Self-Determination Theory Interventions for Health Behavior Change: Meta-Analysis and Meta-Analytic Structural Equation Modeling of Randomized Controlled Trials

Paschal Sheeran
University of North Carolina at Chapel Hill and Duke University

Charles E. Wright, Aya Avishai, and Megan E. Villegas
University of North Carolina at Chapel Hill

Jan Willem Lindemans
Duke University

William M. P. Klein
National Cancer Institute, Bethesda, Maryland

Alexander J. Rothman
University of Minnesota

Eleanor Miles
University of Sussex

Nikos Ntoumanis
Curtin University

Objective: We conducted a meta-analysis of randomized controlled trials (RCTs) to promote health behavior change based on self-determination theory (SDT). The review aimed to (a) quantify the impact of SDT interventions on health behaviors, (b) test mediation by theoretically specified variables (autonomous motivation and perceived competence), and (c) identify moderators of intervention effectiveness.

Method: Computerized searches and additional strategies identified 56 articles that yielded 65 independent tests of SDT interventions. Random effects meta-analysis and metaregressions were conducted via STATA; meta-analytic structural equation modeling (MASEM) was used to test mediation.

Results: The sample-weighted average effect size for SDT interventions was $d = .23$, and there were significant effects for physical activity, sedentary behavior, diet, alcohol consumption, and smoking cessation ($d = .16$ to $d = .29$). Effect sizes exhibited both publication bias and small sample bias but remained significantly different from zero, albeit of smaller magnitude, after correction for bias ($d = .15$). MASEM indicated that autonomous motivation and perceived competence mediated intervention effects on behavior. Metaregression analyses indicated that features of the sample, intervention, or methodology generally did not moderate effect sizes.

Conclusion: The present review indicates that SDT interventions have a significant but small effect on health behavior change and suggests several directions for future research.

What is the public health significance of this article?
This review examines the efficacy of health behavior interventions based on self-determination theory. Findings indicate that interventions have a significant but small effect on behavior change.

Keywords: health behavior, meta-analysis, physical activity, randomized trial, self-determination theory

Supplemental materials: http://dx.doi.org/10.1037/ccp0000501.supp
Noncommunicable diseases accounted for 73% of all global deaths in 2017, and more than 50% of all deaths were attributable to just four risk factors related to lifestyle choices: high blood pressure, smoking, high blood glucose, and high body mass index (The Lancet, 2018). The implication is that behavioral interventions that effectively target diet, physical activity, alcohol consumption, and smoking have the potential to reduce rates of mortality and morbidity considerably (Kaplan, 2019). Health behavior theories specify a range of constructs that (a) predict health behaviors and (b) can be modified by interventions (Sheeran, Klein, & Rothman, 2017). One prominent theory that has been used extensively to promote health behavior change is self-determination theory (SDT; Ryan & Deci, 2017; Ryan, Patrick, Deci, & Williams, 2008). However, a quantitative synthesis of the efficacy of SDT interventions in changing health behaviors remains to be undertaken. We undertook a meta-analysis of randomized controlled trials (RCTs) to (a) determine the efficacy of SDT interventions in promoting health behavior change, (b) test mediators of SDT intervention effects, and (c) identify factors that moderate intervention effectiveness.

According to SDT, the “psychological states most essential for making meaningful change in terms of health behavior are: (1) being autonomously motivated for the change, and (2) perceiving oneself to be competent to make the change” (Ryan & Deci, 2017, p. 455). Autonomously motivated is an overarching term for regulatory styles that reflect self-endorsed reasons for behavioral engagement, such as enjoyment (intrinsic motivation), alignment with one’s core values (integrated regulation), and personal utility (identified regulation). Autonomous motivation is often contrasted in the SDT literature with controlled motivation, the overarching term that refers to non–self-determined regulatory styles. These styles of behavioral regulation reflect internal pressure or the need to prove something to others (introjected regulation), or external pressure and contingent rewards (external regulation). Perceived competence is the second antecedent of health behavior change (Ryan & Deci, 2017). According to Williams et al. (2006), perceived competence refers to feeling able to attain health outcomes from RCTs, is needed. Accordingly, the present review aimed to: (a) quantify the impact of SDT interventions on health behavior change, (b) test mediators of SDT intervention effects, and (c) identify factors that moderate intervention effectiveness.

Third, evidence that autonomous motivation and perceived competence predict health behaviors relies on correlational data (Ng et al., 2012; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). However, the fact that a particular variable predicts behavior in correlational tests does not indicate whether interventions that increase scores on that variable will change behavior (Sheeran, Harris, & Epton, 2014). This is because (a) correlational designs cannot rule out the influence of third variables (i.e., variables such as health literacy, conscientiousness, or optimism that could engender spurious links between the predictors and behavior) and (b) evidence indicates that findings from correlational tests generally overestimate the behavioral impact of intervention studies that change the relevant predictor (Sheeran et al., 2017). A synthesis of experimental or intervention studies is needed to determine whether SDT interventions change health behaviors and to formally assess whether autonomous motivation and perceived competence mediate the impact of SDT interventions on behavior change.

The foregoing discussion indicates that a new, comprehensive review of SDT interventions, focused on high-quality evidence from RCTs, is needed. Accordingly, the present review aimed to: (a) quantify the impact of SDT interventions on health behavior change via meta-analysis; (b) determine whether SDT interventions promote health behavior change by increasing autonomous motivation and perceived competence on both autonomous motivation and perceived competence, and how changes in these proximal determinants influence health. This model forms the focus of the present review. Although reviews are largely supportive of SDT predictions, there are notable gaps in the evidence base. First, it is not yet clear how effective are SDT interventions in promoting health behavior change. Multiple SDT interventions proved effective in changing behavior (e.g., Chatzisarantis & Hagger, 2009; Fortier, Sweet, O’Sullivan, & Williams, 2007; Gourlan, Sarrazin, & Trouilloud, 2013; Ha, Lonsdale, Ng, & Lubans, 2017), but there are also multiple reports of ineffective interventions (Duda et al., 2014; Gillison, Standage, & Skevington, 2013; Mayer et al., 2018; Mendoza et al., 2017). This offers a clear rationale for a quantitative synthesis that estimates the magnitude of SDT intervention effects, and for moderator analyses to identify factors that determine effectiveness. Second, previous reviews of SDT interventions did not address all relevant outcomes. Gillison, Rouse, Standage, Sebire, and Ryan (2019) meta-analyzed 84 experimental and quasi-experimental studies of SDT interventions to promote health behaviors. The review observed significant changes in perceived autonomy support $g = .84$ and autonomous motivation $g = .41$ but did not report intervention effects on perceived competence and did not test SDT effects on health behaviors.

1 Although it would have been desirable to test Ryan et al.’s (2008) model wherein (a) interventions determine levels of perceived autonomy support, (b) perceptions of autonomy support, in turn, predict satisfaction of needs for autonomy, competence, and relatedness, (c) needs satisfaction predicts autonomous motivation and perceived competence, and (d) autonomous motivation and perceived competence predict health behavior change, too few data were available to do so in the present review. There were 17, 12, 12, and 11 tests of intervention effects on perceptions of autonomy support and satisfaction of needs for autonomy, competence, and relatedness, respectively. However, few studies reported relevant intercorrelations among these variables, which meant that the relationships specified by Ryan et al. (2008) could not be modeled.
motivation and perceived competence using meta-analytic structural equation modeling (MASEM); and (c) identify sample, intervention, or methodological features that moderate intervention effectiveness using metaregression analyses.

**Method**

The meta-analysis was registered at Prospero (CRD42018097040) and followed PRISMA guidelines (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009). The PRISMA Checklist is presented in Table S1 in the online supplemental materials. Study data have been deposited on the Open Science Framework (https://osf.io/k8maf/?view_only=4e5e7f1f078426cbb94892f76d8190a).

**Search Strategy**

Studies were obtained via (a) a computerized search of relevant databases (PubMed, PsycINFO, Web of Science) initiated on February 19, 2018, (b) a manual search of the reference lists of previous reviews and articles that met the inclusion criteria for the review, and (c) requests for unpublished studies via e-mails to key researchers and the listservs of professional societies (Society for Personality and Social Psychology, Society of Behavioral Medicine, European Health Psychology Society, selfdeterminationtheory.org). The computerized search strategy included terms for (a) self-determination theory, (b) RCT (e.g., trial, intervention), and (c) various health behaviors. Search terms were optimized for each database by a medical librarian (see Table S2 in the online supplemental materials). Study data have been deposited on the Open Science Framework (https://osf.io/k8maf/?view_only=4e5e7f1f078426cbb94892f76d8190a).

**Coded Variables**

Sample, intervention, and methodological characteristics. Sample, intervention, and methodological characteristics that could potentially moderate effect sizes were coded from each study (see Table S3 in the online supplemental materials). Sample characteristics included designations such as clinical (i.e., participants diagnosed with physical ailments), sedentary/inactive, over-weight, adolescents, and older adults as well as mean age, gender composition of sample, and mean body mass index (BMI); intervention characteristics included the source and setting of the intervention, composition of sample, and mean body mass index (BMI); methodological features included whether the control condition was active and aspects of study quality, assessed using the Cochrane Collaboration’s Tool for Assessing Risk of Bias (Higgins & Green, 2011).

**Analysis Strategy**

We used Cohen’s $d$ as the effect size metric. Effect sizes represent the difference in the behavior of interest at follow-up for the treatment compared with the control condition; larger positive values indicate more effective interventions (i.e., higher rates of healthy behaviors and lower rates of unhealthy behaviors). When multiple indicators of behavior were reported in a single study, we used each individual effect size to assess the impact of interventions on these different outcomes and also computed the weighted average effect size within the study to represent the overall study effect. When studies included more than one treatment condition, we divided the sample size for the control group by the number of intervention groups, so as not to “double count” participants (Higgins & Green, 2011). To offer a strong test of the effectiveness of SDT interventions on health behaviors, effect sizes were computed using (a) data from the longest follow-up after the intervention and (b) intention-to-treat analyses if both intention-to-treat and per protocol analyses were reported (Sheeran et al., 2014).

We used STATA Version 14.0 (StataCorp, 2015) to conduct random effects meta-analyses and metaregressions. After correcting for publication bias using the procedure recommended by Coyne, Thombs, and Hagedoorn (2010); we coded whether or not studies had adequate power (i.e., 55% power to detect a medium-sized effect even when it is present) and regressed effect sizes on this predictor. We also used random effects metaregressions to test associations between effect sizes and (a) sample characteristics, (b) features of the intervention, and (c) methodological features, including study quality (risk of bias).

**Search Strategy**

Studies were obtained via (a) a computerized search of relevant databases (PubMed, PsycINFO, Web of Science) initiated on February 19, 2018, (b) a manual search of the reference lists of previous reviews and articles that met the inclusion criteria for the review, and (c) requests for unpublished studies via e-mails to key researchers and the listservs of professional societies (Society for Personality and Social Psychology, Society of Behavioral Medicine, European Health Psychology Society, selfdeterminationtheory.org). The computerized search strategy included terms for (a) self-determination theory, (b) RCT (e.g., trial, intervention), and (c) various health behaviors. Search terms were optimized for each database by a medical librarian (see Table S2 in the online supplemental materials). Study data have been deposited on the Open Science Framework (https://osf.io/k8maf/?view_only=4e5e7f1f078426cbb94892f76d8190a).

**Coded Variables**

Sample, intervention, and methodological characteristics. Sample, intervention, and methodological characteristics that could potentially moderate effect sizes were coded from each study (see Table S3 in the online supplemental materials). Sample characteristics included designations such as clinical (i.e., participants diagnosed with physical ailments), sedentary/inactive, over-weight, adolescents, and older adults as well as mean age, gender composition of sample, and mean body mass index (BMI); intervention characteristics included the source and setting of the intervention, total contact time, as well as modes of delivery; methodological features included whether the control condition was active and aspects of study quality, assessed using the Cochrane Collaboration’s Tool for Assessing Risk of Bias (Higgins & Green, 2011).

**Reliability of coding.** Charles Wright and Megan Villegas independently coded effect sizes ($k = 38, 34\%$ of tests) along with sample, intervention, and methodological characteristics ($k = 20, 36\%$ of tests). Coding proved reliable ($M_{ICC} = .98, M_{KAPPA} = .94$; all ICC and Kappa values were greater than $0.70$). Discrepancies were resolved through discussion.
Results

Trial Characteristics

On average, tests of interventions involved 115 participants in the treatment condition and 91 participants in the control condition ($SD = 159$ and 144, respectively). Interventions primarily targeted adults ages 24–49 years ($k = 39$), adolescents aged 12–18 years ($k = 15$), and university students ($k = 8$), but there were 13 studies of sedentary/inactive participants and 12 studies with clinical samples. Participants were predominantly white ($M = 58.1\%$) and female ($M = 62.1\%$) and had a mean age of 35.7 years ($SD = 17.0$). Participants had an average BMI of 26.45 ($SD = 3.10$) in the 22 studies that reported BMI.

Almost one half of articles included in the review came from the United States ($27$ of $56$). Interventions were conducted at schools or universities ($k = 14$), in hospital/clinic settings ($k = 13$), community centers ($k = 11$), and/or at home ($k = 7$), and predominantly involved group counseling sessions ($k = 21$), one-to-one, in-person counseling sessions ($k = 21$), or counseling via telephone ($k = 15$) or online ($k = 11$). Interventions were mainly delivered by a researcher ($k = 25$) or a counselor ($k = 12$). Most interventions lasted at least one month and up to six months. The mean number of intervention sessions was 8.25 ($SD = 15.94$), and the average contact time was 9.52 hr ($SD = 18.73$). Follow-up periods for interventions ranged from immediate to 2 years ($M = 12.60$ weeks, $SD = 25.05$). The mean attrition rate was 19.14%. Most studies were adequately powered according to Coyne et al.’s (2010) criterion ($k = 41$). Study quality assessed via the Cochrane tool generated mixed results (see Table S5 in the online supplemental materials). Selective reporting ($k = 5$) and failure to blind outcome assessors ($k = 14$) were infrequent; however, incomplete outcome data ($k = 26$), lack of random sequence generation ($k = 33$), and lack of allocation concealment ($k = 36$) were relatively common.

Impact of SDT Interventions on Health Behaviors

The sample-weighted average effect size for 65 trials was of small magnitude ($d_{\text{av}} = .23, 95\%\ CI [.16, .29]$). Table 1 presents effect sizes by type of behavior. Most interventions targeted physical activity ($k = 50$), sedentary behavior ($k = 10$), diet-related behaviors ($k = 8$), and smoking cessation ($k = 6$), and were similarly effective in promoting these behaviors ($.16 \leq d_{\text{av}} \leq .25$), $Q = 3.97, p = .27$. SDT Interventions led to significant reductions in alcohol consumption and significant improvements in dental...
care and asthma management but had no effect on blood glucose monitoring, screen time, or cancer screening. It made no difference to effect sizes whether physical activity was measured objectively via accelerometer/pedometer data ($d_+ = .29$) or by self-reports ($d_+ = .23$), $Q = 5.86$, $p = .12$. There was no difference in the effect size observed for the 26 studies that used an immediate follow-up in the wake of the intervention compared to the 30 studies that used a longer-term follow-up ($d_+ = .24$ and .22, respectively), $Q = 0.12$, $p = .734$. It also made little difference to the sample-weighted average $d_+$ if a single effect size was computed for studies that had multiple treatment arms ($d_+ = .25$, 95% CI [.18, .32], $k = 56$, $Q = 161.72$, $p < .001$, $I^2 = 66.0\%$).

Figure S1 in the online supplemental materials presents the forest plot of effect sizes. Effects were heterogeneous ($Q = 148.58$, $p < .001$), and heterogeneity was of moderate magnitude ($I^2 = 56.9$). Inspection of the funnel plot (see Figure 2) suggested that the observed effects were characterized by publication bias and Egger’s regression proved significant ($B = 1.17$, $SE = 0.36$, $p = .002$). Trim and fill analysis to correct for publication bias led to the imputation of $k = 11$ additional effects and yielded an adjusted $d_+ = .15$ (95% CI [.08, .22]).

Meta-regression indicated that the effects were characterized by small sample bias ($B = -.30$, $SE = 0.10$, $p = .004$), Studies that were adequately powered according to Coyne et al.’s (2010) criterion yielded a smaller average effect size ($d_+ = .18$, 95% CI [.12, .24]) compared with underpowered studies ($d_+ = .50$, 95% CI [.30, .70]). Seven studies included in the review were unpublished (13.0%). Meta-regression of effect sizes on publication status (published = 1, unpublished = 0) indicated that the association was not significant ($B = -.11$, $SE = 0.14$, $p = .42$).

**Meta-Analytic Structural Equation Model**

Having demonstrated that SDT interventions are effective in promoting health behavior change, we next tested whether these changes were mediated by autonomous motivation and perceived competence. First, we meta-analyzed the impact of interventions on subsequent autonomous motivation and perceived competence. Second, we meta-analyzed the z-transformed correlations among autonomous motivation, perceived competence, and health behaviors reported in the primary studies. These correlations were then submitted to a meta-analytic structural equation model (Jak, 2015) to assess whether autonomous motivation and perceived competence mediated the effect of SDT interventions on health behaviors.

The impact of SDT interventions on autonomous motivation was tested in 45 trials; the sample-weighted average effect size was of small magnitude ($d_+ = .23$, 95% CI [.12, .34], $Q = 204.65$, $I^2 = 78.5\%$). The impact of SDT interventions on perceived competence was assessed in 26 trials and generated a small average effect size ($d_+ = .21$, 95% CI [.11, .30], $Q = 61.45$, $I^2 = 59.3\%$). We also tested whether SDT interventions influenced controlled motivation; however, the effect was negligible ($d_+ = -.01$, 95% CI [−.14, .13], $Q = 60.55$, $p < .001$, $I^2 = 65.3\%$). Because controlled motivation hardly qualifies as a mediator of intervention effects, this variable is not considered fur-
th. Forest plots and funnel plots are presented in the online supplemental materials.

Autonomous motivation had a medium-sized average correlation with behavior ($r_a = .27$, 95% CI [0.21, 0.32], $k = 17$). The average correlation between perceived competence and behavior was also medium-sized ($r_p = .34$, 95% CI [0.24, 0.44], $k = 12$); autonomous motivation and perceived competence were significantly associated ($r_p = .38$, 95% CI [0.26, 0.49], $k = 9$). All three average correlations were heterogeneous ($Q = 55.16$, 103.80, and 59.46, respectively, $p < .001$) and heterogeneity was of substantial magnitude ($I^2 = 71.0, 89.4$, and 86.6, respectively).

We undertook meta-analytic structural equation modeling of the correlation matrices using the metaSEM package Version 1.2.3 in R Version 3.6.1. Figure 3 presents the path model. The paths from SDT intervention to autonomous motivation and perceived competence were both significant, and the paths from autonomous motivation and perceived competence to health behaviors were significant. We tested the indirect paths from intervention to behavior via autonomous motivation ($B = .035$, 95% CI [0.006, 0.082]) and via perceived competence ($B = .027$, 95% CI [0.011, 0.051]); both indirect paths proved significant indicating that these constructs mediated the SDT intervention effects on behavior. The direct path from SDT intervention to health behaviors became nonsignificant (Estimate = 0.046, 95% CI [−0.008, 0.101]); 57.4% of the total effect of SDT interventions on health behaviors was channeled through the mediators.

**Moderator Analyses**

Table 2 presents the results of the metaregression analyses used to test moderation by sample, intervention, and methodological features. Of the many moderators tested, only two factors predicted effect sizes. Overweight samples ($B = .508, SE = .160, p = .002$) and higher mean BMI of study participants ($B = .053, SE = .017, p = .010$) were associated with larger effects. It is notable that intervention setting, delivery, intensity, or source were not related to effectiveness, and interventions were effective irrespective of the time interval between the end of the intervention and obtaining behavioral data, the use of active control conditions, and whether the intervention targeted a single behavior or multiple behaviors. We also assessed whether risk of bias predicted effect sizes; no significant associations were observed (see Table S6 in the online supplemental materials).

**Discussion**

This is the first meta-analysis of the efficacy of SDT as a conceptual framework for designing and delivering interventions to promote health behavior change. Across 65 randomized tests, we found that the sample-weighted average effect size was $d_z = .23$ (95% CI [0.16, 0.29]). Interventions were similarly effective for physical activity, dietary change, and smoking cessation. Despite extensive efforts to include the gray literature, there was evidence of publication bias and small sample bias. After correcting for publication bias, the overall sample-weighted effect size reduced to $d_z = .15$ (95% CI [0.08, 0.22]). The implication is that interventions based on SDT lead to significant changes in health behaviors but the magnitude of behavioral change is small.

Mediation and moderation analyses were also undertaken. We tested a process model of SDT intervention effects (Williams et al., 2002, 2006) using meta-analytic structural equation modeling. Findings indicated that autonomous motivation and perceived competence predicted health behavior, and these variables simultaneously mediated the effects of SDT interventions on health behaviors. We assessed more than 30 potential moderators of SDT intervention effects that pertained to features of the sample, intervention, and methodology. A single feature, the mean BMI of the sample, was associated with health behavior change, and this finding must be viewed in the context of the large number of tests of moderation.

Findings from the present meta-analysis support the efficacy of SDT interventions in promoting health behavior change, but also help to specify strengths and weaknesses of this approach. Key strengths are that (a) SDT interventions engender significant change in health behaviors, (b) the structure of the SDT finds empirical support in randomized tests; in particular, intervention effects are mediated by the factors specified by the theory (autonomous motivation and perceived competence), and (c) SDT interventions are similarly effective irrespective of multiple features of the intervention (source, setting, mode of delivery, and intensity), sample, and methodology (e.g., use of active control conditions, long-term behavioral follow-ups, targeting multiple health behaviors).

The key weakness identified by the present review is that SDT interventions are not very powerful, especially given that the interventions involved an average of 8.25 sessions and 9.52 hr of contact time. The experimental medicine approach (Sheeran et al., 2017) indicates that interventions’ power or behavioral impact depends upon two component processes: Target engagement—the extent to which the intervention engages relevant targets (here, autonomous motivation and perceived competence), and target validity—the extent to which these targets determine behavior change. We observed that the impact of interventions on autonomous motivation and perceived competence was small and these
goals and SDT’s conceptual goal of enabling individuals to make authentic decisions about health behavior change (i.e., make choices based on reasons that are fully endorsed by the self). According to Ryan and Deci (2017), participants’ autonomy should be considered an important outcome in its own right, and not merely serve as a means for attaining specific behavioral goals such as tobacco cessation or increased physical activity. A reflective and true choice could involve the decision not to engage in a particular health behavior (e.g., not to participate in an exercise program, or try to quit smoking or lose weight), and should, according to Ryan and Deci (2017), be supported by health practitioners. Although this stance is aligned with principles of modern biomedical ethics (e.g., Beauchamp & Childress, 2001), there are cultural, financial, and political constraints that must be navigated by policymakers, practitioners, and researchers as they endeavor to promote health behavior changes that participants may not fully endorse.

The effects of changing autonomous motivation and perceived competence on health behavior change were modest in the present review, and of equivalent magnitude to the effect sizes observed in Ng et al.’s (2012) meta-analysis of observational studies. How might the SDT framework be extended so as to generate larger changes in health behaviors? SDT focuses on individuals’ conscious motivation, which suggests that developments might profitably address three issues. First, research on the intention-behavior gap (review by Sheeran & Webb, 2016) indicates that motivation often does not get translated into action, even when participants have high perceived competence or self-efficacy (Sheeran, 2002). This is because motivation is only the starting point for successful goal striving: People still have to manage self-regulatory problems such as forgetting to act, missing opportunities, or getting derailed by temptations, distractions, or unwanted internal states (e.g., mood, ego-depletion) to successfully achieve their goals (Gollwitzer & Sheeran, 2006). Koestner and colleagues have shown that supplementing autonomous motivation and perceived competence with if-then plans or implementation intentions (Gollwitzer, 1999) improves rates of behavioral performance and goal attainment (Koestner, Lekes, Powers, & Chicoine, 2002, 2006, 2008). Implementation intentions are plans that have the structure: If [opportunity/obstacle] – then I will [response].

Figure 3. Meta-analytic structural equation model: Self-determination theory interventions promote health behavior change via increased autonomous motivation and perceived competence. Solid lines indicate significant paths; dashed line indicates nonsignificant path; curved line indicates that autonomous motivation and perceived competence were allowed to covary ($r = .38$). * $p < .05$, ** $p < .01$, *** $p < .001$. 

targets had small associations with behavior in the MASEM. That is, effect sizes for target engagement and target validity both were small.

Why did SDT interventions not have a larger effect on the specified targets? In the present review, the impact of SDT interventions on autonomous motivation was smaller than that observed in Gillison et al.’s (2019) meta-analysis of the behavior change techniques used in SDT interventions ($d = .23$ vs. .41), whereas the effect on perceived competence was similar to that observed in a meta-analysis of interventions to promote self-efficacy for physical activity ($d = .21$ vs. .16; Ashford, Edmunds, & French, 2010). None of these reviews observed even medium-sized effects ($d = .50$), however, which likely speaks to the difficulty of changing autonomous motivation and perceived competence for consequential health behaviors in field settings.

Two considerations may be important in this regard. First, it is challenging to train people in positions of authority to adopt a need-supportive communication style, based on SDT principles (Ntoumanis, Quested, Reeve, & Cheon, 2018). For instance, authority figures may hold personality dispositions (e.g., dominance orientation, authoritarianism), or beliefs about motivational style that do not align well with the principle of supporting others’ needs for autonomy, competence, and relatedness. Need-supportive communication can be perceived as ineffective (“Sounds nice, but it won’t work!”), idealistic, impractical, or too time consuming. In contrast, people in authority may believe that a controlling communication is both effective and easy to apply, especially under time pressure (e.g., when there are brief windows of opportunity for one-to-one consultation). Furthermore, prevailing cultural norms (within an organization or society at large) as to what the expected and common (i.e., normative) approaches should be for motivating and communicating with others, can influence the degree to which health care professionals, teachers, and others adopt need-supportive communication. For these reasons, it may be difficult to instantiate the need-supportive communicative styles that could effectively promote autonomous motivation and perceived competence.

The second consideration is that there may be a tension between public health goals and SDT’s conceptual goal of enabling individuals to make authentic decisions about health behavior change (i.e., make choices based on reasons that are fully endorsed by the self). According to Ryan and Deci (2017), participants’ autonomy should be considered an important outcome in its own right, and not merely serve as a means for attaining specific behavioral goals such as tobacco cessation or increased physical activity. A reflective and true choice could involve the decision not to engage in a particular health behavior (e.g., not to participate in an exercise program, or try to quit smoking or lose weight), and should, according to Ryan and Deci (2017), be supported by health practitioners. Although this stance is aligned with principles of modern biomedical ethics (e.g., Beauchamp & Childress, 2001), there are cultural, financial, and political constraints that must be navigated by policymakers, practitioners, and researchers as they endeavor to promote health behavior changes that participants may not fully endorse.
The if part of the plan specifies good opportunities to act (e.g., particular times and places) or obstacles to goal attainment (e.g., laziness, TV viewing habits), whereas the plans’ then part specifies instrumental responses to those cues (e.g., “I will go to the gym on Monday after work!,” “I will tell myself I’ll be full of energy after going to the gym!”). Meta-analyses support the efficacy of implementation intentions in promoting behavior change (e.g., Adriaanse et al., 2011; Bélanger-Gravel, Godin, Bilodeau, & Poirier, 2013; Gollwitzer & Sheeran, 2006). Koestner et al. (2002, 2006, 2008) observed that autonomous motivation and perceived competence have synergistic relations with if-then planning, which suggests that implementation intentions could be deployed to complement future SDT interventions on health behaviors.

Second, SDT interventions do not explicitly target nonconscious or automatic processes such as antagonistic habits (e.g., cue-driven sedentary behaviors) and implicit associations (approach/avoidance biases, automatic affect) that can militate against health behavior performance (e.g., Brand & Ekkekakis, 2018; Rhodes, McEwan, & Rebar, 2019; reviews by Rothman et al., 2015; Sheeran, Gollwitzer, & Bargh, 2013). It is also the case that health behavior performance is not merely the product of individual-level processes but is also a function of contextual affordances (Person × Situation interactions). For example, changing physical activity often requires interventions at multiple levels in addition to the individual level, such as modifying built environments, social environments, policies, and practices (Sallis, 2018). Greater analysis of how SDT variables interact with, or could help to

### Table 2

<table>
<thead>
<tr>
<th>Moderator variable</th>
<th>Used (%)</th>
<th>B</th>
<th>SE</th>
<th>p</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sample features</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (% female)³</td>
<td>—</td>
<td>.002</td>
<td>.002</td>
<td>.385</td>
<td>8.06</td>
</tr>
<tr>
<td>Race/ethnicity (% non-white)²</td>
<td>—</td>
<td>.000</td>
<td>.002</td>
<td>.994</td>
<td>19.13</td>
</tr>
<tr>
<td>Age²</td>
<td>—</td>
<td>−.002</td>
<td>.002</td>
<td>.382</td>
<td>2.66</td>
</tr>
<tr>
<td>BMI²</td>
<td>—</td>
<td>.053</td>
<td>.017</td>
<td>.010</td>
<td>76.52</td>
</tr>
<tr>
<td>Sedentary/inactive participants</td>
<td>13 (23.2)</td>
<td>.083</td>
<td>.094</td>
<td>.382</td>
<td>0.12</td>
</tr>
<tr>
<td>Clinical patients</td>
<td>12 (21.4)</td>
<td>−.069</td>
<td>.093</td>
<td>.465</td>
<td>1.13</td>
</tr>
<tr>
<td>Overweight participants</td>
<td>4 (7.1)</td>
<td>.508</td>
<td>.160</td>
<td>.002</td>
<td>35.33</td>
</tr>
<tr>
<td>University students</td>
<td>6 (10.7)</td>
<td>.155</td>
<td>.128</td>
<td>.232</td>
<td>6.32</td>
</tr>
<tr>
<td>Adolescents</td>
<td>11 (19.6)</td>
<td>−.061</td>
<td>.093</td>
<td>.515</td>
<td>6.40</td>
</tr>
<tr>
<td>Older adults</td>
<td>3 (5.4)</td>
<td>−.092</td>
<td>.174</td>
<td>.599</td>
<td>2.60</td>
</tr>
<tr>
<td><strong>Intervention features</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setting of intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home</td>
<td>7 (12.5)</td>
<td>−.186</td>
<td>.099</td>
<td>.065</td>
<td>14.16</td>
</tr>
<tr>
<td>Clinic/Hospital</td>
<td>13 (23.2)</td>
<td>.109</td>
<td>.094</td>
<td>.254</td>
<td>3.61</td>
</tr>
<tr>
<td>Community center</td>
<td>11 (19.6)</td>
<td>−.039</td>
<td>.090</td>
<td>.663</td>
<td>6.17</td>
</tr>
<tr>
<td>School/University</td>
<td>14 (25.0)</td>
<td>.034</td>
<td>.089</td>
<td>.700</td>
<td>0.87</td>
</tr>
<tr>
<td>Mode of delivery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One-to-one</td>
<td>21 (37.5)</td>
<td>.039</td>
<td>.080</td>
<td>.626</td>
<td>6.34</td>
</tr>
<tr>
<td>Group session</td>
<td>21 (37.5)</td>
<td>.050</td>
<td>.079</td>
<td>.530</td>
<td>1.36</td>
</tr>
<tr>
<td>Online</td>
<td>11 (19.6)</td>
<td>.002</td>
<td>.092</td>
<td>.982</td>
<td>5.63</td>
</tr>
<tr>
<td>Telephone advice/counseling</td>
<td>15 (26.8)</td>
<td>.021</td>
<td>.086</td>
<td>.810</td>
<td>5.91</td>
</tr>
<tr>
<td>Digital materials</td>
<td>6 (10.7)</td>
<td>−.086</td>
<td>.132</td>
<td>.515</td>
<td>5.46</td>
</tr>
<tr>
<td>Mail</td>
<td>7 (12.5)</td>
<td>−.173</td>
<td>.105</td>
<td>.106</td>
<td>11.64</td>
</tr>
<tr>
<td>Intensity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact time of intervention²</td>
<td>—</td>
<td>.002</td>
<td>.003</td>
<td>.601</td>
<td>3.83</td>
</tr>
<tr>
<td>Number of sessions³</td>
<td>—</td>
<td>.002</td>
<td>.003</td>
<td>.386</td>
<td>3.32</td>
</tr>
<tr>
<td>Duration of intervention⁴</td>
<td>—</td>
<td>.027</td>
<td>.017</td>
<td>.117</td>
<td>2.22</td>
</tr>
<tr>
<td>Source of intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Researcher</td>
<td>27 (48.2)</td>
<td>−.019</td>
<td>.077</td>
<td>.803</td>
<td>4.81</td>
</tr>
<tr>
<td>Nurse</td>
<td>5 (8.9)</td>
<td>.108</td>
<td>.136</td>
<td>.429</td>
<td>0.51</td>
</tr>
<tr>
<td>Doctor</td>
<td>5 (8.9)</td>
<td>.148</td>
<td>.121</td>
<td>.226</td>
<td>3.11</td>
</tr>
<tr>
<td>Counselor</td>
<td>14 (25.0)</td>
<td>.055</td>
<td>.089</td>
<td>.535</td>
<td>4.75</td>
</tr>
<tr>
<td>Educator</td>
<td>7 (12.5)</td>
<td>.033</td>
<td>.106</td>
<td>.759</td>
<td>3.42</td>
</tr>
<tr>
<td>Fitness Trainer</td>
<td>6 (10.7)</td>
<td>.033</td>
<td>.130</td>
<td>.800</td>
<td>5.44</td>
</tr>
<tr>
<td>Methodological features</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to follow-up⁵</td>
<td>—</td>
<td>−.001</td>
<td>.001</td>
<td>.338</td>
<td>0.93</td>
</tr>
<tr>
<td>Active control group</td>
<td>23 (42.6)</td>
<td>.029</td>
<td>.077</td>
<td>.710</td>
<td>8.63</td>
</tr>
<tr>
<td>Usual care</td>
<td>22 (40.7)</td>
<td>.003</td>
<td>.077</td>
<td>.969</td>
<td>5.13</td>
</tr>
<tr>
<td>Waitlist control</td>
<td>8 (14.8)</td>
<td>.024</td>
<td>.110</td>
<td>.830</td>
<td>5.65</td>
</tr>
<tr>
<td>Multi-behavior intervention</td>
<td>11 (20.4)</td>
<td>.002</td>
<td>.095</td>
<td>.981</td>
<td>5.50</td>
</tr>
</tbody>
</table>

Note. "Used" is the number (percentage) of studies that deployed the relevant feature.

- ³ Fifty-five studies reported gender information.
- ² Twenty-nine studies reported race/ethnicity information.
- ² Twenty-two studies reported age information.
- ² Twenty-two studies reported participants’ body mass index (BMI).
- ² Thirty-six studies reported total contact time of information.
- ² Fifty-one studies reported the number of intervention sessions.
- ² Fifty-three studies reported the duration of the intervention.
- ² Fifty-six studies reported the time interval between the end of the intervention and the final behavioral follow-up.
The present meta-analysis shows that SDT interventions have a significant but small effect on health behaviors. The structure of the theory is supported by findings showing that autonomous motivation and perceived competence mediate intervention effects on health behaviors, and that effectiveness of SDT interventions was largely unaffected by features of the sample, intervention, and methodology. Trials of SDT interventions to date are characterized by publication bias and small sample bias, however, and more and better-powered RCTs are warranted to evaluate this framework. Our review offers several suggestions about how the effectiveness of future SDT interventions might be improved.

References

Studies included in the meta-analysis are preceded by an asterisk.


http://dx.doi.org/10.1037/0033-2909.74.2.166

http://dx.doi.org/10.1177/1745691615598515


http://dx.doi.org/10.1177/1090198118796458

http://dx.doi.org/10.1037/hea0000311

http://dx.doi.org/10.1177/1090198110384468

http://dx.doi.org/10.1080/104632802100000003

http://dx.doi.org/10.1037/a0029203

http://dx.doi.org/10.1037/a0030605

http://dx.doi.org/10.1146/annurev-psych-010416-044007

http://dx.doi.org/10.1111/spc3.12265

http://dx.doi.org/10.1080/17477160802113415

http://dx.doi.org/10.7717/peerj.4598/supp-10

http://dx.doi.org/10.1007/s12160-014-9655-2


http://dx.doi.org/10.1080/1354850903111806

http://dx.doi.org/10.1186/1479-5868-9-78


http://dx.doi.org/10.1038/oby.2009.281

http://dx.doi.org/10.1016/S0140-6736(18)32858-7

http://dx.doi.org/10.5993/ajhb.40.4.9


http://dx.doi.org/10.1159/000381473

http://dx.doi.org/10.1007/s12144-015-9388-9

http://dx.doi.org/10.1037/0278-6133.21.1.40

http://dx.doi.org/10.1037/0278-6133.25.1.91

http://dx.doi.org/10.1093/her/17.5.512


Received July 10, 2019
Revision received March 9, 2020
Accepted March 13, 2020