doi:10.1037/0022-3514.50.6.1253

* Polonsky, W. H., Fisher, L., Schikman, C. H., Hinnen, D. A., Parkin, C. G., Jelsovsky, Z., … Wagner, R. S. (2011). Structured self-monitoring of blood glucose significantly reduces A1C levels in poorly controlled, noninsulin-treated Type 2 diabetes results from the structured testing program study. Diabetes Care, 34(2), 262-267. doi:10.2337/dc10-1732

* Polzien, K. M., Jakicic, J. M., Tate, D. F., & Otto, A. D. (2007). The efficacy of a technology-based system in a short-term behavioral weight loss intervention. Obesity, 15(4), 825-830. doi:10.1038/oby.2007.584

Pornpitakpan, C (2004). The persuasiveness of source credibility: A critical review of five decades' evidence. *Journal of Applied Social Psychology*, *34*, 243-281. doi:10.1111/j.1559-1816.2004.tb02547.x

Portnoy, D. B., Scott-Sheldon, L. A. J., Johnson, B. T., & Carey, M. P. (2008). Computer-delivered interventions for health promotion and behavioral risk reduction: a meta-analysis of 75 randomized controlled trials, 1988-2007. *Preventive Medicine*, *47*(1), 3–16. doi:10.1016/j.ypmed.2008.02.014

Powers, W. T. (1973). Behavior: The control of perception. Chicago: Aldine.

Powers, W. T., Clark, R. K., & McFarland, R. L. (1960a). A general feedback theory of human behavior: Part I. Perceptual and Motor Skills, 11, 71-78.

Powers, W. T., Clark, R. K., & McFarland, R. L. (1960b). A general feedback theory of human behavior: Part II. Perceptual and Motor Skills, 11, 309-323.

Prestwich, A., Webb, T. L., & Conner, M. T. (2015). Using theory to develop and test interventions to promote changes in health behaviour: Evidence, issues, and recommendations. Current Opinion in Psychology, 5, 1-5. doi:10.1016/j.copsyc.2015.02.011

* Proudfoot, J., Clarke, J., Birch, M-R., Whitton, A. E., Parker, G., Manicavasagar, V., ... & Hadzi-Pavlovic, D. (2013). Impact of a mobile phone and web program on symptom and functional outcomes for people with mild-to-moderate depression, anxiety and stress: a randomised controlled trial. BMC Psychiatry, 13, 312. doi: 10.1186/1471-244X-13-312

* Quinn, C. C., Clough, S. S., Minor, J. M., Lender, D., Okafor, M. C., & Gruber-Baldini, A. (2008). WellDoc mobile diabetes management randomized controlled trial: Change in clinical and behavioral outcomes and patient and physician satisfaction. Diabetes Technology & Therapeutics, 10, 160-168. doi:10.1089/dia.2008.0283.

* Ralston, J. D., Cook, A. J., Anderson, M. L., Catz, S. L., Fishman, P. A., Carlson, J., … Green, B. B. (2014). Home blood pressure monitoring, secure electronic messaging and medication intensification for improving hypertension control: A mediation analysis. Applied Clinical Informatics, 5, 232–248. doi:10.4338/ACI-2013-10-RA-0079

* Raynor, H. A., Steeves, E. A., Hecht, J., Fava, J. L., & Wing, R. R. (2012). Limiting variety in non-nutrient-dense, energy-dense foods during a lifestyle intervention: a randomized controlled trial. American Journal of Clinical Nutrition, 95, 1305–1314. doi:10.3945/ajcn.111.031153

Reijonsaari, K., Vehtari, A., Kahilakoski, O., van Medelen, W., Aro, T., & Taimela, S. (2012). The effectiveness of physical activity monitoring and distance counseling in an occupational setting – Results from a randomized controlled trial (CoAct). BMC Public Health, 12, 344. doi:10.1186/1471-2458-12-344

Rhodes, R. E., & de Bruijn, G.-J. (2013). How big is the physical activity intention-behaviour gap? A meta-analysis using the action control framework. British Journal of Health Psychology, 18(2), 296–309. doi:10.1111/bjhp.12032

* Richardson, C. R., Buis, L. R., Janney, A. W., Goodrich, D. E., Sen, A., Hess, M. L., … Piette, J. D. (2010). An online community improves adherence in an internet-mediated walking program. Part 1: Results of a randomized controlled trial. Journal of Medical Internet Research, 12(4), 138-153. doi:10.2196/jmir.1338

Richardson, C. R., Newton, T. L., Abraham, J. J., Sen, A., Jimbo, M., & Swartz, A. M. (2008). A meta-analysis of pedometer-based walking interventions and weight loss. Annals of Family Medicine, 6(1), 69-77. doi:10.1370/afm.761

Rogers, R. W. (1983). Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. In J. T. Cacioppo & R. E. Petty (Eds.), Social psychophysiology: A sourcebook. London: Guilford.

Roggeveen, A. L., & Johar, G. V. (2002). Perceived source variability versus familiarity: Testing competing explanations for the truth effect. Journal of Consumer Psychology, 12(2), 81-91. doi:10.1207/153276602760078622

* Rosal, M. C., Ockene, I. S., Restrepo, A., White, M. J., Borg, A., Olendzki, B., … Reed, G. (2011). Randomized trial of a literacy-sensitive, culturally tailored diabetes self-management intervention for low-income latinos. Diabetes Care, 34(4), 838-844. doi:10.2337/dc10-1981

* Rosal, M. C., Olendzki, B., Reed, G. W., Gumieniak, O., Scavron, J., & Ockene, I. (2005). Diabetes self-management among low-income Spanish-speaking patients: A pilot study. Annals of Behavioral Medicine, 29(3), 225-235. doi:10.1207/s15324796abm2903_9

* Rote, A. E. (2013). Examining the efficacy of a Facebook-mediated intervention to increase steps per day in college freshmen. Unpublished doctoral dissertation, University of Wisconsin, Milwaukee

Rothstein, H. R., Sutton, A. J., & Borenstein, M. (2005). Publication bias in meta-analysis: Prevention, assessment, and adjustments. Chichester, UK: Wiley.

* Runyan, J. D., Steenbergh, T. A., Bainbridge, C., Daugherty, D. A., Oke, L., & Fry, B. N. (2013). A smartphone ecological momentary assessment intervention ‘‘app’’ for collecting real-time data and promoting self-awareness. PLoS ONE, 8, e71325. doi:10.1371/journal.pone.0071325

* Samuel-Hodge, C. D., Johnston, L. F., Gizlice, Z., Garcia, B. A., Lindsley, S. C., Bramble, K. P., … Keyserling, T. C. (2009). Randomized trial of a behavioral weight loss intervention for low-income women: The Weight Wise Program. Obesity, 17, 1891–1899. doi:10.1038/oby.2009.128

Schlenker, B. R., Dlugolecki, D. W., & Doherty, K. (1994). The impact of self-presentations on self-appraisals and behavior: The power of public commitment. Personality and Social Psychology Bulletin, 20, 20-33. doi:10.1177/0146167294201002

Schoutrop, M. J. A., Lange, A., Hanewald, G., Davidovich, U., & Salomon, H. (2002). Structured writing and processing major stressful events: A controlled trial. Psychotherapy and Psychosomatics, 71, 151-157. doi:10.1159/000056282

Schwarzer, R. (1988). Meta: Programs for secondary data analysis. Berlin: Free University of Berlin.

Sedikides, C., & Strube, M. J. (1997). Self-evaluation: To thine own self be good, to thine own self be sure, to thine own self be true, and to thine own self be better. Advances in Experimental Social Psychology, 29, 209–269.

* Sengpiel, J., Fuehner, T., Kugler, C., Avsar, M., Bodmann, I., Boemke, A., … Gottlieb, J. (2010). Use of telehealth technology for home spirometry after lung transplantation: a randomized controlled trial. Progress in Transplantation, 20, 310-317.

* Seto, E., Leonard, K. J., Cafazzo, J. A., Barnsley, J., Masino, C., & Ross, H. J. (2012). Mobile phone-based telemonitoring for heart failure management: A randomized controlled trial. Journal of Medical Internet Research, 14(1), e31. doi:10.2196/jmir.1909

Shah, J. (2003a). The motivational looking glass: How significant others implicitly affect goal appraisals. Journal of Personality and Social Psychology, 85, 424-439. doi:10.1037/0022-3514.85.3.424

Shah, J. (2003b). Automatic for the people: How representations of significant others implicitly affect goal pursuit. Journal of Personality and Social Psychology, 84, 661-681. doi:10.1037/0022-3514.84.4.661

Shah, J. Y., Friedman, R., & Kruglanski, A. W. (2002). Forgetting all else: On the antecedents and consequences of goal shielding. Journal of Personality and Social Psychology, 83(6), 1261–1280. doi:10.1037//0022-3514.83.6.1261

* Shapiro, J. R., Koro, T., Doran, N., Thompson, S., Sallis, J. F., Calfas, K., & Patrick, K. (2012). Text4Diet: A randomized controlled study using text messaging for weight loss behaviors. Preventive Medicine, 55, 412–417. doi:10.1016/j.ypmed.2012.08.011

Sheeran, P. (2002). Intention-behavior relations: A conceptual and empirical review. European Review of Social Psychology, 12, 1-36.

Sheeran, P., & Abraham, C. (2003). Mediator of moderators: Temporal stability of intention and the intention-behavior relation. Personality and Social Psychology Bulletin, 29, 205-215. doi:10.1177/0146167202239046

Sheeran, P., Milne, S., Webb, T. L., & Gollwitzer, P. M. (2005). Implementation intentions and health behaviour. In Predicting health behaviour: Research and practice with social cognition models (pp. 276–323). Open University Press.

Sheeran, P., Trafimow, D., & Armitage, C. J. (2003). Predicting behaviour from perceived behavioural control: tests of the accuracy assumption of the theory of planned behaviour. British Journal of Social Psychology, 42, 393–410. doi:10.1348/014466603322438224

Sheeran, P., & Webb, T. L. (2011). From goals to action. In H. Aarts & A. Elliott (Eds.), Frontiers in Social Psychology: Goal-directed behavior (pp. 175-202). Psychology Press.

* Sheldon, A. W. (1996). Computer-assisted diet and exercise training in the behavioral treatment of Type I diabetes. Unpublished doctoral dissertation, University of Miami, US.

* Sherwood, N. E., Crain, A. L., Martinson, B. C., Anderson, C. P., Hayes, M. G., Anderson, J. D., … Jeffery, R. W. (2013). Enhancing long-term weight loss maintenance: 2 year results from the Keep It Off randomized controlled trial. Preventive Medicine, 56, 171–177. doi:10.1016/j.ypmed.2012.12.014

Skinner, E. A., Edge, K., Altman, J., & Sherwood, H. (2003). Searching for the structure of coping: A review and critique of category systems for classifying ways of coping. Psychological Bulletin, 129, 216–269. doi:10.1037/0033-2909.129.2.216

Skoranski, A. M., Most, S. B., Lutz-Stehl, M., Hoffman, J. E., Hassink, S. G., & Simons, R. F. (2013). Response monitoring and cognitive control in childhood obesity. Biological Psychology, 92, 199–204.

* Smith, D. E., Heckemeyer, C. M., Kratt, P. P., & Mason, D. A. (1997). Motivational interviewing to improve adherence to a behavioral weight-control program for older obese women with NIDDM - A pilot study. Diabetes Care, 20(1), 52-54. doi:10.2337/diacare.20.1.52

Smith, J., & Mattick, R. P. (2013). Evidence of deficits in behavioural inhibition and performance monitoring in young female heavy drinkers. Drug and Alcohol Dependence, 133, 398-404. doi:10.1016/j.drugalcdep.2013.06.020

Sobel, M. E. (1982). Asymptotic confidence intervals for indirect effects in structural models. In S. Leinhardt (Ed.), Sociological methodology (pp. 290–312). San Francisco: Jossey-Bass.

* Spence, J. C., Burgess, J., Rodgers, W., & Murray, T. (2009). Effect of pretesting on intentions and behaviour: A pedometer and walking intervention. Psychology & Health, 24(7), 777-789. doi:10.1080/08870440801989938

StataCorp. (2009). Stata Statistical Software (Vol. 11th Edition). TX: College Station.

* Steinberg, D. M., Tate, D. F., Bennett, G. G., Ennett, S., Samuel-Hodge, C., & Ward, D. S. (2013). The efficacy of a daily self-weighing weight loss intervention using smart scales and e-mail. Obesity, 21, 1789-1797. doi:10.1002/oby.20396

Stuckey, H. L., Boan, J., Kraschnewski, J. L., Miller-Day, M., Lehman, E. B., & Sciamanna, C. N. (2011). Using positive deviance for determining successful weight-control practices. Qualitative Health Research, 21, 563-579. doi:10.1177/1049732310386623

* Suffoletto, B., Calabria, J., Ross, A., Callaway, C., & Yealy, D. M. (2012). A mobile phone text message program to measure oral antibiotic use and provide feedback on adherence to patients discharged from the emergency department. Academic Emergency Medicine, 19, 949-958. doi:10.1111/j.1553-2712.2012.01411.x

* Suffoletto, B., Wagner, A. K., Arenth, P. M., Calabria, J., Kingsley, E., Kristan, J., & Callaway, C. W. (2013). Mobile phone text messaging to assess symptoms after mild traumatic brain injury and provide self-care support: A pilot study. Journal of Head Trauma Rehabilitation, 28, 302-312. doi:10.1097/HTR.0b013e3182847468

* Sugden, J. A., Sniehotta, F. F., Donnan, P. T., Boyle, P., Johnston, D. W., & McMurdo, M. E. T. (2008). The feasibility of using pedometers and brief advice to increase activity in sedentary older women - a pilot study. BMC Health Services Research, 8, 169. doi:10.1186/1472-6963-8-169

Suls, J., Martin, R., & Wheeler, L (2002). Social comparison: Why, with whom, and with what effect? Current Directions in Psychological Science, 11, 159-163. doi:10.1111/1467-8721.00191

Sweeny, K., Melnyk, D., Miller, W., & Shepperd, J. A. (2010). Information avoidance: Who, what, when, and why. Review of General Psychology, 14, 340-353. doi:10.1037/a0021288

* Talbot, L. A., Gaines, J. M., Huynh, T. N., & Metter, E. J. (2003). A home-based pedometer-driven walking program to increase physical activity in older adults with osteoarthritis of the knee: A preliminary study. Journal of the American Geriatrics Society, 51(3), 387-392. doi:10.1046/j.1532-5415.2003.51113.x

* Tan, M. Y., Magarey, J. M., Chee, S. S., Lee, L. F., & Tan, M. H. (2011). A brief structured education programme enhances self-care practices and improves glycaemic control in Malaysians with poorly controlled diabetes. Health Education Research, 26(5), 896-907. doi:10.1093/her/cyr047

* Tate, D. F., Wing, R. R., & Winett, R. A. (2001). Using Internet technology to deliver a behavioral weight loss program. Journal of the American Medical Association, 285(9), 1172-1177. doi:10.1001/jama.285.9.1172

Te Velde, S. J., Wind, M., Perez-Rodrigo, C., Klepp, K-I, & Brug, J. (2008). Mothers' involvement in a school-based fruit and vegetable promotion intervention is associated with increased fruit and vegetable intakes – the Pro Children study. The International Journal of Behavioral Nutrition and Physical Activity, 5, 48. doi: 10.1186/1479-5868-5-48

* Thorndike, A. N., Sonnenberg, L., Healey, E., Myint-U, K., Kvedar, J. C., & Regan, S. (2012). Prevention of weight gain following a worksite nutrition and exercise program: a randomized controlled trial. American Journal of Preventive Medicine, 43(1), 27-33. doi:10.1016/j.amepre.2012.02.029

Triandis, H. C. (1977). Interpersonal behavior. Monterey, CA: Brooks/Cole.

Triandis, H. C. (1980). Values, attitudes, and interpersonal behavior. In H. E. Howe, Jr. & M. Page (Eds.), Nebraska symposium of motivation (Vol. 27, pp. 195–259). Lincoln: University of Nebraska Press.

Tuckey, M., Brewer, N., & Williamson, P. (2002). The influence of motives and goal orientation on feedback-seeking. Journal of Occupational and Organizational Psychology, 75, 195–216. doi:10.1348/09631790260098677

Tukey, J. W. (1962). The future of data analysis. The Annals of Mathematical Statistics, 33, 1-67. doi:10.1214/aoms/1177704711

* Turner-McGrievy, G., & Tate, D. (2011). Tweets, Apps, and Pods: Results of the 6-month Mobile Pounds Off Digitally (Mobile POD) randomized weight-loss intervention among adults. Journal of Medical Internet Research, 13(4). doi:10.2196/jmir.1841

* van der Meer, V., Bakker, M. J., van den Hout, W. B., Rabe, K. F., Sterk, P. J., Kievit, J., … SMASHING Study Group. (2009). Internet-based self-management plus education compared with usual care in asthma: a randomized trial. Annals of Internal Medicine, 151(2), 110-120. doi:10.326/0003-4819-151-2-200907210-00008

VanWormer, J. J., French, S. A., Pereira, M. A., & Welsh, E. M. (2008). The impact of regular self-weighing on weight management: A systematic literature review. International Journal of Behavioral Nutrition and Physical Activity, 5, 54. doi:10.1186/1479-5868-5-54

Viswesvaran, C., & Ones, D. S. (1995). Theory testing: Combining psychometric meta-analysis and structural equations modeling. Personnel Psychology, 48, 865-885. doi:10.1111/j.1744-6570.1995.tb01784.x

Wang, Z., Kueffer, A., Wang, J., & Maercker, A. (2014). Use of an internet-based self-help program for trauma victims: evaluation of dropout rates and their predictors. Verhaltenstherapie, 24(1), 6-14. doi:10.1159/000358472

* Wang, J., Sereika, S. M., Chasens, E. R., Ewing, L. J., Matthews, J. T., & Burke, L. E. (2012). Effect of adherence to self-monitoring of diet and physical activity on weight loss in a technology-supported behavioral intervention. Patient Preference and Adherence, 6, 221-226. doi:10.2147/ppa.s28889

Webb, T. L. (2006). Getting things done: Self-regulatory processes in goal pursuit. Social Psychological Review, 8, 2-13.

Webb, T. L., Benn, Y., & Chang, B. P. I. (2014). Antecedents and consequences of monitoring domestic electricity consumption. Journal of Environmental Psychology, 40, 228-238. doi:10.1016/j.jenvp.2014.07.001

Webb, T. L., Chang, B. P. I., & Benn, Y. (2013). 'The ostrich problem': Motivated avoidance or rejection of information about goal progress. Social and Personality Psychology Compass, 7, 794-807. doi:10.1111/spc3.12071

Webb, T. L., Miles, E. M., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. Psychological Bulletin, 138, 775-808. doi:10.1037/a0027600

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. Psychological Bulletin, 132, 249-268. doi:10.1037/0033-2909.132.2.249

Webber, J., Scheuermann, B., McCall, C., & Coleman, M. (1993). Research on self-monitoring as a behavior management technique in special-education classrooms - a descriptive review. Remedial and Special Education, 14, 38-56. doi:10.1177/074193259301400206

* Webber, K. H., Tate, D. F., & Bowling, J. M. (2008). A randomized comparison of two motivationally enhanced Internet behavioral weight loss programs. Behaviour Research and Therapy, 46(9), 1090-1095. doi:10.1016/j.brat.2008.06.008

Webber, K. H., Tate, D. F., Ward, D. S., & Bowling, J. M. (2010). Motivation and its relationship to adherence to self-monitoring and weight loss in a 16-week internet behavioral weight loss intervention. Journal of Nutrition Education and Behavior, 42, 161-167. doi:10.1016/j.jneb.2009.03.001

Wilde, M. H., & Garvin, S. (2007). A concept analysis of self-monitoring. Journal of Advanced Nursing, 57, 339-350. doi:10.1111/j.13652648.2006.04089.x

Williams, A. B., Fennie, K. P., Bova, C. A., Burgess, J. D., Danvers, K. A., & Dieckhaus, K. D. (2006). Home visits to improve adherence to highly active antiretroviral therapy: A randomized controlled trial. Journal of Acquired Immune Deficiency Syndromes, 42(3), 314-321. doi:10.1097/01.qai.0000221681.60187.88

Wilson, G. J., & Sherrell, D. L. (1993). Source effects in communication and persuasion research: A meta-analysis of effect size. Journal of the Academy of Marketing Science, 21(2), 101-112. doi:10.1007/BF02894421

* Wing, R. R., Crane, M. M., Thomas, J. G., Kumar, R., & Weinberg, B. (2010). Improving weight loss outcomes of community interventions by incorporating behavioral strategies. American Journal of Public Health, 100(12), 2513-2519. doi:10.2105/ajph.2009.183616

* Wing, R. R., Jeffery, R. W., Hellerstedt, W. L., & Burton, L. R. (1996). Effect of frequent phone contacts and optional food provision on maintenance of weight loss. Annals of Behavioral Medicine, 18(3), 172-176. doi:10.1007/bf02883394

* Wing, R. R., Tate, D. F., Gorin, A. A., Raynor, H. A., & Fava, J. L. (2006). A self-regulation program for maintenance of weight loss. The New England Journal of Medicine, 355, 1563-71. doi:10.1056/NEJMoa061883

Wood, L., Egger, M., Gluud, L. L., Schulz, K. F., Juni, P., Altman, D. G., … Sterne, J. A. C. (2008). Empirical evidence of bias in treatment effect estimates in controlled trials with different interventions and outcomes: Meta-epidemiological study. British Medical Journal, 336(7644), 601–605. doi:10.1136/bmj.39465.451748.AD

* Young, B. W., Medic, N., & Starkes, J. L. (2009). Effects of self-monitoring training logs on behaviors and beliefs of swimmers. Journal of Applied Sport Psychology, 21(4), 413-428. doi:10.1080/10413200903222889

Zizzo, D. J. (2010). Experimenter demand effects in economic experiments. Experimental Economics, 13, 75-98. doi:10.1007/s10683-009-9230-z

Zuckerman, M., Brown, R. H., Fox, G. A., Lathin, D. R., & Minasian, A. J. (1979). Determinants of information seeking behavior. Journal of Research in Personality, 13, 161-179.

Footnotes

[1] The measures of progress monitoring and goal attainment needed to be empirically distinct. For example, studies that prompted participants to monitor their blood glucose levels and then used frequency of monitoring as a measure of goal attainment were not suitable for inclusion. However, studies that prompted participants to monitor their blood glucose levels were included if an independent outcome measure like blood glucose levels (e.g., HbA1c levels) was used as a measure of goal attainment.

[2] Databases include the Science Citation Index Expanded (1900-present), Social Sciences Citation Index (1956-present), Arts & Humanities Citation Index (1975-present), Conference Proceedings Citation Index – for Science and for Social Science & Humanities (1990-present), Book Citation Index– for Science and for Social Science & Humanities (2005-present), Current Chemical Reactions (1985-present), Index Chemicus (1993-present), BIOSIS Citation Index (1926-present), BIOSIS Previews (1969-present), Current Contents Connect (1998-present), Data Citation Index (1900-present), Derwent Innovations Index (1963-present), MEDLINE (1950-present), SciELO Citation Index (1997-present), and the Zoological Record (1864-present)

[3] It was not possible to use random OR intervention / experiment* as recommended by Haynes, McKibbon, Wilczynski, Walter, and Werre (2005) as this combination of search terms produced over half a million records in Web of Science, even when combined with the other search filters.

[4] To examine the impact of these estimation procedures, we compared the effect sizes for progress monitoring and goal attainment when estimated values were included versus excluded from respective computations. Findings showed that the effect size for goal

attainment did not differ when effect sizes based on estimated values were included (d_+ = 0.40) versus excluded (d_+ = 0.40), Q(1) = 0.00, p = .96. However, the effect size for progress monitoring was slightly smaller when effect sizes based on estimated values were included (d_+ = 1.98) versus excluded (d_+ = 2.06), Q(1) = 10.74, p < .01. This is not surprising as the estimation procedures are conservative in assuming the smallest possible effect size that would produce a given significance value and that the effect size is zero when the effect is reported as non-significant. However, the fact that estimation procedures were used to compute a relatively small proportion of the effect sizes (7% of the effect sizes for progress monitoring, 9% for goal attainment) and the difference in the sample-weighted effect sizes for progress monitoring is small suggests that these procedures did not unduly influence our findings.

[5] Effect sizes for the three studies employing cluster randomization were adjusted using the design effect equation of: 1 + (M - 1 - ICC), where M and ICC refer to the average cluster size and inter-class correlation coefficient, respectively. In the absence of an ICC, it was estimated to be 0.05. The design effect was then used to calculate the corrected sample size for the treatment and control conditions (Higgins & Green, 2011). In order to check that the inclusion of studies with cluster-randomized designs did not bias effect sizes, we also conducted a sensitivity analysis removing studies where the unit of analysis was the group. The effect sizes did not differ significantly when studies with cluster randomized designs were included (d_+ = 1.98 and 0.40 for effects on progress monitoring and goal attainment, respectively) versus excluded (d_+ = 1.96 and 0.40, respectively), Q(1) = 0.33 and 0.02, p = 0.57 and 0.89.

[6] The 20 studies used in the mediation analysis were Akers, Cornett, Savla, Davy, and Davy (2012), Boutelle, Kirschenbaum, Baker, and Mitchell (1999), Chambliss, Huber, Finlay, McDoniel, Kitzman-Ulrich, and Wilkinson (2011), Cussler et al. (2008), Duran et al. (2010), Gokee-La Rose, Gorin, and Wing (2009), Hellerstedt and Jeffrey (1997, behavior-focused phone group), Helsel et al. (2007), Kempf, Tankova, and Martin (2013), Kraschnewski et al. (2011), Morgan et al. (2009), Nguyen, Gill, Wolpin, Steele, and Benditt (2009), Pellegrini et al. (2012), Runyan, Steenbergh, Bainbridge, Daugherty, Oke, and Fry (2013), Samuel-Hodge et al. (2009), Tate et al. (2001), Tan, Maganee, Chee, Lee, and Tan (2011), Wang, Sereika, Chasens, Ewing, Matthews, and Burke (2012), Webber, Tate, and Bowling (2008), and Wing, Crane, Thomas, Kumar, and Weinberg (2010). These 20 studies did not differ significantly from excluded studies in terms of their reported effect on goal attainment ($d_+ = 0.44$ and 0.39, respectively), $Q(1) = 0.71$, $p = 0.40$, but did tend to report smaller effects on the frequency of progress monitoring ($d_+ = 1.51$) than excluded studies ($d_+ = 2.06$), $Q(1) = 83.47$, $p < .001$. A potential explanation of these differences is that studies may have been more likely to report the correlation between progress monitoring and goal attainment (and therefore could be included in the mediation analysis) if participants in the comparison condition were also asked to monitor their progress – a methodological feature that led to smaller effect sizes for progress monitoring.

[7] For the purposes of this analysis we recomputed the effect size for goal attainment using only the measures for which the primary studies reported the correlation between the frequency of progress monitoring and goal attainment. For example, Cussler et al. (2008) reported the effect of their intervention on two behaviors (energy expenditure and energy intake) and five outcomes (weight, BMI, percentage body fat, total body fat, and fat-free

mass). However, Cussler et al. only reported the correlation between the frequency of progress monitoring and three of these measures of goal attainment (weight, energy expenditure, and energy intake). For the purposes of the mediation analyses, we therefore recomputed the effect of this intervention on the three measures of goal attainment for which correlations were reported.

[8] The 6 studies used in the mediation analysis were Arbour and Martin Ginis (2008), Haapala, Barengo, Biggs, Surakka, and Manninen (2009), Janson, Fahy, Covington, Paul, Gold, and Boushey (2003), Tan et al. (2011), Tate et al. (2001), and Wing et al. (2010). These 6 studies did not differ significantly from excluded studies in terms of their reported effect on goal attainment ($d_+ = 0.55$ and 0.39, for included versus excluded studies, respectively), $p = .08$, but did tend to report smaller effects on the frequency of progress monitoring ($d_+ = 1.48$) than excluded studies ($d_+ = 2.00$), $Q(1) = 30.24$, $p < .001$.

[9] Where studies measured both behavior and outcomes, only the measures relevant to the nature of progress monitoring (i.e., behavioral measures when participants were prompted to monitor their behavior, outcome measures when participants were prompted to monitor outcomes) were included in this analysis.

[10] The only exception was the effect of interventions on goal attainment among (the relatively few) studies using cluster or minimization randomization procedures.

Table 1

Dimensions of Progress Monitoring

Dimension	Definition	Example
Focus of Progress Monitoring		
Monitor behavior	The person monitors their behavior(s)	A person uses a pedometer and records the number of steps that they take
Monitor outcomes	The person monitors the outcome(s) of their behavior (including thoughts and feelings)	A person weighs themselves and records their weight on a graph
Public vs. Private Monitoring		
Public monitoring	Progress is monitored in a public context	A person weighs themselves at a dieting group, in front of others who are trying to lose weight
Private monitoring (reported)	Progress is monitored privately, but the information derived from progress monitoring is reported to at least one other person	A person weighs themselves and telephones a research assistant to report their weight
Private monitoring (not reported)	Progress is monitored privately, and the information derived from progress monitoring is not reported to anyone else	A person weighs themselves, but does not report their weight to anyone
Recording of Monitoring		
Monitoring is recorded	The information obtained from monitoring is physically recorded	A person weighs themselves and writes this information in their diary
Monitoring is not recorded	The information obtained from monitoring is not	A person weighs themselves, but does not record or

	recorded in any way	report this information
Reference Value [a]		
Past	Goal progress is compared to a past state or previous rate of progress	A person compares how much they weigh now, to how much they weighed previously
Desired (future) target	Goal progress is compared to a desired future state or goal	A person compares how much they weigh now, to how much they would like to weigh
Others	Goal progress is compared to others progress or states (close others or those striving for a similar goal)	A person compares how much they weigh now, to how much others around them weigh
Monitor Rate of Progress vs. Distance from the Goal		
Monitor rate of progress toward a goal	The person monitors their rate of progress toward a specified goal	A person notes that they weigh 1kg less each week
Monitor distance from the goal	The person monitors how far they are away from a goal or starting point	A person notes that they weigh 6kg more than desired
Passive vs. Active Monitoring		
Passive monitoring	The person attends to information about progress that can be accessed without deliberate effort; that is, information that is readily available in the environment	A person notices that clothes feel looser than before, recognizes that a number of friends have commented on their weight loss, or receives text alerts with their weight
Active monitoring	The person makes deliberate efforts to attend to goal-related behavior, and/or seeks out information about goal-related outcomes	A person steps on a set of weighing scales or records the amount of exercise performed

Notes. [a] Because participants asked to monitor their progress toward a specified goal might evaluate their progress with respect to different reference values (e.g., participants asked to walk 10,000 steps per day might compare the number of steps that they took on a particular day to this value or to the number of steps that they took the previous day), we suggest that the nature of the reference value should only be coded if the intervention explicitly directs participants to monitor their progress with respect to a particular reference value.

Table 2

Effect Sizes for Progress Monitoring and Goal Attainment for Studies Included in the Meta-Analysis

Study	Progress Monitoring Method	Focal Behavior/Outcome	N_E	N_C	Effect size (d) PM	Effect size (d) GA
Abrahams et al. (2010)	Diary	Prophylaxis use	125	128	0.27*[a]	0.15[c]
Abraira et al. (1995)	SMBG	BG	75	78	2.41***[a]	0.47**[c]
Acharya et al. (2011)	PDA	Weight	129	62	0.66***[a]	0.12[de]
Akers et al. (2012)	Tracking sheets	Weight, diet	18	21	-0.13***[a]	-0.02[d]
Allen et al. – Comp. 1 (2013)[f]	Phone	Weight	11	4	2.76***[b]	0.45[d]
Allen et al. – Comp. 2 (2013)[g]	Phone	Weight	10	4	2.71**[b]	0.42[d]
Allen et al. – Comp. 3 (2013)[h]	Phone	Weight	10	4	2.02 **[b]	-0.10[d]
Amsberg et al. (2009)	Blood sugar	BG	36	38	0.70 **[a]	0.47[c]
An et al. (2006	Website	Smoking	257	260	10.72***[b]	0.45***[c]
Anderson et al. (2011)	Diary	Weight	18	13	4.31*** [b]	3.21***[d]
Andrews et al. (2011)	Pedometer	BG	240	246	4.11***[b]	-0.02[de]
Antypas & Wangberg (2014)	Website	PA	27	37	0.17[a]	0.84*[c]
Arbour & Martin Ginis (2008)	Log book	PA	25	17	0.10[a]	0.50[de]
Aronson (2006)	Diary	Medication adherence	19	19	-0.61[a]	0.11[c]
Atienza et al. (2008)	PDA	Diet	16	11	2.95***[b]	0.51[d]
Beasley et al (2008)	Diary	Weight	71	78	0.00[a]	0.25[d]
Bell et al. (2012)	Log/diary	BG	31	33	-0.36[a]	0.32[d]
Berg et al. (1997)	Diary	Asthma	31	24	4.32***[a]	0.12[de]

Blasco et al. (2012)	Internet	CAD	87	83	4.07***[b]	0.09[d]
Boutelle et al. (1999)	Diary	Weight	26	31	0.47[a]	1.64*
Brindal et al. (2013)	Phone	Weight	21	23	0.95**[a]	0.37[de]
Buist et al. (2006)	Diary	Asthma	149	147	0.00[a]	0.16[de]
Caldwell et al. (2005)	Diary	Heart failure	20	16	0.62[a]	1.01**[de]
Carli et al. (2008)	UV meter	Sun protection	46	40	3.39***[b]	-0.51*[c]
Carter et al. – Comp. 1 (2013)[i]	Phone	Weight, diet, PA	40	20	0.94**[a]	0.30[d]
Carter et al. – Comp. 2 (2013)[j]	Phone	Weight, diet, PA	27	20	0.14[a]	-0.33[d]
Chambliss et al. (2011)	PDA	Weight	34	33	-0.59*[a]	-0.08[c]
Chao et al. (2010)	Step log	PA	20	20	3.52***[b]	0.27[d]
Chau et al. (2012)	PDA	COPD	22	18	3.64***[b]	-0.05[d]
Cho et al. (2006)	SMBG	BG	35	36	0.50*[a]	0.82**[de]
Clarke et al. (2009)	Website	Depression	58	58	2.58***[b]	0.81***[de]
Coughlin et al. – Comp. 1 (2013)[k]	Diary	Diet	292	144	0.26**[a]	0.13[d]
Coughlin et al. – Comp. 2 (2013)[l]	Diary	Diet	301	144	0.38***[a]	0.27**[dl]
Cussler et al. (2008)	Website	Weight, diet, PA	38	40	4.17***[b]	0.01[c]
D'Eramo – Comp. 1 (1987)[m]	SMBG	Weight	15	6	0.42[a]	0.54[de]
D'Eramo – Comp. 2 (1987)[n]	SMBG	Weight	19	6	0.51[a]	0.53[de]
De Blok et al. (2006)	Diary	PA	8	8	4.61***[b]	1.50**[de]
De Cocker et al. (2008)	Pedometer	PA	51	52	0.38[a]	-0.11[de]
De Cocker et al. (2012)	Diary	PA	32	37	-0.19[a]	0.51[d]
Dennis et al. (2012)	Website	Weight, diet, PA	18	21	3.39***[b]	-0.06[de]

Dennison et al. – Comp. 1 (2014)[o]	Website	Weight, diet, PA	247	138	2.35***[b]	0.91***[d]
Dennison et al. – Comp. 2 (2014)[p]	Website	Weight, diet, PA	264	138	2.09***[b]	0.77**[d]
DeWalt et al. (2006)	Diary	Healthcare use	52	59	1.22***[a]	-0.19[c]
Domingo et al. (2011)	Website/television	Healthcare use	44	42	3.48***[b]	-0.11[c]
Duran et al. (2010)	SMBG	BG	99	62	2.28***[a]	2.70***[de]
Farmer et al. – Comp. 1 (2007)[q]	SMBP	BG	150	76	3.31***[b]	0.16[dq]
Farmer et al. – Comp. 2 (2007)[r]	SMBP	BG	151	76	2.97***[b]	0.20[dr]
Gajecki et al. (2014)	Phone	Alcohol	341	489	3.50***[b]	-0.19*[de]
Gokee LaRose et al. (2010)	Diary	Weight	21	23	0.96***[b]	-1.22**[d]
Gokee LaRose et al. (2009)	Digital scales	Weight	20	17	1.12***[a]	0.10[d]
Gold et al. (2007)	Website	Diet	51	50	0.58***[a]	0.46*[d]
Goto et al. (2014)	Phone	PA, blood coagulation	16	16	4.11***[b]	0.05[de]
Goulis et al. (2004)	Phone	Weight, BP, Physiol.	45	77	3.08*** [b]	0.57**[de]
Haapala et al. (2009)	Phone	Weight, diet, PA	45	40	2.43***[b]	0.42[de]
Haddock et al. (2014)	Website	Weight, diet, PA	229	253	0.91***[a]	0.25**[d]
Hannum et al. (2004)	Diary	Weight, diet	26	27	0.16[a]	0.38[d]
Hellerstedt & Jeffrey – Comp. 1 (1997)[s]	Phone	Weight	20	11	4.32***[b]	-1.48**[d]
Hellerstedt & Jeffrey – Comp. 2 (1997)[t]	Phone	Diet, PA	17	11	3.70***[b]	0.83[d]
Helsel et al. (2007)	Diary	Weight	21	21	0.23[a]	0.07[d]
Homko et al. (2012)	Website/phone	BG	40	40	0.04[a]	0.21[c]
Hurling et al. (2007)	Website	Weight, PA	47	30	3.71***[b]	2.86***[d]
Hyman et al. (1998)	Diary	Cholesterol	65	58	3.44***[b]	0.10[d]

Janson et al. (2003)	Diary	Asthma	31	27	-0.09[a]	0.72**[de]
Janson et al. (2009)	Diaries	Asthma	45	39	0.17[a]	0.12[d]
Jefferson (2005)	Diary	Mood, weight	21	29	3.82***[b]	-0.09[de]
Jennings et al. (2014)	Website	PA	77	77	3.79***[b]	0.06[de]
Jurgens et al. (2013)	Diary	Heart failure	48	51	0.77***[a]	0.13[c]
Kempf et al. (2013)	Diary	Diabetes	62	60	2.75***[b]	0.43*[de]
Kim et al. (2012)	Website	Weight, BG	19	23	3.73***[b]	0.29[d]
King et al. (2008)	PDA	PA	19	18	3.34 ***[b]	0.71*[c]
Kirwan et al. (2013)	Diary	Diabetes	32	36	0.43[a]	3.78***[d]
Kobulnicky (2002)	Diary	Effects of chemotherapy	42	29	3.95***[b]	0.05[d]
Kraschnewski et al. (2011)	Website	Weight, diet, PA	43	45	2.16***[b]	0.28[d]
Kristal et al. (2000)	Diary	Diet	601	604	2.87***[b]	0.21***[d]
Kroenke et al. (2010)	Phone	Depression	202	203	4.50***[b]	0.54***[de]
Kwon et al. (2004)	SMBG	BG	51	50	5.23***[a]	0.89***[de]
Ligibel et al. (2012)	Diary	PA	48	51	2.80***[b]	0.18[d]
Linde & Jeffrey (2011)	Diary	Weight, diet, PA	22	26	1.16***[a]	0.20[d]
Logan et al. (2012)	SMBP	BP	55	55	3.26***[b]	0.38[d]
Maljanian et al. (2005)	Diary	Diabetes	181	162	0.13[a]	0.15[de]
Marquez-Contreras et al. (2006)	MEMS	BP	100	100	1.11***[a]	0.24[de]
Maruyama et al. (2010)	Website	PA	48	39	0.61**[a]	0.44*[c]
McKinstry et al. (2013)	PDA	BP	182	177	4.17***[b]	0.41***[d]
McManus et al. (2010)	SMBP	BP	234	246	3.49***[b]	3.80***[d]

McMurdo et al. – Comp. 1 (2010)[u]	Diary	PA	60	33	4.61***[b]	1.32***[d]
McMurdo et al. – Comp. 2 (2010)[v]	Diary	PA	53	33	4.50***[b]	3.31***[d]
Mehos et al. (2000)	SMBP	BP	18	18	4.00***[b]	0.56[d]
Moreland et al. – Comp. 1 (2006)[w]	SMBG	BG	50	49	0.44*[a]	0.14[d]
Moreland et al. – Comp. 2 (2006)[x]	SMBG	BG	50	49	-0.07[a]	0.07[d]
Morgan et al. (2009)	Website	Weight, PA	24	31	0.51[b]	1.21***[d]
Muchmore et al. (1994)	SMBG	BG	12	11	3.61***[b]	1.86***[de]
Nanchahal et al. (2009)	Pedometer	Weight	48	55	3.24***[b]	0.07[d]
Nguyen et al. (2009)	Phone	PA	9	8	0.68[a]	-0.54[de]
O'Kane et al. (2008)	SMBG	BG	96	88	3.68***[b]	0.09[de]
Ornes (2006)	Diary	PA	30	29	3.41***[b]	0.73**[de]
Orsama et al. (2013)	PDA	Blood glucose	24	24	3.02***[b]	0.47[d]
Oshima et al. (2013)	PDA	Weight	28	28	1.51***[a]	0.30[de]
Pellegrini et al. (2012)	Website	Weight, diet, PA	17	13	0.29[a]	0.13[d]
Petersen et al. (2012)	Pedometer	PA	192	173	3.87***[b]	0.07[d]
Petrella et al. (2014)	Phone	PA	67	60	3.37***[b]	-0.04[de]
Phelan et al. (2014)	Phone	Weight, diet, PA	128	133	0.28*[a]	0.16[d]
Piette et al. (2011)	Diary	Physical activity	145	146	-0.47***[a]	0.40**[de]
Polonsky et al. (2011)	SMBG	BG	188	187	-0.37***[a]	0.33**[d]
Polzien et al. (2007)	Diary	Weight, diet, PA	16	16	0.58[a]	0.07[d]
Proudfoot et al. (2013)	Website	Depression	126	185	1.14***[b]	0.24*[de]
Quinn et al. (2008)	Log Book	Diabetes	13	13	4.26***[a]	0.72[c]

Ralston et al. (2014)	Diary/Survey	BP	186	197	0.29**[a]	0.29**[d]
Raynor et al. (2012)	Diary	Weight	94	96	0.00[a]	0.42**[c]
Richardson et al. (2010)	Website	PA	254	70	0.44**[a]	0.16[d]
Rosal et al. (2011)	SMBG	BG	124	128	0.58***[a]	0.19[d]
Rosal et al. (2005)	SMBG	BG	15	10	0.81[a]	1.04*[d]
Rote (2013)	Website	PA	27	26	0.41[a]	1.34***[de]
Runyan et al. (2013)	Phone	Time management	41	20	2.70***[b]	0.68*[c]
Samuel-Hodge et al. (2009)	Diary	Weight	64	62	3.64***[b]	0.38*[d]
Sengpiel et al. (2010)	PDA	Lung function	28	28	0.30[a]	0.23[c]
Seto et al. (2012)	Phone	Heart function	44	50	3.82***[b]	0.05[de]
Shapiro et al. (2012)	Phone	Weight, PA	64	79	3.17***[b]	0.19[d]
Sheldon (1996)	Diary	Diet	8	6	1.55*[a]	0.45[de]
Sherwood et al. (2013)	Diary/Survey	Weight	178	186	0.45***[a]	0.16[d]
Smith et al. (1997)	Diary	Weight, diet, BG	6	10	1.29*[a]	0.65[d]
Spence et al. (2009)	Log sheets	Physical activity	16	16	3.52***[b]	1.07**[de]
Steinberg et al. (2013)	Phone	Weight, diet, PA	45	44	3.82***[a]	1.60***[d]
Suffoletto et al. (2012)	Phone	Antibiotic adherence	72	72	3.31***[b]	0.27[c]
Suffoletto et al. (2013)	Phone	Symptom assessment	14	22	4.06***[b]	0.38[d]
Sugden et al. (2008)	Diary	PA	27	18	0.88 **[a]	-0.04[d]
Talbot et al. (2003)	Pedometer	PA	17	17	3.55***[b]	0.29[de]
Tan et al. (2011)	SMBG	BG	82	82	14.46***[a]	0.49**[c]
Tate et al. (2001)	Website	Weight	33	32	1.09***[a]	0.65**[d]

Thorndike et al. (2012)	Website	Weight	145	130	3.36***[b]	0.16[d]
Turner-McGrievy & Tate (2011)	Phone	Weight	42	45	0.22[a]	0.05[d]
Van der Meer et al. (2009)	Website	Asthma	91	92	2.46***[b]	3.80***[d]
Wang et al. (2012)	PDA	Weight	59	60	0.29[a]	0.46*[d]
Webber et al. (2008)	Diary	Weight	33	33	0.03[a]	0.31[d]
Wing et al. – Comp. 1 (2006)[y]	Phone	Weight	103	49	3.82***[b]	0.37[d]
Wing et al. – Comp. 2 (2006)[z]	Website	Weight	100	49	3.75***[b]	0.04[d]
Wing et al. (2010)	Website	Weight	74	76	0.16[a]	0.61[d]
Wing et al. - Study 1 (1996)	Diary	Weight	23	27	3.51***[b]	0.44*[d]
Young & Starkes (2009)	Swim log	PA	15	11	-0.71[a]	1.00***[de]

Note. N_E = Number of participants in treatment group. N_C = Number of participants in comparison group. Comp. = Comparison. PM = Progress monitoring. GA = Goal attainment. Monitor BG = Monitoring of blood glucose, Monitor BP = Monitoring of blood pressure, PA = Physical activity, BG = Blood glucose. BP = Blood pressure, PDA = Personal digital assistant, MEMS = Medication event monitoring system (a product developed by the Aardex Group), Physiol. = Physiological measure(s) (e.g., cholesterol, HDL)

[a] = Effect size calculated by comparing the frequency of progress monitoring in the treatment group and comparison conditions.

[b] = Effect size calculated by comparing the frequency of progress monitoring in the treatment group to zero (i.e., studies where the frequency of progress monitoring was not reported for the comparison condition).

[c] = Effect size calculated using follow-up measures.

[d] = Effect size calculated using change scores from baseline.

[e] = Effect size calculated by converting a follow-up measure to change score.

[f] = Comparison 1 from Allen et al. (2013): Intensive counseling + smartphone vs. intensive counseling

[g] = Comparison 2 from Allen et al. (2013): Less intensive counseling + smartphone vs. intensive counseling

[h] = Comparison 3 from Allen et al. (2013): Smartphone vs. intensive counseling

[i] = Comparison 1 from Carter et al. (2013): Smartphone vs. diary

[j] = Comparison 2 from Carter et al. (2013): Website vs. diary

[k] = Comparison 1 from Coughlin et al. (2013): Personal contact vs. self-directed

[l] = Comparison 2 from Coughlin et al. (2013): Interactive technology vs. self-directed

[m] = Comparison 1 from D'Eramo (1987): Diabetes skills instruction + 11 week diabetes education vs. skills instruction.

[n] = Comparison 2 from D'Eramo (1987): Diabetes skills instruction + 11 week diabetes education + follow-up counseling vs. skills instruction.

[o] = Comparison 1 from Dennison et al. (2014): Power + coaching vs. control.

[p] = Comparison 2 from Dennison et al. (2014): Power only vs. control.

[q] = Comparison 1 from Farmer et al. (2007): Less intensive blood glucose monitoring vs. control.

[r] = Comparison 2 from Farmer et al. (2007): More intensive blood glucose monitoring vs. control.

[s] = Comparison 1 from Hellerstedt and Jeffrey (1997): Weight focused phone group vs. minimal contact.

[t] = Comparison 2 from Hellerstedt and Jeffrey (1997): Behavior focused phone group vs. minimal contact.

[u] = Comparison 1 from McMurdo et al. (2010): Behavior change + pedometer vs. usual care.

[v] = Comparison 2 from McMurdo et al. (2010): Behavior change vs. usual care.

[w] = Comparison 1 from Moreland et al. (2006): Blood glucose monitoring + manual vs. usual care.

[x] = Comparison 2 from Moreland et al. (2006): Blood glucose monitoring vs. usual care.

[y] = Comparison 1 from Wing et al. (2006): Face to face vs. newsletter control.

[z] = Comparison 2 from Wing et al. (2006): Internet vs. newsletter control.

Table 3

Categorical Moderators of the Effect of Interventions on Progress Monitoring and Goal Attainment

	Progress Monitoring					Goal Attainment				
Moderator	N	k	Q	95% CI	d_+	N	k	Q	95% CI	d_+
Focus of PM[a]										
Monitor behavior	12624	78	4510.44***	[1.84, 2.54]	2.19	11461	78	383.73***	[0.33, 0.52]	0.43
Monitor outcomes	12390	83	4433.71***	[2.00, 2.66]	2.33	11360	83	571.64***	[0.31, 0.52]	0.42
Public vs. Private Monitoring										
Public monitoring	218	3	71.16***	[0.18, 4.76]	2.47_a	214	3	11.35**	[-0.16, 1.26]	0.55_a
Private (reported)	13417	95	1359.49***	[2.17, 2.85]	2.51_a	12155	95	665.24***	[0.37, 0.58]	0.47_a
Private (not reported)	3251	14	973.15***	[0.40, 1.78]	1.09_b	3177	14	42.77***	[0.05, 0.33]	0.19_b
			1039.30***					49.86***		
Recorded vs. Not Recorded monitoring										
Recorded	16931	106	6362.60***	[2.08, 2.70]	2.39_a	15589	106	748.26***	[0.34, 0.53]	0.43_a
Not recorded	3020	32	295.99***	[0.36, 0.85]	0.60_b	2809	32	86.48***	[0.15, 0.42]	0.29_b

			1784.65***					12.71***		
Reference Value										
Past	2491	12	631.54***	[1.98, 3.79]	2.88_a	2019	12	68.15***	[0.20, 0.66]	0.43
Desired (future) target	5740	44	1874.19***	[1.87, 2.80]	2.33_b	5480	44	333.38***	[0.25, 0.58]	0.41
Others	479	2				176	2			
			67.70***					0.14		
Monitor Rate vs. Distance										
Monitor rate of progress	293	3	91.89***	[-0.18, 3.85]	1.84_b	286	3	2.85	[0.10, 0.68]	0.39
Monitor distance from goal	8593	44	3017.50***	[1.72, 2.67]	2.20_b	8172	44	449.23***	[0.29, 0.59]	0.44
			6.68**					0.19		
Passive vs. Active Monitoring										
Passive monitoring	2063	13	436.12***	[1.35, 2.71]	2.03_b	1426	13	18.90	[0.24, 0.54]	0.39
Active monitoring	17462	111	6612.62***	[2.02, 2.62]	2.32_a	16105	111	787.97***	[0.34, 0.52]	0.43
			24.90***					0.49		
Method used to Promote PM										
BP monitor	1126	5	5.95	[3.07, 3.56]	3.31_a	1074	5	136.40***	[-0.18, 1.45]	0.64_a

BG monitor	1886	15	737.08***	[0.90, 2.50]	1.70_{e}	1726	15	88.15***	[0.34, 0.86]	0.60_{a}
Website	5576	30	1632.30***	[1.40, 2.40]	1.90_{d}	4787	30	185.10***	[0.31, 0.63]	0.47_{b}
Written diary	5815	46	1964.24***	[1.11, 1.92]	1.51_{f}	5626	46	183.01***	[0.29, 0.54]	0.42_{b}
Phone	2934	24	873.23***	[1.99, 3.34]	2.67_{c}	2775	23	102.07***	[0.06, 0.43]	0.25_{c}
PDA	1156	12	449.60***	[0.98, 2.93]	1.96_{d}	1140	12	21.70*	[0.02, 0.39]	0.21_{c}
Pedometer	1258	5	248.60***	[1.52, 4.52]	3.02_{b}	1070	5	1.36	[-0.10, 0.14]	0.02_{d}
MEMS	200	1						200	1	
			826.86***					102.38***		
Source of the Intervention										
Health professionals	3944	32	1827.89***	[1.67, 2.96]	2.31_{a}	3800	32	137.85***	[0.22, 0.52]	0.37
Researchers	6215	42	2515.50***	[1.13, 2.13]	1.63_{c}	5864	42	121.52***	[0.25, 0.46]	0.35_{b}
Mixed team	1790	16	567.26***	[1.29, 2.66]	1.97_{b}	1662	16	64.02***	[0.22, 0.66]	0.44
Not face-to-face	8002	48	2341.74***	[1.65, 2.46]	2.06_{b}	7072	48	509.45***	[0.27, 0.61]	0.54_{a}
			213.40***					7.13		
Focal Behavior or Target Outcome										
Depression	832	3	226.75***	[0.56, 4.91]	2.74_{a}	658	3	18.21***	[0.15, 1.16]	0.66_{a}

Blood pressure	1615	6	590.07***	[1.21, 4.19]	2.70_{a}	1563	6	148.48***	[0.03, 1.23]	0.63_{a}
Asthma management	700	5	189.69***	[0.05, 2.59]	1.32_{d}	657	5	69.36***	[-0.14, 1.34]	0.60_{a}
Physical activity	2808	25	1312.18***	[1.28, 2.75]	2.02_{b}	2347	25	142.85***	[0.37, 0.82]	0.59_{a}
Blood glucose	3385	24	1426.23***	[1.27, 2.61]	1.94_{b}	3378	24	145.91***	[0.32, 0.70]	0.51_{a}
Weight	6255	50	1549.38***	[1.32, 2.00]	1.66_{c}	5487	50	138.27***	[0.20, 0.40]	0.30_{b}
Diet	1446	6	331.15***	[0.42, 3.01]	1.71_{c}	1419	6	5.61	[0.12, 0.34]	0.23_{b}
Heart care / cholesterol	757	10	251.03***	[1.75, 3.94]	2.85_{a}	757	10	7.36	[-0.00, 0.28]	0.14_{b}
Use of healthcare systems	363	3	59.85***	[1.08, 4.23]	2.66_{a}	347	3	3.77	[-0.29, 0.30]	0.01_{b}
Alcohol	830	1				830	1			
Smoking cessation	517	1				517	1			
Prophylaxis use	253	1				253	1			
Sun protection	91	1				86	1			
Time management	61	1				61	1			
Medication adherence	38	1				38	1			

			452.48***					114.43***		
Measure										
Objective	10667	79	3831.55***	[1.96, 2.67]	2.31_a	10867	80	547.54***	[0.33, 0.55]	0.44_a
Self-report	9203	58	3328.98***	[1.12, 1.88]	1.50_b	4658	24	116.90**	[0.19, 0.50]	0.34_b
Combination						2873	34	158.80***	[0.17, 0.52]	0.34_b
			564.86***					10.33**		
Nature of the Comparison Group										
No monitoring	10864	67	968.41***	[3.10, 3.57]	3.34_a	9883	67	598.04***	[0.28, 0.55]	0.42
Some monitoring	9087	71	1077.50***	[0.50, 0.86]	0.68_b	8565	71	239.73***	[0.29, 0.47]	0.38
			5252.05***					1.62		
Study Quality										
Participant blinding										
Blind	2159	14	876.54***	[0.72, 2.44]	1.58_b	1911	14	38.85***	[0.14, 0.49]	0.32_b
Not blind	8154	34	2684.96***	[2.12, 3.24]	2.68_a	7285	34	479.14***	[0.34, 0.73]	0.53_a
			360.58***					17.37***		
Experimenter blinding										

Blind	6616	44	2808.16***	[1.43, 2.41]	1.92_{b}	6027	44	164.89***	[0.26, 0.48]	0.37
Not blind	7449	33	2564.17***	[1.97, 3.09]	2.53_{a}	6864	33	401.73***	[0.23, 0.60]	0.41
			202.39***					1.39		
Randomization success										
Successful	12,340	88	4464.83***	[1.62, 2.28]	1.95_{b}	11229	88	286.77***	[0.25, 0.40]	0.33_{c}
US + not controlled	2591	18	1000.74***	[1.98, 3.61]	2.80_{a}	2513	18	140.53***	[0.23, 0.73]	0.48_{b}
US + controlled	2276	16	784.73***	[1.22, 2.69]	1.95_{b}	2007	16	163.55***	[0.29, 0.94]	0.62_{a}
Not assessed	1725	11	648.59***	[0.61, 2.68]	1.65_{c}	1664	11	183.54***	[0.04, 0.98]	0.51_{ab}
			252.31***					46.03***		
Type of randomization										
Individual	9653	88	3971.82***	[1.63, 2.31]	1.97_{c}	9003	88	403.54***	[0.28, 0.48]	0.38_{b}
Cluster	417	3	124.60***	[0.19, 4.92]	2.56_{a}	306	3	3.11	[-0.12, 0.54]	0.21_{c}
Stratified	375	1				291	1			
Minimisation	466	3	168.03***	[-0.91, 4.42]	2.22_{b}	466	3	5.37	[-0.23, 0.61]	0.19_{c}
Combined	8067	39	2512.03***	[1.58, 2.50]	2.04_{c}	7357	39	413.29***	[0.31, 0.64]	0.47_{a}
			25.80***					17.79***		

Quality of randomization										
High[b]	5429	35	2128.99***	[1.40, 2.44]	1.92_b	5184	35	133.76***	[0.23, 0.47]	0.35_b
Medium[c]	11567	73	4057.69***	[1.73, 2.46]	2.09_a	10379	73	562.79***	[0.30, 0.54]	0.42_a
Low[d]	2955	30	1055.83***	[1.21, 2.30]	1.75_c	2835	30	137.61***	[0.21, 0.58]	0.40
			54.96***					4.29		
Type of Participant										
General public	3420	14	1136.43***	[1.32, 3.08]	2.20_b	2969	14	103.82***	[0.27, 0.76]	0.52_a
Specific samples	14780	114	5040.47***	[1.64, 2.17]	1.91_c	13688	114	616.01***	[0.30, 0.47]	0.39_b
Diabetes	4026	30	1759.84***	[1.26, 2.46]	1.86^e	4038	30	152.14***	[0.32, 0.63]	0.48^e
Overweight	5406	47	1304.96***	[1.24, 1.93]	1.59^e	4724	47	145.41***	[0.22, 0.45]	0.33^e
Psychological illness	467	3	43.35***	[1.02, 3.68]	2.18^e	446	3	18.51***	[-0.12, 1.33]	0.60^e
Other conditions	4881	34	1846.29***	[1.78, 2.89]	2.34^e	4480	34	311.73***	[0.16, 0.55]	0.35^e
University students	1751	10	475.50***	[1.20, 3.65]	2.42_a	1741	10	77.83***	[0.06, 0.77]	0.41
			88.41***					10.15**		

Notes. Effect sizes with different subscripts (within each moderator) differ significantly ($p < 0.05$).

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

[a] = Levels of the moderator were not compared as categories are not mutually exclusive (i.e., interventions could prompt participants to monitor their behavior and the outcomes of their behavior, see, for example, Farmer et al., 2007).

[b] = Truly randomized (and method described) and experimenter unlikely to know condition or described as randomized and double blinded (but method not described) and no significant differences in relevant pre-test measures.

[c] = Randomised, but method not described and experimenter blinded or randomization described but it is possible that the experimenter may have known the condition.

[d] = Randomized, but method not described and experimenter was not blinded to condition.

[e] = Effect sizes for different specific samples were not statistically compared.

PM = Progress monitoring, BCT = Behavior change technique, BP = Blood pressure, BG – Blood glucose, PDA = Personal digital assistant, MEMs = Medication event monitoring system.

Table 4

Continuous Moderators of the Effect of Interventions on Progress Monitoring and Goal Attainment

			Progress Monitoring						Goal Attainment					
Moderator	M	SD	N	k	I^2	β	95% CI	Adj-R^2	N	k	I^2	β	95% CI	Adj-R^2
Age	48.00	13.44	19951	138	98.18	0.02	[-0.00, 0.04]	1.61	18398	138	83.48	0.00	[-0.01, 0.01]	-0.82
% female	66.31	24.47	19951	138	98.18	0.00	[-0.01, 0.01]	-0.73	18398	138	83.73	-0.00	[-0.00, 0.00]	-1.03
Duration[a]	178.78	163.36	19951	138	98.18	0.00	[-0.00, 0.00]	-0.77	18398	138	83.68	-0.00	[-0.00, 0.00]	-1.16

Note. [a] Duration was coded as the number of days over which participants were asked to monitor their progress.

* $p < 0.05$

Table 5

Effect of Additional Behavior Change Techniques (BCTs) on Goal Attainment

Behavior Change Technique		N	k	Q	95% CI	d_+
Goal setting – behavior	Included	6073	46	215.82***	[0.36, 0.61]	0.48_a
	Not included	12325	92	621.28***	[0.25, 0.46]	0.35_b
Goal setting – outcome	Included	3345	22	206.59***	[0.30, 0.78]	0.54_a
	Not included	15053	116	595.94***	[0.29, 0.45]	0.37_b
Review behavioral goals	Included	4046	31	130.27***	[0.24, 0.53]	0.38
	Not included	14352	107	704.35***	[0.31, 0.50]	0.40
Review outcome goals	Included	1000	10	20.53*	[0.15, 0.56]	0.36
	Not included	17398	128	817.21***	[0.32, 0.49]	0.40
Action planning	Included	5757	43	445.32***	[0.32, 0.68]	0.50_a
	Not included	12641	95	364.88***	[0.27, 0.42]	0.34_b
Prompt identification of discrepancy	Included	5053	45	321.63***	[0.28, 0.61]	0.45_a
	Not included	13345	38	489.64***	[0.29, 0.46]	0.38_b
Feedback on behavior - immediate	Included	1316	6	61.10***	[0.29, 1.07]	0.68_a

Feedback on behavior - delayed	Included	2420	11	45.28***	[0.22, 0.76]	0.49_{a}
Feedback on outcome(s) of behavior - immediate	Included	2830	17	104.28***	[0.18, 0.62]	0.40
Feedback on outcome(s) of behavior - delayed	Included	1632	12	36.89***	[0.14, 0.91]	0.52_{a}
	No feedback	7392	66	435.60**	[0.22, 0.48]	0.35_{b}

Figure 1

Flow of Information Through the Review

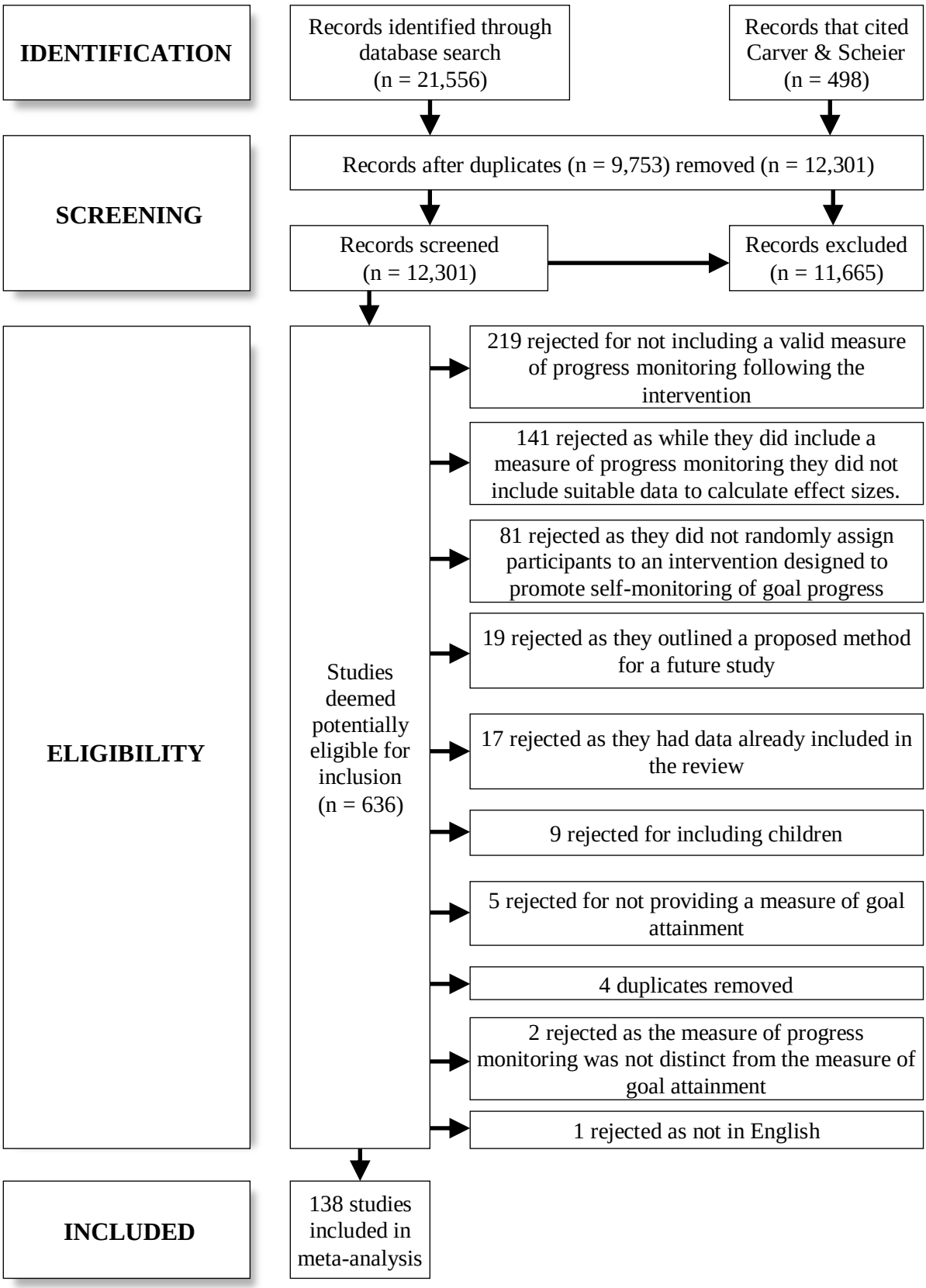


Figure 2

Forest plot showing the Effect of Interventions on the Frequency of Progress Monitoring

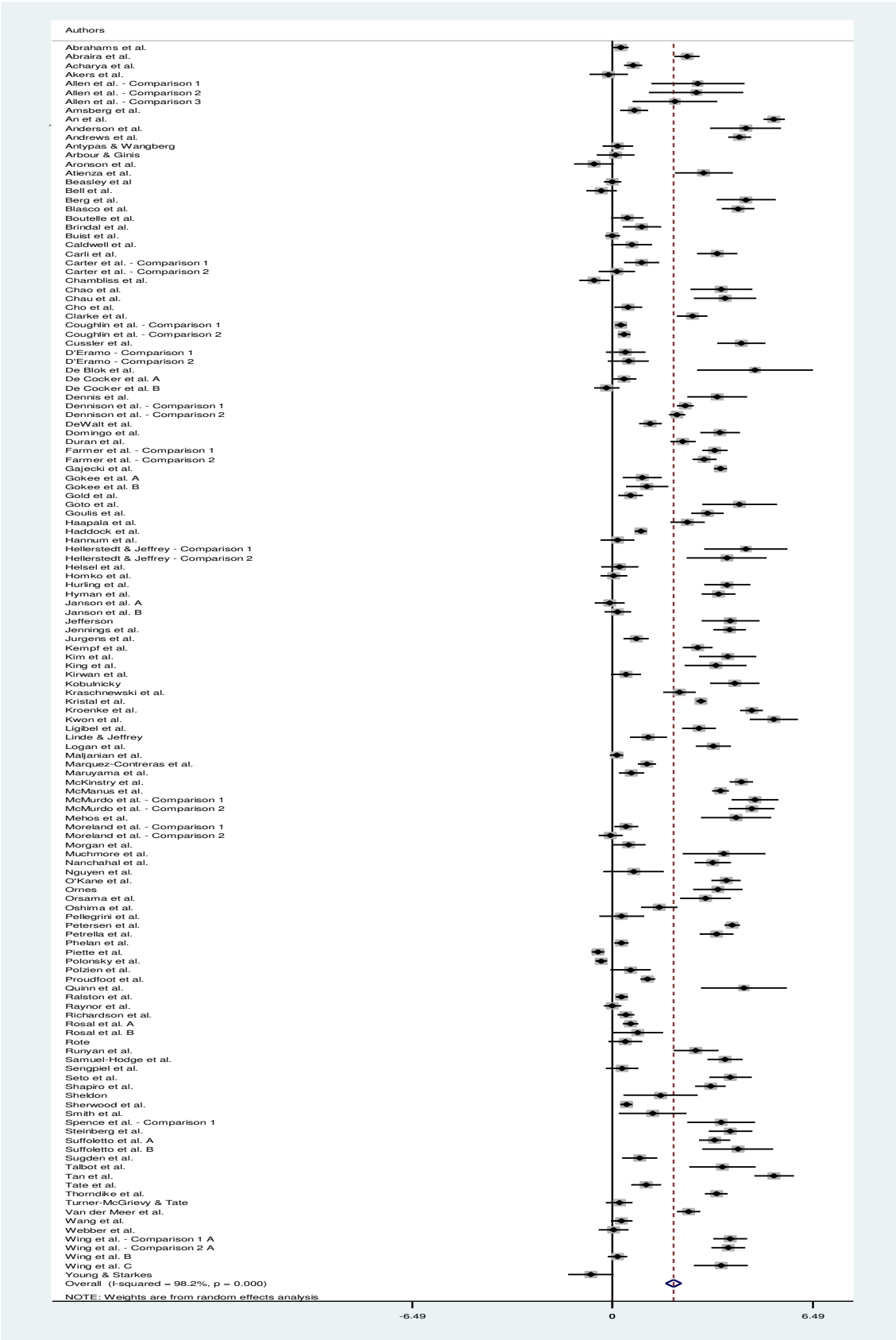


Figure 3

Forest Plot showing the Effect of the Interventions on Goal Attainment

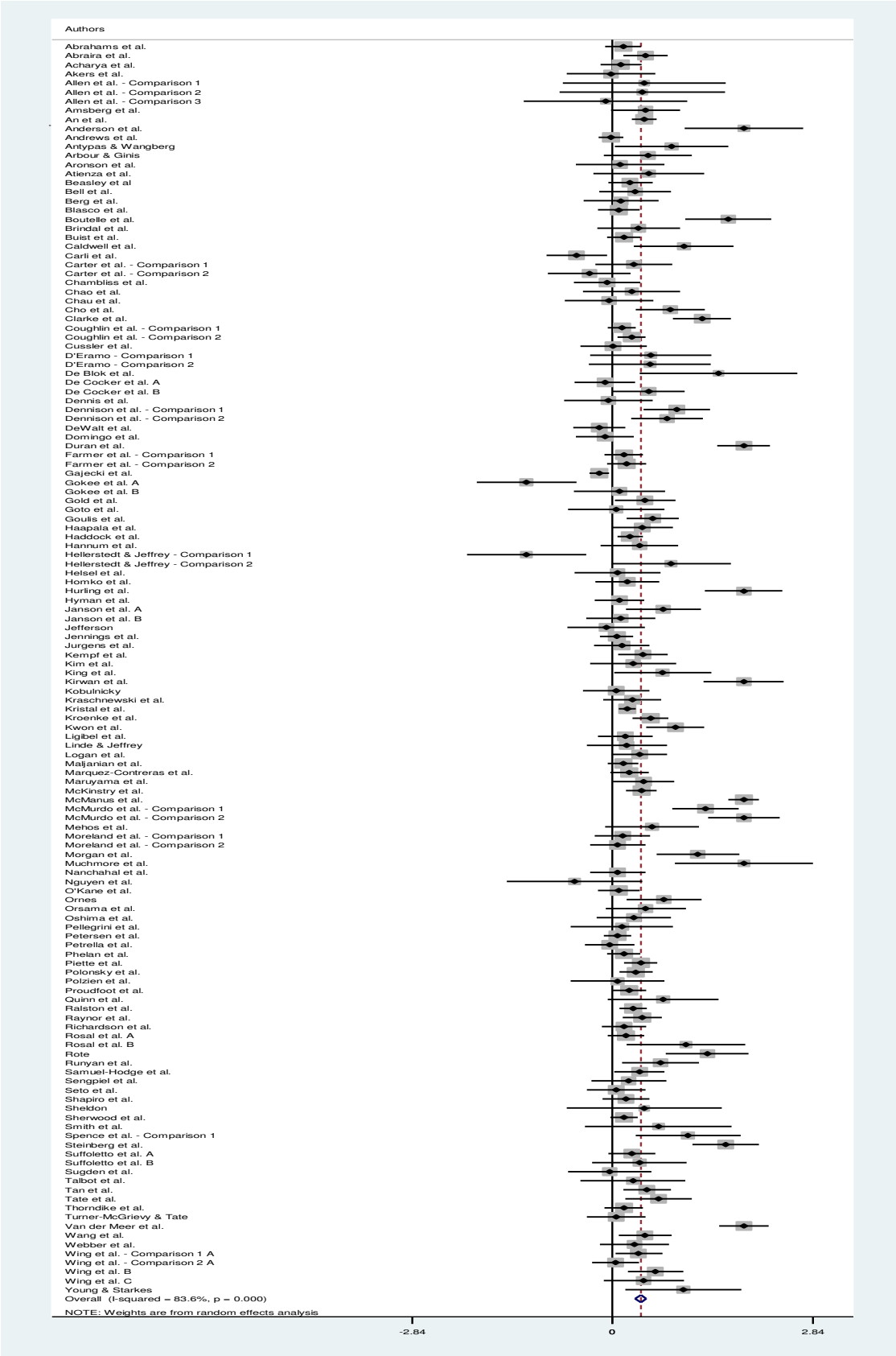
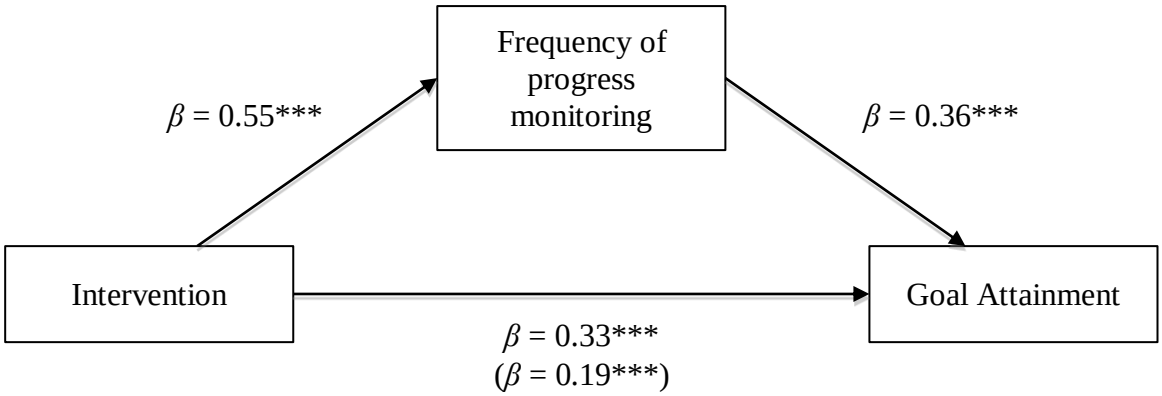


Figure 4

Mediation of the effect of Interventions on Goal Attainment by Changes in the Frequency of Progress Monitoring

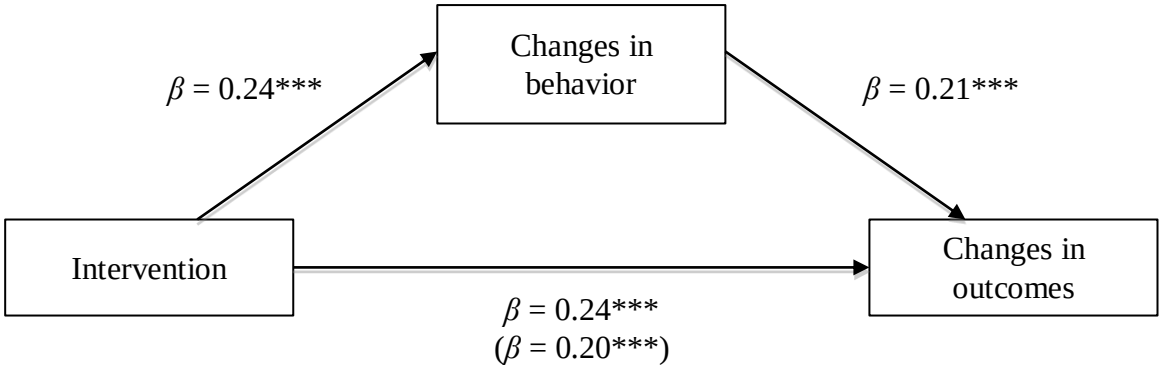


Note. The value in parentheses represents the effect of interventions on goal attainment, controlling for changes in the frequency of progress monitoring.

*** p < .001

Figure 5

Mediation of the effect of Interventions on Outcomes by Changes in Behavior



Note. The value in parentheses represents the effect of interventions on outcomes, controlling for changes in behavior.

*** p < .001