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How best to reduce unhealthy risk-taking behaviours? A meta-review of evidence syntheses of interventions using self-regulation principles

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ABSTRACT

Self-regulation is a key antecedent of health and behaviour-change interventions have utilised self-regulation approaches to promote health. The present study used a novel methodology, a *nested meta-review*, to: (a) integrate and summarise information from evidence syntheses of diverse self-regulation interventions to reduce risk-taking, in the behavioural domains of smoking, alcohol and drug use, unhealthy eating, externalising problem behaviours, and sexual risk-taking; (b) identify intervention features implicated in risk-taking prevention or reduction; and (c) provide recommendations for future research and practice. Searches of eight databases yielded 21 eligible evidence syntheses, 15 taking a primarily social-cognitive strategy ($k = 1,103$ total studies), and 6 taking a primary trait/developmental strategy ($k = 119$); total $N > 650,000$. Intervention features most frequently associated with reduced risk-taking included: delivery of multiple components through (either, or a mix of) group, individual, computer, and one-one-one delivery; screening and pharmacotherapy, where relevant; targeting only one behavioural outcome; provision of counselling, stress-management, skills-training, self-monitoring, self-control and impulsivity training, and personalised feedback; identification of barriers and ‘resolution’ of barriers; tailoring to age and ethnicity; and, also, incorporating social support by peers. Some of these patterns were more visible in meta-analyses with higher methodological quality. Recommendations for research and practice are offered.

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Risk-taking behaviours, including smoking, heavy alcohol use, high sugar consumption, and unprotected sex, are among the strongest contributors to disease as well as to total and cause-specific mortality across nations (Kvaavik, Batty, Ursin, Huxley, & Gale, 2010; Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Moreover, risk-taking behaviours tend to coexist, and concurrent risk-taking substantially increases the likelihood of disease-specific mortality (Kvaavik et al., 2010; Schuit, van Loon, Tijhuis, & Ocké, 2002; Silva, Peres, Boing, González-Chica, & Peres, 2013). Thus, risk-taking behaviours are among the most important public health targets; yet, they are also among the most difficult behaviours to modify because they are often highly reinforcing and can become habits (Barker & Taylor, 2014; MacPherson et al., 2010; Rothman et al., 2015). Accordingly, health promotion efforts have centred on preventing or reducing such behaviours (Cutler, 2004).

A large body of evidence indicates that low self-regulation—one's ability to flexibly activate, monitor and adapt one's behaviour—is a key antecedent of risk-taking behaviours, such as unhealthy eating (e.g., Evans, Fuller-Rowell, & Doan, 2012; Hofmann, Adriaanse, Vohs, & Baumeister, 2014); substance misuse and addiction (Baumeister & Vonasch, 2015); and unprotected sex (Moilanen, 2015). Conversely, high self-regulation has been consistently associated with overall long-term health and well-being (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Moffitt et al., 2011). Consequently, many behaviour-change interventions have utilised self-regulation theories and mechanisms to reduce or prevent risk-taking behaviours and promote health (Stautz, Zupan, Field, & Marteau, 2018). Accordingly, evidence syntheses have explored whether, and, under which conditions, interventions targeting self-regulation succeed in reducing risk-taking behaviours (e.g., Allom, Mullan, & Hagger, 2016; Chamberlain et al., 2017). Nonetheless, no meta-review has yet compiled information about the antecedents of health behaviour change with a specific focus on self-regulation components and risk-taking outcomes. Therefore, the purpose of the present meta-review is to synthesise information from self-regulation interventions to reduce risk-taking. We focus on identifying the self-regulation intervention features that are most consistently associated with behaviour change across a broad array of behaviour types and populations, and are thus most likely to be actively contributing to behaviour change.

Identification of the intervention features most frequently associated with risk-taking reduction across this broad literature can provide guidance on the elements of interventions that are most promising for application in practice, including clinical practice. Intervention features that are most consistently implicated in behaviour change—even across heterogeneous populations with varied health status and target risk behaviours—are particularly applicable to 'real world' practice, in which risk behaviours are likely to co-occur. In this meta-review, we aim to provide guidance on the implications of these results for practice and to identify gaps in knowledge that present opportunities for further research on self-regulation interventions. Before doing so, we set the context by reviewing relevant substantive concepts.

Constructs used in the meta-review

What are risk-taking behaviours?

Broadly, risk-taking behaviours can be defined as '... any consciously, or non-consciously controlled behaviour with a perceived uncertainty about its outcome, and/or about its possible benefits, or costs for the physical, economic or psycho-social well-being of oneself or others' (Trimpop, 1994, p. 9). There are additional definitions of risky behaviours depending on the field of research. Across the fields of health psychology and behaviour medicine, risk-taking behaviours as typically classed as behaviours that are 'health-compromising' or 'health-impairing' (Sutton, 2004). Classifying behaviours as health compromising can vary across populations and contexts (Sutton, 2004), but certain behaviours are seen as 'key' risk-taking behaviours. Those include smoking, high alcohol consumption, not getting enough sleep, not exercising regularly, not maintaining a desirable body weight, and eating 'unhealthily' (Belloc & Breslow, 1972; Blaxter, 1990).

What is self-regulation?

Self-regulation is defined as the person's ability to activate, monitor, inhibit, persevere, and/or adapt their behaviour, attention, emotion, and cognition in response to internal or environmental feedback, with the aim to accomplish personally relevant goals (Moilanen, 2007, 2015). We note that there is disagreement surrounding definitions and conceptualizations of self-regulation, with a particularly contentious area being the distinction between self-regulation and self-control (Gillebaart, 2018). We align our thinking with arguments that distinguish self-regulation from self-control, with self-control being a component of self-regulation. Self-regulation refers to *everything* the person does to *achieve* desired goals, while self-control refers to *everything* the person does to *steer* themselves towards desired goals (Gillebaart, 2018). If, for example, the overall desired goal is sexual health,

then self-control would be reflected in various effortful and effortless strategies, such as habitually purchasing and carrying condoms, habitually scheduling check-ups and appointments with relevant health care providers, deliberately negotiating safer-sex with sexual partners, deliberately avoiding situations that could pose sexual health at risk, and the like. Finally, studies commonly operationalise self-regulation and self-control as interchangeable constructs, suggesting operational definition problems in the self-regulation literature that pose problems to evidence syntheses (e.g., by hampering study search and selection efforts).

Social-cognition vs. trait approaches to self-regulation

The self-regulation literature highlights a number of germane theoretical issues. First, social-cognition approaches to self-regulation have largely focused on intentional process as antecedents or causes of risk-taking behaviour, downplaying or overlooking trait self-regulation (de Ridder & de Wit, 2006; de Ridder et al., 2012). By contrast, developmental or trait approaches to risk-taking behaviours have downplayed deliberative processes (Moilanen, 2015). Social-cognition approaches to self-regulation processes involve goal-directed behaviours that are more intentional in nature, or more 'conscious' to the individual, while trait self-regulation processes are broad, largely biologically-based attributes, demonstrating a 'typical' response by the individual (a disposition or trait). While these processes are distinguishable, they also have some commonalities. For example, an individual who typically engages in unprotected sex when 'in the heat of the moment', may still forego this 'typical' response when consciously pursuing the goal of sexual health. Indeed, research suggests that while people may vary in their dispositional and intentional self-regulation capacities, the two processes are positively correlated, with one depending on the other for successful self-regulation (Fujita, 2011; Moilanen, 2007).

We argue that overall health and well-being is contingent on self-regulation processes being integrated, and we further argue for scholarship integrating self-regulation processes that appear disconnected. There have been attempts to integrate self-regulation scholarship with related domains (for overviews, see Kwasnicka, Dombrowski, White, & Sniehotta, 2016; Lerner et al., 2011). For example, Johnson, Landrum, and McCloskey (2019) argued for integrations between the areas of self-regulation, emotional regulation, habits, attitudes, and ecological perspectives, which to date have only been loosely interconnected. Similarly, in their theoretical review, Kwasnicka et al. emphasised interconnections between motives, self-regulation, resources, habit, and the surrounding environment. Ecological models tend to emphasise the contexts within which behaviours develop and are enacted. Accordingly, behaviour occurs within environmental and social contexts, which may either facilitate or hinder behaviour change maintenance (cf. Johnson, Redding, et al., 2010; Panter-Brick, Clarke, Lomas, Pinder, & Lindsay, 2006). Thus, ecological factors are important for both behaviour initiation and maintenance.

Related, the literature shows that the adult social-cognition, as well as the broader social psychological literature, has tended to separate emotion from cognition, and has also portrayed emotion and cognition as opposing processes. Moreover, social-cognitive approaches have portrayed emotions as largely disruptive to cognition and goal-oriented behaviour, indicating that emotion should be properly managed to achieve goals, or that emotional states are separate, fixed goals that do not vary as a function of other objectives (for relevant reviews see Inzlicht, Bartholow, & Hirsh, 2015; Isen, 2003; Johnson et al., 2019). By contrast, infant, child, and developmental approaches to self-regulation have integrated emotional, cognitive, and behavioural processes to a greater extent, and have also placed emotion in a positive light (Diamond & Aspinwall, 2003; Isen, 2003). We posit that separating emotion from other self-regulation processes provides a distorted picture of human functioning, downplaying the potentially positive impact of emotion and emotional regulation on psychological and physical health (Johnson & Acabchuk, 2018; Terry & Leary, 2011; Tugade & Fredrickson, 2007). Once again, we argue that theories and methods ought to link and integrate emotions with intentional goal-oriented behaviour. Accordingly, our meta-review includes evidence syntheses from both the social-cognition and trait perspectives.

The present meta-review

The present meta-review synthesised information from evidence syntheses of interventions using self-regulation components to reduce or prevent risk-taking behaviours. We use the terms ‘risk taking’ and ‘risk-taking behaviours’ interchangeably in this manuscript. This term is not intended to imply a willing decision to engage in these behaviours. Indeed, many of the behaviours of interest are influenced by processes that directly impair agency and informed decision making (e.g., addictive behaviours).

The reviewed studies were obtained in two ways. First, we obtained a sample of meta-analyses from a recent meta-review of health behaviour change (Hennessy, Johnson, Acabchuk, McCloskey, & Stewart-James, *in press*); these evidence syntheses were generally grounded in social-cognition perspectives and were the primary focus of our meta-review. Yet, as noted above, evidence from only one paradigm may ultimately leave unanswered questions. We therefore supplemented the Hennessy et al. data set with evidence syntheses of interventions that have explored the self-regulation—risk reduction relationship from a trait/developmental perspective. Broadly, these latter interventions aimed to reduce and/or prevent risk-taking behaviours, through targeting traits and temperaments that have been associated with impaired self-regulation, most notably, impulsivity, sensation seeking, and trait self-control. The current meta-review may also be distinguished from the Hennessy et al. meta-review in that it focuses specifically on risk-reduction interventions and thus provides greater detail on conceptual and methodological issues specific to efforts to reduce health risks. It also offers the advantage that the trials in the included meta-analyses have a higher degree of overlap than in the Hennessy et al. meta-review with its 66 meta-analyses (see Hennessy & Johnson, *in press*), providing more precision in the conclusions drawn about health behaviour change in this particular domain (risk-taking).

Meta-review approaches

In meta-reviews, sometimes labelled *overviews of reviews*, and *reviews of reviews*, the primary unit of analysis is an evidence synthesis (a summary of empirical literature; Cooper & Koenka, 2012). Numerous evidence syntheses are published, with some estimates suggesting that about 22 systematic reviews are published every day in the broad biomedical research field (Page et al., 2016). The Cochrane group alone publishes 11 reviews daily (Bastian, Glasziou, & Chalmers, 2010). With the increasing numbers of published reviews, a logical next step is to conduct reviews of extant reviews, aiming to compare and contrast available evidence, filter down large volumes of evidence, and provide targeted information to inform decision-making in health care and intervention development (Aromataris et al., 2015).

The principles guiding the design of meta-reviews are still evolving but largely parallel those of a systematic review of primary data (Hartling, Chisholm, Thomson, & Dryden, 2012; Hennessy, Johnson, & Keenan, 2019). Considering the designs of its sampled reviews, a meta-review is expected to not merely repeat their data collection and analytical strategies, but to go beyond those to provide a broader but also condensed picture of the phenomenon under investigation (Aromataris et al., 2015). To that end, meta-reviews can be flexible, combining various methods and approaches to the included data. A useful description of the scope of a meta-review refers to ‘lumping’ or ‘splitting’ information (Weir, Grimshaw, Mayhew, & Fergusson, 2012). *Lumping* refers to focusing on finding commonalities in evidence across different approaches, while *splitting* refers to approaching the evidence with a narrow focus. Lumping allows greater leeway in generalising the evidence, with greater applicability in practice and policy (Baker, Costello, Dobbins, & Waters, 2014).

‘Nested’ meta-reviews

We have largely employed a lumping approach in the present meta-review and have conducted what may be labelled as a *nested* meta-review. That is, within a larger scale meta-review afforded by the data provided by Hennessy et al. (*in press*), we nested a smaller-scale *scoping*

meta-review of interventions evaluating the success of trait/developmental self-regulation interventions to reduce risk-taking behaviours. This nested approach is roughly the equivalent to nesting strategies utilised in mixed-method designs of primary research (Small, 2011). Broadly, *nesting* refers to combining multiple data types from similar data sources. In primary research, these data sources would be similar participants, organisations, or entities (Lieberman, 2005), while in evidence syntheses, data types would be similar bodies of evidence. The additional data type may serve an illustrative function, or a deeper analytical function, offering complementary evidence (Lieberman, 2005; Small, 2011). Scoping reviews can be stand-alone studies or nested within larger studies and aim to ‘map rapidly the key concepts underpinning a research area and the main sources and types of evidence available’ (Mays, Roberts, & Popay, 2001, p. 194).

Scoping reviews may or may not be ‘systematic’ in nature and tend to have broad foci, such as mapping available evidence in a relatively new research field, identifying literature gaps, and determining if a larger-scale systematic review is warranted (Arksey & O’Malley, 2005; Protogerou et al., 2015). A scoping review may include studies with diverse designs, diverse population characteristics, various methodological qualities, and may analyse the data from either a quantitative or qualitative lens, or, both (Arksey & O’Malley, 2005).

Purpose of the current meta-review

The purpose of the present meta-review was (a) to synthesise and summarise information from evidence syntheses of self-regulation interventions to reduce risk-taking, drawing from social-cognition and trait perspectives; (b) to identify intervention features most likely to be implicated in risk-taking prevention or reduction; and (c) to provide recommendations for future research and practice.

Method

Social-cognition perspective meta-review

As indicated above, the evidence syntheses grounded on social-cognition perspectives were drawn from the Hennessy et al. (in press) meta-review, which was preregistered in PROSPERO (CRD42017074018); the current study is registered on the Open Science Framework platform (<https://osf.io/zqfwe/>). The selection criteria, search, and screening procedures that Hennessy et al. followed are, briefly, as follows.

Study selection criteria

Eligible studies were meta-analyses that (a) evaluated behavioural health interventions that quantitatively assessed any self-regulation mechanism; and (b) reported a quantitative association between a self-regulation component and a health behavioural outcome in a non-institutionalized sample. Relevant reviews examined (a) any self-regulation mechanism (i.e., cognitive, emotion, self-related), or (b) any proxy of self-regulated behaviour, drawn from version 1.0 of the behaviour change taxonomy of behaviour change techniques (BCTs; Michie et al., 2013; i.e., goal-setting, prompt review of goals, prompt self-monitoring, emotional control training, prompt self-talk, stress management, action planning, barrier identification/ problem solving, relapse prevention/ coping planning, time management, inhibitory control training, and feedback provision); it also used earlier versions of BCT lists when available. The present meta-review focusses on a subset of Hennessy et al.’s sample, those focused on risk-taking behavioural outcomes. Other meta-analyses in their sample concerned health behaviour promotion; cardiovascular disease prevention and management; diabetes prevention and management; and medication adherence and chronic respiratory disease management.

Search, screening, and data-extraction strategies

Seven databases, including PsycINFO, CINAHL, PubMed, EMBASE (Scopus), Education Resources Information Center (ERIC), Cochrane Database of Abstracts of Reviews of Effects (DARE), and the Cochrane Database of Systematic Reviews, were searched as recently as August 2017. In addition, a smaller-scale search was conducted by the authors of the present meta-review in April 2019; it found a newer version of one meta-analysis (Ebbert, Elrashidi, & Stead, 2015), which was entered into the sample instead of the earlier one (Ebbert et al., 2007). Reference lists of eligible meta-analyses and relevant meta-reviews were hand-searched. There were no publication type or language restrictions, but there were date restrictions (meta-analyses published from 2006 onwards), aiming to provide the most recent relevant practice, because methodological quality is known to be improving as new reporting guidelines are instituted (e.g., Johnson et al., 2014), and because of the observation that more recent meta-analyses of the same literature overlap extensively with earlier ones. Studies were screened at the title, abstract, and full-text level. Data were extracted independently and in duplicate and discrepancies were resolved through discussion.

Quality assessment

Hennessy et al. (in press) appraised the meta-analyses for quality using the AMSTAR 2 instrument (Shea et al., 2017), a critical appraisal tool for systematic reviews and meta-analyses that include randomised and/or non-randomised biomedical interventions; coding was in duplicate and achieved consensus. The AMSTAR 2 consists of 16 items, each allowing 'yes', 'partial yes', or 'no' options. Hennessy et al. classified meta-analyses that satisfied at least 70% of the eligible AMSTAR 2 items as of 'higher' quality, those with 50–69% as 'medium' quality, and those below 50% as 'low' quality. Table 1 provides the AMSTAR 2 scores for the meta-analyses included in the meta-review of social-cognitive evidence syntheses. In addition, the present meta-review provided the quality appraisal strategies employed by the meta-analyses themselves, including how quality may have impacted outcomes (Table 1).

Trait perspective meta-review

A scoping review was conducted to identify evidence syntheses of behavioural interventions to reduce risk-taking employing a trait self-regulation framework, following the guidelines of Arksey and O'Malley (2005).

Eligibility criteria

Studies were eligible if they (1) were evidence syntheses of any kind; (2) reported associations between trait self-regulation components and risk-taking behaviours; or (3) were full-text peer-reviewed publications, written in the English language. Studies were excluded if they were (1) duplicate versions of the original study (e.g., conference presentations); (2) abstracts; or (3) governmental reports, and editorial or opinion pieces. There were no population or publication date restrictions.

Retrieval

The scoping search was conducted through Google Scholar's advanced search option, using combinations in three types of key terms, as described online (<https://osf.io/p5xd2/>). We also searched the reference lists of the retrieved evidence syntheses, to identify studies that may have been potentially missed in the first search. The first author conducted this search and two co-authors then examined and confirmed it.

Table 1. Key features and results of meta-analyses in the sample, listed in alphabetical order by first author.

Table 1. Key features and results of meta-analyses in the sample listed in alphabetical order by first author							MAMQ ^a ; authors' PSMQ assessment (linkage to results)
Meta-Analysis	Purpose; intervention design(s); target population (s); <i>k</i> (<i>N</i>)	Outcome Variable(s)	Meta-Analytic Results for Risk-Reduction (and Qualification(s), if relevant)				
			Self-regulation BCTs		Other BCTs	Other intervention features	
			Positive	Null			
Albarracín et al. (2008)	Evaluation of HIV/AIDS prevention intervention success; single-group pre-post with independent samples at each time; U.S. Latinx populations; 142 (<i>N</i> = 110,092)	HIV/AIDS knowledge; condom use	Self-management training	NA	Threat/fear induction (condom use and knowledge change); information provision; condom use skills; interpersonal skills training; attitudinal and normative arguments; HIV counselling	Higher education (increased condom use); male gender (increased condom use); female gender (increased knowledge); Latin American context (increased condom use); lay and community agents; health and community settings; HIV testing	8%; no PSMQ appraisal (unknown)
Allom et al. (2016)	Estimation of size and variability of the effect of inhibitory control training on health behaviour; RCTs; all; 19 (<i>N</i> = NR)	Alcohol consumption; eating behaviours	Inhibitory control training	NA	None reported	Go/no-go (more effective) and stop-signal training (less effective); tasks tailored to target behaviour; objective measures (only post-intervention) and subjective measures (all times); shorter (larger effect) and longer follow-ups	41%; no PSMQ appraisal (unknown)
St. Amand, Bard, & Silovsky (2008)	Evaluation of child sexual and general problem behaviour intervention success; RCTs, single-group pre-post, and single-group waitlist; sexually abused children ≤12 years old (outpatients); 11 (<i>N</i> = 1,081)	Sexual and general problem behaviour	Self-control training	NA	Parenting skills training; behaviour-management skills training; rule-setting about sexual behaviour; abuse prevention skills training	Age (preschool); group, individual and family modalities; sex education	8%; no PSMQ appraisal (unknown)
	Identification of Behaviour change techniques	Smoking cessation	Self-monitoring; action planning	NA		Medication provision; weight control; clinical	44%; 11 studies (59%) classified as of high

Bartlett, Sheeran, and Hawley (2014)	associated with greater effectiveness in smoking cessation interventions for people with chronic obstructive pulmonary disease (COPD); RCTs; Adults with COPD; 17 ($N = 7,446$)					Social support facilitation; associating COPD with smoking.	setting (highest success); home setting; group (highest success) and individual modalities	quality, conceptualised as presence/absence of adequate power and sample size, based on the Delphi list (Verhagen et al., 1998) (these were not linked to results)
Chamberlain et al. (2017)	Efficacy evaluation of smoking cessation interventions during pregnancy; RCTs, cluster RCTs, RCTs with cross-over, Quasi-RCTs; female smokers (or ex-smokers) who are pregnant (or seeking pre-pregnancy consultation); 86 ($N = 29,000$)	Smoking behaviour; Perinatal health.	Personalised feedback provision (only in conjunction with other Behaviour change techniques)	NA		Social support by peers; Counselling.	Targeting smoking cessation-only (more successful) and broader maternal health (less successful); researcher or pregnancy staff provider; intensive or less intensive frequency; short or long duration	87%; studies classified as of mixed quality/unclear on RoB (analyses suggested no clear patterns)
Cristea, Kok, and Cuijpers (2016)	Effectiveness evaluation of cognitive bias modification interventions for substance addiction prevention; adult smokers and drinkers; 24 ($N = 3,175$)	Alcohol and smoking addiction cessation	Attention bias modification (only for cognitive bias change)	Approach-avoidance task; Inhibitory control training	None reported	None	None	44%; most studies classified as of high/unclear risk of bias for most criteria using RoB (smaller effect sizes for addiction and craving appeared with higher risk of bias)
Ebbert et al. (2015)	Effectiveness/efficacy evaluation of behavioural and pharmacological interventions for smokeless tobacco cessation; US, Swedish, and Norwegian adult users of tobacco products placed in the mouth and not burned; 34 ($N = 16,000$)	Smokeless tobacco cessation	Personalised feedback provision (only when delivered as part of telephone counselling)	NA		Telephone counselling	Oral examination (only when used with phone counselling); pharmacological treatment	78%; studies classified as of limited methodological quality based on RoB (unknown, although authors conducted other sensitivity analyses)
Hajek et al. (2013)	Effectiveness evaluation of smoking relapse prevention interventions; adults who had quit smoking; 63 ($N = \text{NR}$)	Smoking relapse prevention/cessation	None	Coping skills training	None reported	None	None	69%; most studies classified as of unclear risk of bias with the Cochrane risk of bias tool (Higgins et al., 2011); studies classified as of

(Continued)

Table 1. Continued.

Meta-Analytic Results for Risk-Reduction (and Qualification(s), if relevant)							MAMQ ^a ; authors' PSMQ assessment (linkage to results)
Meta-Analysis	Purpose; intervention design(s); target population (s); <i>k</i> (<i>N</i>)	Outcome Variable(s)	Self-regulation BCTs		Other BCTs	Other intervention features	
			Positive	Null			
Onrust, Otten, Lammers, and Smit (2016)	Effectiveness evaluation of school-based intervention to prevent / reduce substance abuse; controlled trials; students between 4-and 21-years old; 241 (<i>N</i> = 436,180)	Smoking, alcohol or drug use prevention / reduction	Stress management; barrier identification or problem solving; self-control (these worked across adolescent periods)	Refusal skills training or threat appeals (except for late adolescents)	Basic skills training (for all age groups); adjusting social norms (for early adolescents); refusal skills (for late adolescents only)	Tailoring intervention type and content to age group/ developmental period; parental involvement in interventions; universal and high-risk population interventions; theory-based interventions (for late adolescents only)	overall very low quality using GRADE (unknown) 28%; RoB mentioned but no quality appraisals reported (NR, thus unknown)
Scott-Sheldon, Carey, Elliott, Garey, and Carey (2014)	Efficacy evaluation of interventions to prevent alcohol misuse by first-year college students; RCTs; first-year university students; 41 (<i>N</i> = 24,294)	Alcohol consumption and alcohol-related problems reduction	Barrier identification or problem solving; personalised feedback provision; goal setting	None	NA	Individual- and group-level designs; longer assessment interval (for heavy drinking only); computer-delivered and face-to-face delivery modes; inclusion of multiple Behaviour change techniques; non-Black students (for drinking frequency only)	53%; on average, studies received a total quality score of 12 (20 being the highest) based on adapted validated measures (Jadad et al., 1996; Miller et al., 1995) (no correlation of outcomes with overall quality score)
Song, Huttunen-Lenz, and Holland (2009)	Effectiveness evaluation of complex psycho-educational interventions for smoking relapse prevention; RCTs; former or current smokers motivated to quit; 49 (<i>N</i> = NR)	Rate of smoking abstinence at the longest follow-up	Relapse prevention or coping planning	Coping skills training (for early stages of smoking cessation)	Coping skills training (for relapse prevention in highly motivated quitters)	Self-help materials; face-to-face counselling sessions	25%; studies classified as of poor methodological quality, with moderate to high risk of bias, but used an unknown quality tool (unknown)
Spohr et al. (2015)	Efficacy evaluation of SMS text message-based interventions for smoking cessation; RCTs; smokers; 13 (<i>N</i> = 13,626)	Smoking cessation	None	Relapse prevention/ coping planning; personalised feedback provision	None reported	Earlier follow-up; text plus other modalities; fixed (consistent) number of daily texts	34%; no PSMQ appraisal (unknown)

Tanner-Smith and Lipsey (2015)	Effectiveness evaluation of brief alcohol interventions; RCTs or quasi-RCTs; adolescents (aged 11–18) and young adults (aged 19–30); 185 (N = NR)	Alcohol consumption and alcohol-related problems reduction	Goal setting (adolescents, young adults); personalised feedback provision (young adults)	Basic education/information (adolescents and young adults); blood and alcohol content feedback and personalised feedback (adolescents); norm referencing (young adults)	Decisional balance exercise, norm referencing and motivational interviewing or counselling (adolescents); blood and alcohol information; decisional balance exercise; money/cost information (young adults)	High school setting and self-administered computerised intervention; university campus setting	47%; no PSMQ appraisal (unknown)
Tanner-Smith, Steinka-Fry, Hennessy, Lipsey, and Winters (2015)	Effectiveness evaluation of brief alcohol and illicit drug use interventions; RCTs or quasi-RCTs; young people (aged 11–25); 67 (N = NR)	Alcohol and illicit drug use reduction	Barrier identification or problem solving	Goal setting; Personalised feedback provision	Identification of high-risk drinking situations; information provision about consequences of heavy drinking; discussion of drug moderation strategies	Alcohol-only interventions (alcohol reduction); combined alcohol and illicit drug interventions (alcohol and drug reduction)	44%; no PSMQ appraisal (unknown)
Tyson, Covey, and Rosenthal (2014)	Effectiveness evaluation of theory of reasoned action/planned behaviour sexual risk reduction (STI and unwanted pregnancy) interventions; RCTs or quasi-RCTs; heterosexuals; 32 (N = NR)	Condom use.	Prompt review of goals.	Self-monitoring; barrier identification/ problem solving; relapse prevention/ coping planning	Opportunities for social comparisons; information on consequences of unprotected sex (condom use)	Younger participants; interventions delivered face-to-face	39%; a relatively large number of studies were classified as of unclear based on RoB (condom use effect sizes were significantly larger in studies low in selection bias)

Notes: Abbreviations. BCT = Behaviour change technique. MAMQ = Meta-analysis methodological quality (AMSTAR-2). NA = Not available. NR = Not reported. PSMQ = Primary study methodological quality (as assessed by authors, if relevant). RoB = Cochrane risk of bias tool (Higgins et al., 2011).

^aPercentage of AMSTAR-2 items satisfied.

Data analysis strategy of present meta-review

The meta-analyses obtained from the Hennessy et al. (in press) meta-review were synthesised first. The meta-analyses were described in terms of their publication date, design, purpose, outcomes, population characteristics, intervention features associated (or not) with reduced risk taking, and quality of included meta-analyses, and quality assessments undertaken by the meta-analyses themselves (i.e., of their own included studies) (Table 1). Then, all salient intervention features associated with risk-taking reduction were identified and situated in reverse order of prominence, defined as the frequency with which a given feature was associated with reduced risk across the meta-analyses (Table 2). Then, intervention features that succeeded in reducing risk-taking were categorised as a function of behavioural outcome and situated in reverse order of prominence (features appearing most frequently, first) (Table 3). Finally, all salient intervention features associated with risk-taking reduction were categorised according to intervention dimensions they semantically 'belonged' to and situated in reverse order of prominence (Tables 2, 3, 5 and 6). This latter task was accomplished through deductive content analysis, based on the processes exemplified by Elo and Kyngäs (2008). Such an approach is typically employed when there is available knowledge on the topic under investigation, and the aim is to retest existing concepts, categories, theories or hypotheses, or retest pre-existing data in a new context (Hsieh & Shannon, 2005; Sandelowski, 1993).

Given that previously published reviews and meta-reviews have already provided categories of intervention features associated with reduced risk-taking (e.g., Protogerou & Johnson, 2014; Protogerou & Hagger, 2017), deductive content analysis was deemed apt. Specifically, we expected that intervention feature categories of BCTs, design, recipient characteristics, and context, would be associated with reduced risk-taking. Deductive content analysis was facilitated by developing a categorisation matrix, wherein results were coded according to the pre-existing categories (Tables 3 and 6). Although our matrix organised intervention features according to existing categories of features known to be linked with risk-taking reduction, we were open to new categories, if they emerged; this more flexible approach is known as working with an 'unconstrained matrix' (Elo & Kyngäs, 2008). In Tables 2 and 3, **boldfaced** features indicate features that were discovered by at least one meta-analysis with an overall AMSTAR 2 quality score of at least 50%, while daggers (†) indicate BCTs relevant to self-regulation. The evidence obtained from the scoping literature search was collated and summarised in a similar manner to Hennessy et al.'s (in press) meta-review. Quality appraisal was not conducted for these studies, as they had non-comparable designs. All three authors conferred on the data and reached consensus.

Results

Evidence from interventions employing a social-cognition approach

Descriptive summary of meta-analyses' characteristics

Fifteen meta-analyses ($I = 15$) of interventions employing self-regulation BCTs qualified for the meta-review. As Table 1 indicates, most of the meta-analyses focussed on substance-use related behaviours: alcohol consumption ($I = 6$, 40%), tobacco smoking ($I = 7$, 46.66%), drug use ($I = 2$, 13.33%), and smokeless tobacco ($I = 1$, 6.66%); other reviews addressed sexual risk ($I = 3$, 20%), unhealthy eating ($I = 1$, 6.66%), and perinatal health ($I = 1$, 6.66%). Some meta-analyses targeted more than one risk behaviour. Interventions delivered a range of BCTs, such as self-regulation, social-cognitive, information-provision, and counselling, via a range of methods (i.e., one-to-one, group, computer-based, and text-based). All but two (13.33%) meta-analyses assessed studies that used multiple intervention components.

Meta-analyses appeared between 2007 and 2017 (median = 2014), reviewed between 11 and 241 interventions (median = 41), and included a mix of randomised, pseudo-randomised, and quasi-randomised designs. All studies were published by authors based in universities in the Global North (i.e.,

Table 2. Intervention features examined by social-cognition evidence syntheses and their degree of success or failure.

Intervention features	/ Meta-analyses (%) testing	Meta-analyses providing evidence (percentage of those evaluating)	
		Risk reduction (I)	No risk reduction (I)
Multiple intervention components	13 (87%)	13 (100%)	0 (0%)
Information provision	6 (43%)	5 (83%)	1 (17%)
Skills-training	5 (36%)	3 (60%)	2
Personalised feedback provision^a	4 (29%)	4 (100%)	3
Counselling provision	4 (29%)	4 (100%)	0 (0%)
Barrier identification/ Problem solving^a	4 (29%)	3 (75%)	1 (25%)
Adjusting social norms/ Opportunities for social comparisons	4 (29%)	3 (75%)	1 (25%)
Goal-setting^a	3 (21%)	2 (67%)	1 (33%)
Age/ developmentally-appropriate intervention	3 (21%)	3 (100%)	0 (0%)
Group modality	3 (21%)	3 (100%)	0 (0%)
Individual modality	3 (21%)	3 (100%)	0 (0%)
Medical screening	3 (21%)	2 (67%)	1 (33%)
Family modality	2 (14%)	2 (100%)	0 (0%)
Self-control training ^a	2 (14%)	2 (100%)	0 (0%)
Social support by peers	2 (14%)	2 (100%)	0 (0%)
Discussion	2 (14%)	2 (100%)	0 (0%)
Identification of high-risk situations	2 (14%)	2 (100%)	0 (0%)
Computer-delivered	2 (14%)	2 (100%)	0 (0%)
Face-to-face delivery	2 (14%)	2 (100%)	0 (0%)
Race/ethnic relevant	2 (14%)	2 (100%)	0 (0%)
Pharmacological treatments	2 (14%)	2 (100%)	0 (0%)
Targeting only one risk behaviour	2 (14%)	2 (100%)	0 (0%)
Shorter follow-ups	2 (14%)	2 (100%)	0 (0%)
Longer follow-ups	2 (14%)	2 (100%)	0 (0%)
Targeting multiple (risk) behaviours	2 (14%)	2 (100%)	0 (0%)
Inhibitory control training ^a	2 (14%)	1 (50%)	1 (50%)
Self-monitoring ^a	2 (14%)	1 (50%)	1 (50%)
Relapse prevention/ Coping planning ^a	2 (14%)	1 (50%)	1 (50%)
Utilising multiple BCTs	1 (7%)	1 (100%)	0 (0%)
Text-based delivery	1 (7%)	1 (100%)	0 (0%)
Universal ('all' populations) intervention	1 (7%)	1 (100%)	0 (0%)
High-risk population	1 (7%)	1 (100%)	0 (0%)
Delivered by experts	1 (7%)	1 (100%)	0 (0%)
Delivered by lay/community agents	1 (7%)	1 (100%)	0 (0%)
Health/ Clinical setting	1 (7%)	1 (100%)	0 (0%)
Community setting	1 (7%)	1 (100%)	0 (0%)
Home setting	1 (7%)	1 (100%)	0 (0%)
School/ University setting	1 (7%)	1 (100%)	0 (0%)
Objective measures	1 (7%)	1 (100%)	0 (0%)
Subjective measures	1 (7%)	1 (100%)	0 (0%)
Tasks tailored to target behaviour	1 (7%)	1 (100%)	0 (0%)
Short duration	1 (7%)	1 (100%)	0 (0%)
Long duration	1 (7%)	1 (100%)	0 (0%)
Theory-based intervention	1 (7%)	1 (100%)	0 (0%)
Decisional balance exercise	1 (7%)	1 (100%)	0 (0%)
Rule-setting about target behaviour	1 (7%)	1 (100%)	0 (0%)
Self-management training ^a	1 (7%)	1 (100%)	0 (0%)
Attention bias modification ^a	1 (7%)	1 (100%)	0 (0%)
Action-planning ^a	1 (7%)	1 (100%)	0 (0%)
Stress management ^a	1 (7%)	1 (100%)	0 (0%)
Prompt review goals ^a	1 (7%)	1 (100%)	0 (0%)
Approach-avoidance task	1 (7%)	0 (0%)	1 (100%)
Threat appeals	1 (7%)	0 (0%)	1 (100%)
Higher participant education level	1 (7%)	1 (100%)	0 (0%)
Weight control	1 (7%)	1 (100%)	0 (0%)
Intensive frequency	1 (7%)	1 (100%)	0 (0%)
Less intensive frequency	1 (7%)	1 (100%)	0 (0%)
Gender	1 (7%)	1 (100%)	0 (0%)

Notes: **Boldfaced** features indicate features that were found to be associated with risk reduction in at least one meta-analysis with an overall AMSTAR 2 quality score of at least 50%. BCT = Behaviour change technique.

^aA BCT logically linked to self-regulation.

Table 3. Categorisation matrix for social-cognition-based evidence syntheses: emerging categories and frequency and co-occurrence of intervention features that were tested and found to be linked to risk reduction in reverse order of feature frequency.

Behaviour change techniques (BCTs) (Co-occurrence: 40)	Study features		
	Design features (Co-occurrence: 52)	Recipient features (Co-occurrence: 7)	Context-relevant features (Co-occurrence: 6)
Information provision (5)	Multiple intervention components (13)	Age/developmentally-appropriate (3)	Social support by peers (2)
Personalised feedback provision^a (4)	Group modality (3)	Race/ethnic relevant (2)	Health/Clinical setting (1)
Counselling (4)	Individual modality (3)	Higher participant education level (1)	Community setting (1)
Skills-training (3)	Family modality (2)	Gender (1)	Home setting (1)
Barrier identification/Problem solving^a (3)	Computer-delivered (2)		School/University setting (1)
Adjusting social norms/Opportunities for social comparisons (3)	Face-to-face delivery (2)		
Discussion (2)	Medical screening (2)		
Goal-setting^a (2)	Pharmacological treatments (2)		
Self-control training ^a (2)	Targeting only one risk behaviour (2)		
Identification of high-risk situations (2)	Shorter follow-ups (2)		
Relapse prevention/coping planning ^a (1)	Longer follow-ups (2)		
Decisional balance exercise (1)	Targeting multiple (risk) behaviours (2)		
Rule-setting about target behaviour (1)	Utilising multiple BCTs (1)		
Self-management training ^a (1)	Text-based delivery (1)		
Inhibitory control training ^a (1)	Universal ('all' populations) intervention (1)		
Self-monitoring ^a (1)	High-risk population (1)		
Attention bias modification ^a (1)	Delivered by experts (1)		
Action-planning ^a (1)	Delivered by lay/community agents (1)		
Stress management ^a (1)	Objective measures (1)		
Prompt review goals ^a (1)	Subjective measures (1)		
	Tasks tailored to target behaviour (1)		
	Short duration (1)		
	Long duration (1)		
	Theory-based intervention (1)		
	Weight control (1)		
	Intensive frequency (1)		
	Less intensive frequency (1)		

Note. Numbers in parentheses (*I*) are the numbers of meta-analyses in which a feature appears, indicating feature frequency. Co-occurrence values show how many times a feature appears across meta-analyses, indicating feature prominence. **Boldfaced** features are those discovered by at least one meta-analysis with an overall AMSTAR-2 quality score of at least 50%.

^aA BCT logically linked to self-regulation.

USA, UK, Australia, Canada, Denmark, Romania, and the Netherlands). The number of authors per study ranged from two to seven (median = 3). All meta-analyses were published journal articles, three of which (20%) were Cochrane reviews. Meta-analyses sampled participants across age groups (i.e., children, adolescents, young, middle-aged and older adults), and across settings (i.e., school, university, family, health/clinical, home, community), with an approximate sample size of $N = 634,876$ (median = 13,626). Six meta-analyses (40%) did not report sample size.

Quality of included meta-analyses

Most meta-analyses were classified as of questionable quality, with only four (26.67%) satisfying at least 50% of AMSTAR 2 quality criteria, and of these, two satisfied at least 70% of AMSTAR 2

quality criteria (13.33%). Nine meta-analyses (60%) quality appraised their included studies (viz. primary study quality); of these, five (33.33%) tested whether quality impacted outcomes. Out of these five, two (13.33%) found that study quality (13.33%) impacted outcomes, two did not, and one (6.67%) found no clear evidence of quality impacting outcomes in any direction.

Meta-analyses performed better in relation to some quality criteria than others. Specifically, meta-analyses did well in the following quality domains: inclusion of a PICO description (i.e., population, intervention, control group, and outcome) of research questions and inclusion criteria ($I = 11$, 73.33%); duplication of data extraction process ($I = 9$, 60%); apt choice of statistical tests ($I = 11$, 73.33%); risk-of-bias assessment of included interventions ($I = 7$, 46.67%); good explanation of potential heterogeneity ($I = 12$, 80%); publication bias (small study bias) assessment ($I = 9$, 60%); and provision of conflicts of interest/ funding sources statement ($I = 10$, 66.67%). By contrast, meta-analyses performed worst in the following eight quality areas: adherence to a pre-established protocol (e.g., pre-registered), with deviations from protocol reported ($I = 2$, 13.33%); justification of included intervention designs ($I = 0$, 0%); comprehensive literature search ($I = 2$, 13.33%); duplicated study selection ($I = 5$, 33.33%); justified excluded studies ($I = 4$, 26.67%); described included studies in detail ($I = 6$, 40%); used an appropriate technique to assess risk-of-bias ($I = 4$, 26.67%); and included information of funding sources of included studies ($I = 0$, 0%).

We expected that features discovered by at least one meta-analysis satisfying at least 50% of AMSTAR 2 quality criteria, would be more 'consensually' indicated to be associated with better intervention outcomes under the expectation that higher quality meta-analyses would converge in their findings. We found 22 such features, which appear in **boldface** in Table 2. Additional detail about quality outcomes can be gleaned in Table 1, while files in the OSF platform (<https://osf.io/zqfwe/>) provide detailed quality appraisals, as undertaken by the parent and present meta-review teams.

Intervention features associated with risk reduction

In total, we identified 59 salient intervention features that were tested by the meta-analyses, 57 of which were found to be associated with risk-taking reduction in at least one meta-analysis. In total, 13 meta-analyses (86.67%) found at least one self-regulation technique to be associated with reduced risk-taking. Table 2 provides all intervention features that at least one meta-analysis tested and found to be associated with reduced risk-taking, while indicating feature frequency, or, prominence,¹ across meta-analyses. Table 3 summarises intervention features that at least one meta-analysis tested and found to be associated with reduced risk-taking, while indicating feature frequency across meta-analyses. Considering all behavioural outcomes, we observed six intervention features as most prominently associated with reduced risk-taking (reduced risk in three out of seven behavioural outcomes). The features included five BCTs: barrier identification/ problem solving; information provision; personalised feedback provision; any type of skills training, and any type of therapy or counselling. In addition, one study design feature, the combination of multiple intervention components, proved to be the most prominent correlate of risk-taking reduction across all seven behavioural outcomes. Studies of multiple intervention components also yielded important information about potential moderators of effects. For example, Onrust et al. (2016) examined studies of school-based intervention for substance misuse prevention. The authors found that for both universal and targeted prevention, multiple types of interventions were used (e.g., coping, health education, behaviour management) and importantly that the types of BCTs used varied in effectiveness in an age-specific way. Their review concluded that basic skills (e.g., self-control, decision-making) were effective in both early and late adolescents, whereas focusing on social influences and substance refusal skills was only effective in older adolescents (Onrust et al., 2016). Two BCTs, threat appeals and approach-avoidance training, were not linked to risk-taking reduction by the meta-analyses that evaluated them.

Content analysis of intervention features

Content analysis confirmed our expectation that the four categories of intervention features (design features, BCTs, recipient features and context-relevant features), would be associated with reduced risk-taking. This information appears in [Table 3](#), which provides the intervention features associated with reduced risk-taking, situating them in categories to which they conceptually 'belong', while indicating feature frequency and prominence across the meta-analyses.

Design features. Intervention design features were the most frequent elements examined in the meta-analyses; those interventions most prominently associated with intervention success included the use of multiple intervention components (linked to reduced risk-taking in 13 meta-analyses); modality (group and individual modalities were linked to risk-taking reduction in three meta-analyses; family-based modality, in two); delivery medium (computer-based and face-to-face delivery modes were linked to risk-taking reduction in two meta-analyses); biomedical components (screening and pharmacological treatments were linked to reduced risk-taking in two meta-analyses); follow-up duration (associated with reduced risk-taking in two meta-analyses, although not in a consistent direction); and number of risk-taking behaviours targeted (associated with risk reduction in two meta-analyses, although not in a consistent direction). The remaining design features were less frequently associated with risk-taking reduction (see [Table 3](#)).

Behaviour change techniques. These were also extensively employed by the interventions, and included a broad array of techniques, including—but not limited to—self-regulation techniques. BCTs most prominently associated with intervention success included: information provision (reduced risk in five meta-analyses); personalised feedback and counselling provision (reduced risk in four meta-analyses); skills-training, barrier identification/ problem solving, and adjusting social norms (each reduced risk in three meta-analyses); and discussion, goal-setting, self-control training, and high-risk situation identification (each reduced risk in two meta-analyses). The remaining BCTs reduced risk in no more than one meta-analysis. As [Figure 1](#) and [Table 3](#) show, the self-regulation techniques were all associated with reduced risk-taking in at least one meta-analysis, with personalised feedback provision, barrier identification/ problem solving, goal-setting, and self-control training being most frequently used. [Figure 1](#) additionally shows that higher quality evidence syntheses were somewhat more likely to reveal connections between self-regulation BCTs than were their lower quality counterparts (6 successes vs. 1 failure for higher quality, 85.7%; 17 vs. 8 for lower quality, 68.0%). The lower quality evidence syntheses examined far more BCTs than did the higher quality evidence syntheses (100% vs. 25%).

Recipient features. Meta-analyses only infrequently explored the influence of recipient characteristics on risk-taking reduction. Interventions that were tailored to age/ developmental period or to race/ethnicity of recipients were found to be associated with reduced risk-taking in three and, two, meta-analyses, respectively. Also, gender and higher participant education were associated with intervention success in one meta-analysis, although the patterns of results often conflicted.

Context-relevant features. A small number of features reflected the impact of the immediate and wider social context on intervention success. Two meta-analyses found evidence linking social support provision by peers to reduced risk-taking. In addition, delivery in clinical, community, and school/university settings was found to be linked to risk-taking reduction, by one meta-analysis each.

Evidence from interventions employing a trait self-regulation approach

Descriptive summary of reviews' characteristics

Our search identified six ($I = 6$) evidence syntheses of interventions employing trait self-regulation approaches with the aim to modify risk-taking behaviours, including substance use, unhealthy eating, externalising problem behaviours (e.g., physical aggression, disobeying rules), and delinquency, with an approximate sample size of $N = 19,758$ (median = 4,716). All studies were published as journal articles by authors based in the Global North, and were overviews ($I = 3$, 50%), systematic (narrative) reviews ($I = 2$, 33.33%), and meta-analyses ($I = 1$, 16.66%). Table 4 provides more detail on the evidence syntheses. Compared to the evidence syntheses from the social-cognitive perspective, these reviews were not as meticulous in their reporting of intervention features associated with reduced risk-taking. In addition, only one review appraised the quality of its included interventions, without exploring whether quality impacted findings in any way. Nonetheless, our content analysis of these reviews provided intervention features associated with reduced risk-taking, as well as commonalities and differences in relation to the social-cognitive self-regulation interventions.

Commonalities. Similar to the social-cognitive interventions, trait self-regulation interventions employed a plethora of features to induce behaviour change. Moreover, the same categories of features were implicated in risk reduction including numerous BCTs, design, recipient, and context-relevant characteristics (see Tables 5 and 6). Almost without exception, both perspectives employed the same (self-regulation) BCTs and the same design, recipient, and contextual parameters.

Differences. Trait self-regulation interventions tailored content to risk-prone individuals, that is, individuals high in sensation-seeking, impulsivity, novelty-seeking, and other relevant characteristics associated with risk-taking, as measured by psychometric instruments. These traits were seen as largely inherent, predisposing people to engaging in risk-taking behaviours, and consequently, tended to be delivered early in life and tailored to age/developmental period. Thus, trait perspectives more frequently utilised self-control/impulsivity training and stress-management strategies. For example, Conrod (2016) reviewed studies testing interventions targeted to youth at-risk for substance misuse based on personality features. Many of these studies utilise multiple BCTs (motivational enhancement, skills training, etc) that were selected to target the specific personality vulnerabilities of interest (e.g., impulsivity, anxiety sensitivity). By contrast, social-cognition interventions did not mention sensation-seeking, impulsivity, or dispositional self-regulation/ trait self-control as being decisive determinants of risk-taking, and did not pre-screen recipients on those traits, tailor interventions to those traits, or measure those traits as intervention outcomes, alongside risk-taking. Notably, a number of BCTs were employed only in studies based in the trait self-regulation perspective. Specifically, physical activity, in the form of yoga, aerobic exercise, martial arts, and play/games, were delivered to children and improved self-control and prevented problem behaviours. Other interventions utilised message sensation value, that is, they framed and situated intervention messages in ways that elicited sensory, affective and arousal responses. These interventions were substance-use reduction televised messages placed in programmes typically viewed by sensation-seekers, depicting content designed to 'grab' the attention and 'arouse' sensation-seekers.

Discussion

In the present meta-review, we synthesised information from evidence syntheses ($I = 21$, $N \sim 654,634$) of self-regulation interventions to identify intervention features associated with reduced risk-taking in the behavioural domains of smoking, alcohol and drug use, unhealthy eating, externalising problem behaviours, and sexual risk-taking. Interventions were delivered to people across age groups (children, adolescents, young, middle-aged and older adults) and across settings (school, university, family, health/clinical, home, community).

Table 4. Evidence syntheses that examined risk reduction using trait assumptions.

Evidence synthesis (year; design)	Purpose; intervention design(s); target population(s); <i>k</i> (<i>N</i>)	BCTs associated with risk reduction success			Other intervention features	Methodological quality assessment (results, if reported)
		Self-regulation BCTs	Other BCTs	Multiple BCTs		
Conrod (2016; meta-review)	Efficacy evaluation of brief personality-targeted substance use and misuse prevention RCT interventions for high-risk individuals; 8 (<i>N</i> = ~3,061)	Self-control or impulsivity training; goal-setting; stress management	Information provision; identification of personality- specific cognitive distortions leading to risk-taking; cognitive behaviour therapy; motivational enhancement therapy	Yes	Manualized intervention; tailored to high- risk personality trait; school setting; clinical setting; home setting; group and individual modalities; phone- and email- assisted; culturally adapted; developmentally adapted (MQ: None conducted)	None conducted
Diamond and Lee (2011; meta- review).	Efficacy evaluation of executive function development (RCT or non- RCT) interventions for risk-taking and harmful behaviours (broadly conceptualised) for children between 4 and 12 years old; 4 (<i>N</i> = NA)	Self-control/impulsivity training; stress management; barrier identification/ problem solving; action planning	Mindfulness; play/game exercises; skills-training; aerobics; martial arts; yoga; school curricula	Yes	Early age delivery; poor executive functions to begin with; lower SES; combining BCTs; repeated/ consistent practice; increasing intensity/ difficulty; school setting; home setting; community setting; group and individual modalities; computerised and non-computerised intervention (MQ: None conducted)	None conducted
Palmgreen, Donohew, Lorch, Hoyle, and Stephenson (2001; meta- review)	Effectiveness evaluation of targeted televised campaigns to reduce marijuana use in high sensation- seeking adolescents using controlled interrupted time-series studies; 3 (<i>N</i> = 6,371)	Message sensation value (attention-getting and arousal-enhancing mechanism)	Information provision on consequences of marijuana use (through media depiction)	Yes	High reach; high frequency; tailored to high-sensation seekers; formative research with target population; message placement in high-sensation- value contexts (e.g., in TV shows likely to be watched by those high in sensation seeking) (MQ: None conducted)	None conducted
Piquero, Jennings, Farrington, Diamond, and Gonzalez (2016; meta-analysis)	Effectiveness evaluation of early self- control improvement and delinquency reduction programmes (RCTs) for children ≤10 years; 41 (<i>N</i> = 9,382)	Self-control/ impulsivity training; self- monitoring; stress management	While interventions included other BCTs, unclear which were associated with risk-reduction.	Yes	Small-scale interventions (small number of recipients); briefer duration; older age (only for delinquency outcomes) (MQ: None conducted)	None conducted
Stautz et al. (2018; systematic review)	Effectiveness evaluation of any available intervention to reduce alcohol, tobacco, and unhealthy food consumption, through the impact of trait self-control; 54 (<i>N</i> = NA)	Self-control training; goal- setting; self-monitoring	Unclear	Yes	Unclear (MQ: Study quality was 'weak' in 29 studies, 'moderate' in 23 studies, 'strong' in 1 study, and 'unclear' in 1 study; used scale from Effective Public Health Practice Project, 1998; did not evaluate impact on outcomes)	None conducted
Tomko, Bountress, and Gray (2016; systematic review)	Differential effectiveness evaluation of two or more treatments for alcohol, tobacco, and other drug use disorders, based on pre-treatment impulsivity, sensation seeking, or related constructs; 9 (<i>N</i> = 944)	Relapse prevention/ coping planning; Stress management.	Cognitive behavioural therapy; motivational enhancement therapy; external incentives (cash, gift voucher)	Yes	Pharmacotherapies; longer multicomponent interventions (more effective); single-session intervention (less effective)	None conducted

BCT = Behaviour Change Technique. NA = Not available.

Table 5. Interventions features linked to success in trait-based interventions.

Intervention features	/ Reviews (%)
Counselling/therapy	5 (83.33%)
Stress-management ^a	4 (66.66%)
Self-control/ impulsivity training ^a	4 (66.66%)
Developmentally/age adapted intervention	3 (50%)
Information provision	3 (50%)
Goal-setting ^a	2 (33.33%)
Self-monitoring ^a	2 (33.33%)
Tailored to high-risk trait	2 (33.33%)
School setting	2 (33.33%)
Home setting	2 (33.33%)
Group modality	2 (33.33%)
Individual modality	2 (33.33%)
High frequency	2 (33.33%)
Brief duration	2 (33.33%)
Combining BCTs	2 (33.33%)
Phone assisted	1 (16.66%)
Email assisted	1 (16.66%)
Culturally adapted	1 (16.66%)
Poor executive control in the onset of intervention	1 (16.66%)
Lower SES	1 (16.66%)
Increasing difficulty of tasks	1 (16.66%)
Community setting	1 (16.66%)
Computerised delivery	1 (16.66%)
Agent delivery	1 (16.66%)
Formative research with high-risk population	1 (16.66%)
Contextual cues utilisation	1 (16.66%)
Small number of recipients	1 (16.66%)
Long intervention	1 (16.66%)
Pharmacotherapy	1 (16.66%)
External incentives (cash, gift vouchers)	1 (16.66%)
Play/game tasks	1 (16.66%)
Exercise	1 (16.66%)
Skills-training	1 (16.66%)
Barrier identification/ problem solving ^a	1 (16.66%)
Action planning ^a	1 (16.66%)
Message sensation value (attention getting and arousal enhancing mechanism) ^a	1 (16.66%)
Relapse prevention/ coping planning ^a	1 (16.66%)

^aA BCT logically linked to self-regulation.

We compared and contrasted information from evidence syntheses of various designs that conceptualised self-regulation from social-cognitive (more ‘conscious’; premediated) and trait (more inherent; dispositional) perspectives. We conducted a nested meta-review, including a smaller-scale meta-review—results from evidence syntheses of trait self-regulation studies—to supplement a larger-scale meta-review (evidence syntheses of social-cognitive self-regulation studies). Nesting two data types yielded well-rounded and comprehensive information that would not have been afforded by one data type alone. The evidence was content-analysed. To our knowledge, this meta-review is the first to combine intervention evidence from social-cognitive and trait approaches to self-regulation, using a ‘nested’ strategy. In our discussion we focus on the areas of corroborating evidence across all reviews, and then indicate where reviews diverged. Finally, we offer *post hoc* interpretations of these findings and suggest for key future directions in practice and research.

Risk-taking reduction was a function of specific intervention design features, BCTs, recipient features and context-relevant features. Design features and BCTs appeared more prominently (co-occurring more frequently) in the evidence syntheses, suggesting that a rigorous design and BCTs that address specific mechanisms of behaviour appear paramount for intervention success. Design features most prominently associated with reduced risk-taking across all behavioural domains (i.e., in at least two reviews) included: combining intervention components (employing

Table 6. Categorisation matrix for trait-based evidence syntheses: Emerging categories and frequency and co-occurrence of intervention features that were tested and found to be linked to risk reduction in reverse order of feature frequency.

	Study Features		
	Design (Co-occurrence: 20)	Recipient (Co-occurrence: 8)	Context (Co-occurrence: 6)
Behaviour change techniques (BCTs) (Co-occurrence: 27)			
Counselling/therapy (5)	Group modality (2)	Tailored to developmental/age period (3)	School setting (2)
Stress-management ^a (4)	Individual modality (2)	Tailored to traits predisposing participants to risk-taking (2)	Home setting (2)
Self-control/impulsivity training ^a (4)	High frequency (2)	Tailored to culture (1)	Community setting (1)
Information provision (3)	Brief duration (2)	Poor executive control at the onset of intervention (1)	Contextual cues utilisation (1)
Goal-setting ^a (2)	Combining BCTs (2)	Lower socioeconomic status (1)	
Self-monitoring ^a (2)	Phone assisted (1)		
Play/game activities (1)	Email assisted (1)		
Exercise (1)	Increasing difficulty of tasks (1)		
Skills training (1)	Computerised delivery (1)		
Barrier identification/problem solving ^a (1)	Agent delivery (1)		
Action planning ^a (1)	Formative research with target population (1)		
Delivering messages with a sensational value (attention-getting and arousal-enhancing mechanisms) ^a (1)	Small number of recipients (1)		
Relapse prevention/coping planning ^a (1)	Long intervention (1)		
	Pharmacotherapy (1)		
	External incentives (cash, gift vouchers) (1)		

Notes: Numbers in parentheses show the / of meta-analyses in which a feature appears, indicating feature frequency. Co-occurrence values show how many times a feature appears across meta-analyses, indicating feature prominence.

^aA BCT logically linked to self-regulation.

multiple BCTs while also taking recipient and contextual characteristics into account); choosing any delivery modality (group, family, one-on-one, computer); incorporating screening and pharmacotherapy; targeting only one risk-taking behaviour; and opting for brief yet high frequency sessions. Of these, multi-component designs; group, individual, computer, and one-on-one modalities; screening and pharmacotherapy; and targeting only one behaviour were utilised by higher quality studies (satisfying at least 50% of AMSTAR 2 criteria). BCTs most prominently associated with reduced risk-taking included: information and personalised feedback provision; various forms of counselling and therapy, stress-management techniques; skills-training; barrier identification and problem solving; adjusting social norms/ providing opportunities for social comparisons; engaging in general discussion; goal-setting; self-monitoring; and self-control and impulsivity training; and identification of high-risk situations. Of these, personalised feedback provision, counselling, skills training, barrier identification and problem solving, and goal setting were utilised in higher quality meta-analyses (Figure 1). Self-regulation techniques most prominently associated with reduced risk-taking included stress-management, self-monitoring, and self-control and impulsivity training.

Recipient and context-relevant features were employed much less frequently in the evidence syntheses, suggesting that these were not considered a priority in intervention design and delivery. Specifically, tailoring to age/developmental period and ethnicity were the recipient parameters most prominently associated with reduced risk-taking. Delivery in home and school settings, as well as incorporating social-support by peers, were the contextual parameters most prominently associated with reduced risk. Tailoring interventions to characteristics predisposing recipients to risk-taking (typically, sensation-seeking and impulsivity) was found to be associated with reduced risk-taking, but, notably, this strategy was utilised only by the interventions working

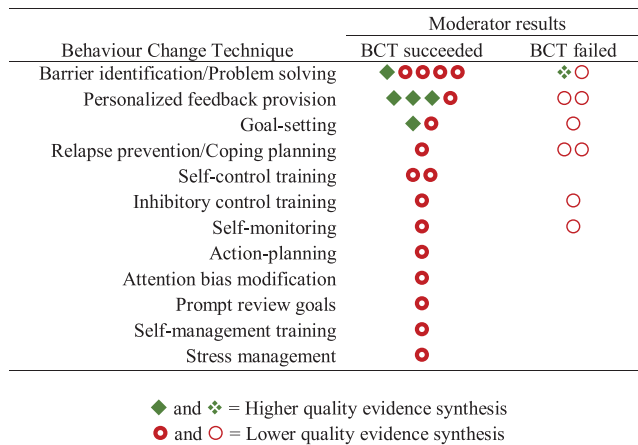


Figure 1. Harvest plot of meta-analytic results for evidence syntheses' moderator tests of behaviour change techniques (BCTs), categorising by success (bold icons) versus failure (unbolded) and categorising high versus low quality meta-analyses (an overall AMSTAR-2 methodological quality score of at least 50%); an absence of type of icon implies no test took place. BCTs are rank-ordered from most evaluated to least evaluated.

from a trait self-regulation perspective. Of the recipient and context-relevant features, tailoring to age and ethnicity, and incorporating peer social support, were features utilised by higher quality meta-analyses.

Condensing the findings further (Table 7), we observe that the intervention features most frequently associated with reduced risk—in the higher quality meta-analyses—include: delivery of multiple components through (either, or a mix of) group, individual, computer, and one-one-one modality; screening and pharmacotherapy, where relevant; targeting only one behavioural outcome; provision of counselling, stress-management, skills-training, self-monitoring, self-control and impulsivity training, and personalised feedback; identification of barriers and 'resolution' of barriers; tailoring to age and ethnicity; and, finally, incorporating social support by peers. We therefore suggest that future interventions prioritise the utilisation of those features. However, additional parameters need to be considered for behavioural change.

Based on these findings, we provide insights and recommendations for future intervention practice and research. These suggestions are informed by our meta-review and present important for future prospective investigations.

Table 7. 'Best practice' intervention features.

Behaviour change techniques (BCTs)	Study features		
	Design	Recipient	Context
Counselling provision	Multi-component intervention	Tailoring to age	Incorporating social support by peers
Stress management	Individual modality	Tailoring to ethnicity	
Skills training	Computer modality		
Self-monitoring	One-on-one modality		
Self-control and impulsivity training	Medical screening		
Personalised feedback	Pharmacotherapy		
Barrier identification	Targeting only one behavioural outcome		
Resolution of barriers			

Notes: Features most prominently associated with reduced risk across all behavioural outcomes in the higher quality reviews (social-cognitive approach). **Boldfaced** features are those discovered by meta-analyses with an overall AMSTAR-2 quality score of at least 50%.

Recommendations for future research

Self-regulation interventions to reduce risk-taking behaviours would benefit from integrating practices from social-cognitive and trait approaches. While interventions from both perspectives have many commonalities in terms of the types of the features employed, none of the social-cognition-driven interventions considered sensation-seeking, trait self-control, and venturesomeness, even though all these affective dispositions have been consistently predictive of virtually all types of risk-taking (de Ridder et al., 2012). One way to utilise these traits in interventions would be to pre-select recipients on the basis of their scores of established psychometric scales (e.g., Sensation Seeking Scales: Zuckerman, 2007; Zuckerman, Eysenck, & Eysenck, 1978; Eysenck's impulsivity, venturesomeness and empathy inventory: Eysenck & Eysenck, 1991; Barratt's Impulsivity Scale: Barratt, 1994). This tack is based on a *specificity hypothesis* (e.g., Morgenstern & McKay, 2007) suggesting that interventions are more likely to be effective when recipients are matched to interventions on the basis on characteristics predisposing them to the condition under investigation. Accordingly, interventions could deliver messages with high sensation value. It has been shown that high-sensation seekers' attention is attracted more by messages that are emotionally powerful, physically arousing, novel, unconventional, fast, and suspenseful (Donohew, Sypher, & Higgins, 2015; Lorch et al., 1994). Intervention content based on these arousing elements is more likely to grab and maintain the attention/ interest of people high in sensation-seeking and impulsivity. For a review and examples of how to design interventions utilising high sensation value messages to reduce risk-taking and promote health, see Xu (2015)) and Zimmerman et al. (2011). Traits predisposing people to risk-taking are assumed to be largely inherent or developed very early in life; for example, new evidence suggests that the overall heritability of self-control is 60% (Willems, Boesen, Li, Finkenauer, & Bartels, 2019). Consequently, at-risk individuals could be identified at an early age, at which time interventions may focus on preventing risk-taking and the associated negative consequences.

Integrating conceptual perspectives, methods, data types, and analytical approaches are practices employed by mixed-methods designs and can have many advantages over single-methods research. Mixed-methods add value by: enhancing the validity and credibility of findings; providing corroborating and complementary evidence; providing a deeper and broader understanding of the phenomenon under investigation; creating 'new' knowledge; and informing research and practice with a high degree of confidence (Hurmerinta-Peltomäki & Nummela, 2006; O'Cathain, Murphy, & Nicholl, 2010; Small, 2011). Based on the above, we argue that integrating intervention components, at minimum utilising BCTs from both social-cognitive and trait self-regulation approaches, would increase the likelihood of intervention success.

Recommendations for clinical practice

The present meta-review also has several implications for clinical practice. First, our results suggest a very broad applicability of self-regulation interventions, highlighting the importance of wide-scale utilisation of these techniques in clinical practice settings. Reviews provide support for these interventions as applied for the prevention or reduction of risk behaviours in the general population, high-risk populations based on some pre-selected variable indicating poor trait self-regulation (e.g., impulsivity, delinquent behaviour), and in the treatment of individuals with conditions characterised by both risk behaviours and poor self-regulation (e.g., substance misuse). Furthermore, substantive support exists for different delivery modalities (e.g., group, individual) and in heterogeneous settings (e.g., school-based, health systems-based). Accordingly, self-regulation interventions can be applied widely in settings in which risk behaviour reduction or prevention is a target health goal.

Second, these results provide several implications for the specific types of self-regulation intervention features most robustly associated with risk behaviour reduction. The most consistent support was provided for interventions that involved multiple techniques or complex, multi-component

treatments (e.g., cognitive-behavioural therapy). Individuals who participate in trials arrive with existing *habits*, which develop as people pursue goals in daily life and which often represent automatic tendencies; such habits may impede the desired behaviour or facilitate it (cf. Johnson et al., 2019; Wood & Neal, 2016). Our impression from reviewing both the social-cognitive and trait-based intervention literature is that scholars have yet to tap the potential of this approach. Nonetheless, one implication of a habit perspective is that, in many and perhaps most instances, the utilisation of a menu of techniques may be the most promising approach for risk behaviour reduction because it will help individuals choose strategies that can best succeed in altering long-held habits. Nonetheless, the stronger effects for multi-component interventions may signal that more complex interventions are necessary to generate genuine change in what is arguably a difficult behaviour to change, given the behaviours targeted in the current samples of meta-analyses. Consider Johnson, Scott-Sheldon, and Carey's (2010) meta-review, which quantitatively pooled effect sizes from 1,011 primary-level psychosocial interventions targeting health behaviours ($N=599,559$); change was, on average, lowest for sexual behaviour, and not much better for addictive behaviours, which comprised the majority of the current samples of meta-analyses.

Moreover, such BCTs as motivational interviewing, self-monitoring, personalised feedback, and perhaps all types of counselling may be particularly appropriate for identifying competing habits and thus addressing resistance to the intervention. A more deliberate focus on habits, both on the part of the systematic review team and on intervention teams, would seem to hold much untapped potential. To date, research has had more of a focus on self-regulation mechanisms than on recipient, or context-specific features, or of interactions of such features with intervention content. This focus may have originated for a wide array of reasons: Historically, psychological theorising was more focused on internal processes than on external factors or contexts. Attempts to reduce risk behaviours also encounter strong habits that persist in part because of environmental cues that were associated with (and frequently rewarding) the risk behaviour in question.

The specific components that had broad support for the reduction of risk behaviour included: goal setting, personalised feedback provision, counselling/therapy, skills training, and barrier identification and problem solving. Although the objective of this meta-review is not to provide an estimate of the magnitude of clinical effects, several general patterns emerge in the meta-analyses included in this review. In general, low-intensity interventions (e.g., informational strategies) exhibit lower effect sizes (small to medium) relative to more intensive interventions (e.g., skills training, contingency management), with were associated with medium to large effect sizes in many studies (e.g., Albarracín, Albarracín, & Durantini, 2008; Chamberlain et al., 2017). Although the magnitude of the effects for lower intensity interventions are somewhat modest, for low-cost interventions that can be implemented on a broad scale even a modest overall effect can have a significant public health impact. Furthermore, many studies reported effect sizes in the medium range, suggesting that there is significant room for improvement in interventions targeting self-regulation. Nonetheless, effect sizes should be interpreted in context, particularly with respect to the comparison condition (e.g., active vs. no intervention control, treatment-as-usual), which varied significantly within and between the meta-analyses included in this review.

An important future direction in this research area is to identify the specific interventions or techniques that may be best fit to a particular individual (i.e., personalised medicine). For example, personalised feedback alone was associated with risk behaviour reduction in some (e.g., Scott-Sheldon et al., 2014), but not all populations (e.g., Ebbert et al., 2015) covered in this meta-review. Thus, when selecting interventions, the individual factors that might impact the effectiveness of an intervention also need to be taken into account.

It is worth noting that none of the meta-analyses in our samples isolated interventions that have taken the innovative Multiphase Optimization Strategy (MOST), which Collins, Murphy, and Strecher (2007) introduced. MOST is inspired by engineering as a framework to optimise the evaluation of behavioural interventions. The strategy is led at the outset by theory and practical considerations, but then it is a data-driven empirical process. Specifically, MOST trials (a) commence with a screening

phase to identify plausible intervention components (e.g., using theory, practical considerations) and then combine them in a full or fractional factorial design; (b) proceed to a refining phase in which components are optimised (e.g., dosage level) and again confirmed with a factorial design; and (c), finally are confirmed as effective using a final RCT. If the process fails during any of these sequences, the process returns to the initial step. Those confirmed in the third step are evidence-based, relatively potent interventions that now are ready for wide dissemination. It is important to realise that any intervention may fail when it is translated from efficacy contexts to any given locale, as effectiveness may hinge on factors that were not included in MOST trials, but according to the MOST process, failures would simply re-start the intervention development process. Future meta-analyses of behavioural interventions ought to make sure to set their inclusion criteria broad enough to incorporate such trials.

Finally, these results raise several implications for treatment development. The consistency of findings across heterogeneous settings and populations highlights the potential for self-regulation interventions for complex, multi-problem populations, such as people with co-occurring substance use disorders and chronic health conditions. Self-regulation interventions can be considered trans-diagnostic interventions, which can be leveraged by treatment developers for testing in complex, high-risk populations.

Recommendations for future meta-reviews

Meta-reviews are a new approach to synthesising evidence, with ‘how-to’ guidance still developing (Hennessy & Johnson, *in press*; Hennessy et al., 2019; Hunt, Pollock, Campbell, Estcourt, & Brunton, 2018). Meta-reviews aim to provide a comprehensive but condensed evidence summary of a body of reviews, without merely repeating the methodology undertaken by the reviews (Aromataris et al., 2015). In addition to summarising the existing evidence, meta-reviews highlight the absence of evidence, and can therefore direct the reader to more detailed, fine-grained, material contained in the included reviews and the primary research. Consequently, meta-reviews may serve as the first step for decision-makers in health care and policy development (Worswick et al., 2013). For the present meta-review, we drew from strategies typically employed by extant meta-reviews and available ‘how-to’ recommendations, but further developed a novel design, described as a *nested meta-review*. In a nested meta-review, a smaller-scale meta-review is situated in a larger-scale meta-review. This is along the line of ‘nesting’ strategies employed in mixed-methods designs of primary research (see Small, 2011 for an explication of nesting). We situated data from reviews of interventions espousing a trait self-regulation approach, into data from reviews of interventions espousing a social-cognition approach. We argue that nesting allowed us to meet the overall aims of the meta-review (that is, aims that ‘any’ meta-review would have), while adding depth and nuance afforded by the complementary data source. Overwhelmingly, researchers work from within an epistemology, following a particular theoretical perspective and particular analytical strategy. A (meta)review that only summarises evidence from that one perspective will ultimately be incomplete, reflecting the epistemological ‘biases’ or ‘preferences’ of the researchers who undertook it. We therefore recommend that future meta-reviews adopt a mixed-methods nested approach. As is the case in primary research mixed-methods, nested meta-reviews can provide a more complete understanding of a problem by offering data that have been compared, contrasted, validated, and /or triangulated (also see Creswell & Plano Clark, 2007; Small, 2011).

These recommendations would also apply to meta-analyses of interventions. An additional recommendation for meta-analyses—not directly drawn from our findings but from the included meta-analyses themselves—is that the underlying mechanisms through which BCTs operate be identified and explored. Isolating the links between mechanisms through which BCTs operate and outcomes can allow for enhanced precision of interventions for reducing risk behaviours. We suggest that meta-analyses go beyond identifying associations between self-regulation techniques (e.g., self-control training) and reduced risk-taking. Rather, meta-analyses could also aim, if data

allow, to identify the underlying emotional and cognitive mechanisms through which self-control training reduces risk-taking. Potential mechanisms explaining the impact of self-control training on risk-taking behaviour involve functions such as automaticity, response conflict, and behavioural inhibition, to name a few. The reviews of Gillebaart and de Ridder (2015); Hofmann, Schmeichel, and Baddeley (2012); and Nigg (2017), provide excellent insights into the ways these functions create self-control and self-regulation.

A final suggestion for meta-analyses relates to study quality appraisal. Meta-analyses would benefit from going beyond describing study quality, to employing quality in subgroup and sensitivity analyses (Johnson, Low, & MacDonald, 2015). Specifically, testing how findings might differ as a function of quality, as a function of quality interacting with key antecedents, or, by excluding studies of low quality, will add nuance to the findings and indicate areas for improvement in future meta-analyses.

Limitations and broad 'Remedies'

We acknowledge that the present meta-review has potential limitations, some of which are inherent to the nature of this research design. We discuss these limitations and offer broad remedies.

First, the evidence of a meta-review is twice removed from the primary data, meaning that the findings of a meta-review are not very detailed. Related, the included reviews of the present study focussed on different risk-taking behaviours and utilised a variety of strategies and outcome measures. While meta-reviews ultimately aim to provide a condensed summary of phenomena, distilling information to the 'essentials', we recommend that the included reviews are also read by those interested in finer detail.

Second, compared to the evidence obtained from the social-cognitive perspective, the evidence from the trait self-regulation perspective was limited. Despite the large body of evidence linking traits, especially impulsivity and sensation-seeking, to risk-taking behaviours, few trait-based interventions seem to exist, and similarly, reviews of this perspective are also few. However, we note that we conducted a small-scale scoping meta-review of the evidence from the trait-perspective, indicating that some reviews may have been missed. We argue that a larger-scale evidence synthesis fully covering the trait self-regulation perspective is warranted.

A third limitation refers to the scarcity of information about emotion and emotional regulation. Even though the trait self-regulation approach addressed emotional parameters to a greater degree, both approaches investigated emotion superficially. When emotion was addressed, it was seen as separate to cognition and 'something to be dealt with'; a vulnerability predisposing people to increased risk-taking. However, we argue that positive emotions, such as compassion towards self and others can promote successful regulation of health-related behaviours and overall well-being (Gentile, Sweet, & He, 2019; Kang et al., 2018; Terry & Leary, 2011). People generally want to feel good and will engage in behaviours to maintain and prolong happy states, instead of 'managing' them to reach other goals; a process known as 'savouring' (Bryant, Chadwick, & Kluwe, 2011) that logically translates into stronger habits in relation to repeated behaviours (Johnson et al., 2019; Wood & Neal, 2007, 2016). Also, emotional goals and emotional regulation has been found to vary as a function of age (Scheibe, English, Tsai, & Carstensen, 2013), with 'curvilinear' trajectories of emotional goals being put forth, whereby emotional goals are overpowering throughout infancy and childhood, less prominent during adolescence and adulthood, and prominent again later in life (Carstensen, Fung, & Charles, 2003; Löckenhoff & Carstensen, 2004; Mikulincer, Shaver, & Pereg, 2003). We also argue that not focussing on emotion, including positive emotion, is not in accordance with definitions of self-regulation. For example, Moilanen (2007) defines self-regulation as '... the ability to flexibly activate, monitor, inhibit, persevere and/or adapt one's behavior, attention, emotions and cognitive strategies in response to direction from internal cues, environmental stimuli and feedback from others, in an attempt to attain personally-relevant goals' (p. 835). This background suggests that emotion is an integral and not necessarily a disruptive influence on self-

regulation. Therefore, the absence of evidence in relation to positive emotions and emotional regulation is a limitation of the present meta-review, and we hope to see emotion being fleshed out in future work.

A fourth potential limitation refers to study quality. Only a small number of reviews from the social-cognitive perspective were classed as of acceptable quality based on the AMSTAR 2 quality tool, indicating unclear or questionable quality across the meta-analyses. This trend notwithstanding, we approach the quality assessments with caution, for two reasons. First, AMSTAR 2 was developed to critically appraise controlled trials in biomedical and public health research, which tend not to focus on psychological mechanisms; moreover, the AMSTAR 2 team did no validity checks within health psychology *per se*. Thus, it is possible that the tool may not be ideal for psychological interventions. For example, the AMSTAR 2 has no item that focuses on the mediation of intervention effects on the ultimate outcome variable, and with the current meta-review, this question is of key importance. Hennessy et al.'s ([in press](#)) meta-review found relatively few meta-analyses that directly evaluated self-evaluative dimensions as mediators of intervention efficacy, and therefore they were left with the relatively indirect strategy of focusing on the BCTs evaluated across the meta-analyses in the sample. Their conclusions as well as the conclusions of the current meta-reviews are also relatively indirect. Moreover, the practice of appraising psychological research with tools that have not been specifically developed for psychological research has been criticised (Protogerou & Hagger, 2019). Similarly, the applicability and utility of the AMSTAR (the predecessor of AMSTAR 2) in studies outside of its original scope has been questioned (e.g., Pieper, Koensgen, Breuing, Ge, & Wegewitz, 2018). Moreover, scholars have concluded that all-too-little is known about what impacts possible methodological defects may have on the results that studies yield (see Johnson et al., 2015; Valentine, 2009); the same point may be levelled at methodological quality inventories of meta-analyses and systematic reviews. Future methodological quality inventories could even evaluate the rigour of particular methods (e.g., the use of prospective vs. retrospective designs), not merely the broad issues that have been salient to the developers of the AMSTAR inventories, who were not, after all, health psychologists. As well, surely, future meta-analyses could look much more carefully for mechanisms. Additionally, the results of our review identify an important gap in the extant literature, as the majority of intervention features were examined only in single meta-analyses (see [Table 2](#)). This factor limits our ability to draw clear conclusions regarding these interventions, particularly using a meta-review methodology rather than, say, a new original meta-analysis. The broader investigation of these intervention components across additional populations, settings, and target behaviours is an important future direction in this area.

Finally, we note that two out of the three authors of the present meta-review have been trained in social-cognitive traditions and have generally been conducting research only within those traditions. In addition, two out of the three authors have almost exclusively conducted evidence syntheses that are quantitative in nature. There was therefore, potential 'social-cognitive bias' or 'quantitative bias' in the present meta-review, reflected in the more extensive focus on the social-cognitive evidence that were meta-analyses. Being cognisant of this possible concern, we minimised bias by supplementing evidence from trait self-regulation reviews of various designs, and by approaching the data qualitatively and quantitatively.

Conclusions

Behaviour change interventions targeting self-regulation mechanisms can prevent or reduce risk-taking behaviours in both the general population and in high-risk populations characterised by poor trait self-regulation or conditions in which risk behaviours are common (e.g., substance misuse). While a plethora of intervention features are implicated in reduced risk-taking, features most frequently associated with reduced risk-taking in evidence syntheses of higher quality, include: delivery of multiple components through (either, or a mix of) group, individual, computer, or one-on-one delivery modality; screening and pharmacotherapy, where relevant; targeting only

one behavioural outcome; provision of counselling, stress-management, skills-training, self-monitoring, self-control and impulsivity training, and personalised feedback; identification of barriers and 'resolution' of barriers; tailoring to age and ethnicity; and, also, incorporating social support by peers.

Note

1. *Prominence* is the frequency with which a given feature is associated with reduced risk-taking in the studies.

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References

(*Asterisked citations were included in the sample of reviews.)

- *Albarracín, J., Albarracín, D., & Durantini, M. (2008). Effects of HIV-prevention interventions for samples with higher and lower percents of Latinos and Latin Americans: A meta-analysis of change in condom use and knowledge. *AIDS and Behavior*, 12, 521–543. doi:10.1007/s10461-007-9209-8
- *Allom, V., Mullan, B., & Hagger, M. (2016). Does inhibitory control training improve health behaviour? A meta-analysis. *Health Psychology Review*, 10, 1–38. doi:10.1080/17437199.2015.1051078.
- Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, 8, 19–32. doi:10.1080/1364557032000119616
- Aromataris, E., Fernandez, R., Godfrey, C. M., Holly, C., Khalil, H., & Tungpunkom, P. (2015). Summarizing systematic reviews: Methodological development, conduct and reporting of an umbrella review approach. *International Journal of Evidence-Based Healthcare*, 13, 132–140. doi:10.1097/XEB.0000000000000055
- Baker, P. R., Costello, J. T., Dobbins, M. B., & Waters, E. (2014). The benefits and challenges of conducting an overview of systematic reviews in public health: A focus on physical activity. *Journal of Public Health*, 36, 517–521. doi:10.1093/pubmed/dfu050
- Barker, J. M., & Taylor, J. R. (2014). Habitual alcohol seeking: Modeling the transition from casual drinking to addiction. *Neuroscience & Biobehavioral Reviews*, 47, 281–294. doi:10.1016/j.neubiorev.2014.08.012
- Barratt, E. S. (1994). Impulsiveness and aggression. In J. Monahan & H. Steadman (Eds.), *Violence and mental disorder: Developments in risk assessment* (pp. 61–79). Chicago, IL: University of Chicago Press.
- *Bartlett, Y. K., Sheeran, P., & Hawley, M. S. (2014). Effective behaviour change techniques in smoking cessation interventions for people with chronic obstructive pulmonary disease: A meta-analysis. *British Journal of Health Psychology*, 19, 181–203. doi:10.1111/bjhp.12071
- Bastian, H., Glasziou, P., & Chalmers, I. (2010). Seventy-five trials and eleven systematic reviews a day: How will we ever keep up? *PLoS Medicine*, 7, e1000326.
- Baumeister, R. F., & Vonnasch, A. J. (2015). Uses of self-regulation to facilitate and restrain addictive behavior. *Addictive Behaviors*, 44, 3–8. doi:10.1016/j.addbeh.2014.09.011
- Belloc, N. B., & Breslow, L. (1972). Relationship of physical health status and health practices. *Preventive Medicine*, 1, 409–421. doi:10.1016/0091-7435(72)90014-X
- Blaxter, M. (1990). *Health and lifestyles*. London: Routledge.
- Bryant, F. B., Chadwick, E. D., & Kluewe, K. (2011). Understanding the processes that regulate positive emotional experience: Unsolved problems and future directions for theory and research on savoring. *International Journal of Wellbeing*, 1, 107–126. doi:10.5502/ijw.v1i1.18
- Carstensen, L. L., Fung, H. H., & Charles, S. T. (2003). Socioemotional selectivity theory and emotion regulation in the second half of life. *Motivation and Emotion*, 27, 103–123. doi:10.1023/A:1024569803230
- *Chamberlain, C., O'Mara-Eves, A., Porter, J., Coleman, T., Perlen, S. M., Thomas, J., & McKenzie, J. E. (2017). Psychosocial interventions for supporting women to stop smoking in pregnancy. *Cochrane Database of Systematic Reviews*, 10, CD001055. doi:10.1002/14651858.CD001055.pub4

- Collins, L. M., Murphy, S. A., & Strecher, V. (2007). The multiphase optimization strategy (MOST) and the sequential multiple assignment randomized trial (SMART): New methods for more potent eHealth interventions. *American Journal of Preventive Medicine*, 32(5), S112–S118.
- Conrod, P. J. (2016). Personality-targeted interventions for substance use and misuse. *Current Addiction Reports*, 3, 426–436. doi:10.1007/s40429-016- 0127-6
- *Conrod, P. J. (2016). Personality-targeted interventions for substance use and misuse. *Current Addiction Reports*, 3, 426–436. doi:10.1007/s40429-016-0127-6
- Cooper, H., & Koenka, A. C. (2012). The overview of reviews: Unique challenges and opportunities when research syntheses are the principal elements of new integrative scholarship. *American Psychologist*, 67(6), 446–462.
- Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage.
- *Cristea, I. A., Kok, R. N., & Cuijpers, P. (2016). The effectiveness of cognitive bias modification interventions for substance addictions: A meta-analysis. *PLoS ONE*, 11, e0162226. doi:10.1371/journal.pone.0162226
- Cutler, D. M. (2004). Behavioral health interventions: What works and why. In N. B. Anderson, R. A. Bulatao, & B. Cohen (Eds.), *Critical perspectives on racial and ethnic differences in health in late life* (pp. 643–674). Washington, DC: The National Academic Press.
- de Ridder, D. T., & de Wit, J. B. F. (2006). Self-regulation in health behavior: Concepts, theories, and central issues. In D. T. de Ridder & J. B. F. de Wit (Eds.), *Self-regulation in health behavior* (1st, pp. 1–24). Chichester: John Wiley & Sons Ltd.
- 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
- Diamond, L. M., & Aspinwall, L. G. (2003). Emotion regulation across the life span: An integrative perspective emphasizing self-regulation, positive affect, and dyadic processes. *Motivation and Emotion*, 27, 125–156. doi:10.1023/A:1024521920068
- *Diamond, A., & Lee, K. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, 333, 959–964. doi:10.1126/science.1204529
- Donohew, L., Sypher, H. E., & Higgins, E. T. (2015). *Communication, social cognition, and affect (PLE: Emotion)*. London and New York: Psychology Press.
- Ebbert, J., Montori, V. M., Vickers-Douglas, K. S., Erwin, P. C., Dale, L. C., & Stead, L. F. (2007). Interventions for smokeless tobacco use cessation. *Cochrane Database of Systematic Reviews*, 4, CD004306. doi:10.1002/14651858.CD004306.pub3
- *Ebbert, J. O., Elrashidi, M. Y., & Stead, L. F. (2015). Interventions for smokeless tobacco use cessation. *Cochrane Database of Systematic Reviews*, 10, CD004306. doi:10.1002/14651858.CD004306.pub5
- Effective Public Health Practice Project. (1998). *Quality assessment tool for quantitative studies*. Hamilton, ON: Author. Retrieved from <http://www.ephpp.ca/index.html>
- Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, 62, 107–115. doi:10.1111/j.1365-2648.2007.04569.x
- Evans, G. W., Fuller-Rowell, T. E., & Doan, S. N. (2012). Childhood cumulative risk and obesity: The mediating role of self-regulatory ability. *Pediatrics*, 129, e68–e73. doi:10.1542/peds.2010-3647
- Eysenck, H. J., & Eysenck, S. B. G. (1991). *Manual of the Eysenck personality scales (EPS adult)*. Kent: Hodder and Stoughton.
- Fujita, K. (2011). On conceptualizing self-control as more than the effortful inhibition of impulses. *Personality and Social Psychology Review*, 15, 352–366. doi:10.1177/1088868311411165
- Gentile, D. A., Sweet, D. M., & He, L. (2019). Caring for others cares for the self: An experimental test of brief downward social comparison, loving-kindness, and interconnectedness contemplations. *Journal of Happiness Studies*, 1–14. doi:10.1007/s10902-019-00100-2
- Gillebaart, M. (2018). The 'operational' definition of self-control. *Frontiers in Psychology*, 9, 1231. doi:10.3389/fpsyg.2018.01231
- Gillebaart, M., & de Ridder, D. T. (2015). Effortless self-control: A novel perspective on response conflict strategies in trait self-control. *Social and Personality Psychology Compass*, 9, 88–99. doi:10.1111/spc3.12160
- Hajek, P., Stead, L. F., West, R., Jarvis, M., Hartmann-Boyce, J., & Lancaster, T. (2013). Relapse prevention interventions for smoking cessation. *Cochrane Database of Systematic Reviews*, 8, CD003999. doi:10.1002/14651858.CD003999.pub4
- Hartling, L., Chisholm, A., Thomson, D., & Dryden, D. M. (2012). A descriptive analysis of overviews of reviews published between 2000 and 2011. *PLoS One*, 7, e49667. doi:10.1371/journal.pone.0049667
- Hennessy, E. A., & Johnson, B. T. (in press). Examining overlap of included studies in meta-reviews: Guidance for interpreting the corrected covered area index. *Research Synthesis Methods*.
- Hennessy, E. A., Johnson, B. T., Acabchuk, R. L., McCloskey, K., & Stewart-James, J. (in press). Self-regulation mechanisms in health behaviour change: A systematic meta-review of meta-analyses, 2006–2017. *Health Psychology Review*.
- Hennessy, E. A., Johnson, B. T., & Keenan, C. (2019). Best practice guidelines and essential steps to conduct rigorous and systematic meta-reviews. *Applied Psychology: Health and Well-Being*. doi:10.1111/aphw.12169
- Higgins, J. P., Altman, D. G., Gøtzsche, P. C., Jüni, P., Moher, D., Oxman, A. D., ... Sterne, J. A. C. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *British Medical Journal*, 343, d5928. doi:10.1136/bmj.d5928

- Hofmann, W., Adriaanse, M., Vohs, K. D., & Baumeister, R. F. (2014). Dieting and the self-control of eating in everyday environments: An experience sampling study. *British Journal of Health Psychology*, 19, 523–539. doi:10.1111/bjhp.12053
- Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences*, 16, 174–180. doi:10.1016/j.tics.2012.01.006
- Hsieh, H. F., & Shannon, S. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15, 1277–1288. doi:10.1177/1049732305276687
- Hunt, H., Pollock, A., Campbell, P., Estcourt, L., & Brunton, G. (2018). An introduction to overviews of reviews: Planning a relevant research question and objective for an overview. *Systematic Reviews*, 7, 39. doi:10.1186/s13643-018-0695-8
- Hurmerinta-Peltomäki, L., & Nummela, N. (2006). Mixed methods in international business research: A value-added perspective. *Management International Review*, 46, 439–459. doi:10.1007/s11575-006-0100-z
- Inzlicht, M., Bartholow, B. D., & Hirsh, J. B. (2015). Emotional foundations of cognitive control. *Trends in Cognitive Sciences*, 19, 126–132. doi:10.1016/j.tics.2015.01.004
- Isen, A. M. (2003). Positive affect as a source of human strength. In L. G. Aspinwall & U. M. Staudinger (Eds.), *A psychology of human strengths: Fundamental questions and future directions for a positive psychology* (pp. 179–195). Washington, DC: American Psychological Association. <http://doi.org/10.1037/10566-013>
- Jadad, A. R., Moore, R. A., Carroll, D., Jenkinson, C., Reynolds, D. J., Gavaghan, D. J., & McQuay, H. J. (1996). Assessing the quality of reports of randomized clinical trials: Is blinding necessary? *Controlled Clinical Trials*, 17, 1–12. doi:10.1016/0197-2456(95)00134-4
- Johnson, B. T., & Acabchuk, R. L. (2018). What are the keys to a longer, happier life? Answers from five decades of health psychology research. *Social Science & Medicine*, 196, 218–226. doi:10.1016/j.socscimed.2017.11.001
- Johnson, B. T., Landrum, A. R., & McCloskey, K. (2019). Attitudes in the 21st century: Accomplishments, challenges, and gaps. In D. Albarracín & B. T. Johnson (Eds.), *The handbook of attitudes, volume 1: Basic principles* (pp. 627–652). New York, NY: Routledge.
- Johnson, B. T., Low, R. E., & MacDonald, H. V. (2015). Panning for the gold in health research: Incorporating studies' methodological quality in meta-analysis. *Psychology & Health*, 30, 135–152. doi:10.1080/08870446.2014.953533
- Johnson, B. T., MacDonald, H. V., Bruneau, M. L., Jr., Goldsby, T. U., Brown, J. C., Huedo-Medina, T. B., & Pescatello, L. S. (2014). Methodological quality of meta-analyses on the blood pressure response to exercise: A review. *Journal of Hypertension*, 32, 706–723. doi:10.1097/HJH.0000000000000097
- Johnson, B. T., Redding, C. A., DiClemente, R. J., Mustanski, B. S., Dodge, B., Sheeran, P., ... Carey, M. P. (2010). A network-individual-resource model for HIV prevention. *AIDS and Behavior*, 14(2), 204–221.
- Johnson, B. T., Scott-Sheldon, L. A., & Carey, M. P. (2010). Meta-synthesis of health behavior change meta-analyses. *American Journal of Public Health*, 100(11), 2193–2198.
- Kang, Y., Cooper, N., Pandey, P., Scholz, C., O'Donnell, M. B., Lieberman, M. D., ... Polk, T. A. (2018). Effects of self-transcendence on neural responses to persuasive messages and health behavior change. *Proceedings of the National Academy of Sciences*, 115, 9974–9979. doi:10.1073/pnas.1805573115
- Kvaavik, E., Batty, G. D., Ursin, G., Huxley, R., & Gale, C. R. (2010). Influence of individual and combined health behaviors on total and cause-specific mortality in men and women: The United Kingdom health and lifestyle survey. *Archives of Internal Medicine*, 170, 711–718. doi:10.1001/archinternmed.2010.76
- Kwasnicka, D., Dombrowski, S. U., White, M., & Sniehotka, F. (2016). Theoretical explanations for maintenance of behaviour change: A systematic review of behaviour theories. *Health Psychology Review*, 10, 277–296. doi:10.1080/17437199.2016.1151372
- Lerner, R. M., Lerner, J. V., Bowers, E. P., Lewin-Bizan, S., Gestsdottir, S., & Urban, J. B. (2011). Self-regulation processes and thriving in childhood and adolescence: A view of the issues. *New Directions for Child and Adolescent Development*, 133, 1–9. doi:10.1002/cd.300
- Lieberman, E. S. (2005). Nested analysis as a mixed-method strategy for comparative research. *American Political Science Review*, 99, 435–452. doi:10.1017/S0003055405051762
- Löckenhoff, C. E., & Carstensen, L. L. (2004). Socioemotional selectivity theory, aging, and health: The increasingly delicate balance between regulating emotions and making tough choices. *Journal of Personality*, 72, 1395–1424. doi:10.1111/j.1467-6494.2004.00301.x
- Lopez, A. D., Mathers, C. D., Ezzati, M., Jamison, D. T., & Murray, C. J. (2006). *Global burden of disease and risk factors*. The World Bank. doi:10.1596/978-0-8213-6262-4
- Lorch, E. P., Palmgreen, P., Donohew, L., Helm, D., Baer, S. A., & Dsilva, M. U. (1994). Program context, sensation seeking, and attention to televised anti-drug public service announcements. *Human Communication Research*, 20, 390–412. doi:10.1111/j.1468-2958.1994.tb00328.x
- MacPherson, L., Reynolds, E. K., Daughters, S. B., Wang, F., Cassidy, J., Mayes, L. C., & Lejuez, C. W. (2010). Positive and negative reinforcement underlying risk behavior in early adolescents. *Prevention Science*, 11, 331–342. doi:10.1007/s11121-010-0172-7
- Mays, N., Roberts, E., & Popay, J. (2001). Synthesising research evidence. In F. Naomi, P. Allen, A. Clark, & N. Black (Eds.), *Studying the organisation and delivery of health services: Research methods* (pp. 188–220). London and New York, NY: Routledge.

- Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., ... Wood, C. E. (2013). The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behaviour change interventions. *Annals of Behavioral Medicine*, 46, 81–95. doi:10.1007/s12160-013-9486-6
- Mikulincer, M., Shaver, P. R., & Pereg, D. (2003). Attachment theory and affect regulation: The dynamics, development, and cognitive consequences of attachment-related strategies. *Motivation and Emotion*, 27, 77–102. doi:10.1023/A:1024515519160
- Miller, W. R., Brown, J. M., Simpson, T. L., Handmaker, N. S., Bien, T. H., & Luckie, L. F. (1995). What works? A methodological analysis of the alcohol treatment outcome literature. In R. K. Hester & W. R. Miller (Eds.), *Handbook of alcoholism treatment approaches: Effective alternatives* (2nd ed., pp. 12–44). Needham Heights, MA: Allyn & Bacon.
- Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., ... Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*, 108, 2693–2698. doi:10.1073/pnas.1010076108
- Moilanen, K. L. (2007). The adolescent self-regulatory inventory: The development and validation of a questionnaire of short-term and long-term self-regulation. *Journal of Youth and Adolescence*, 36, 835–848. doi:10.1007/s10964-006-9107-9
- Moilanen, K. L. (2015). Short-and long-term self-regulation and sexual risk-taking behaviors in unmarried heterosexual young adults. *The Journal of Sex Research*, 52, 758–769. doi:10.1080/00224499.2014.959881
- Morgenstern, J., & McKay, J. R. (2007). Rethinking the paradigms that inform behavioral treatment research for substance use disorders. *Addiction*, 102, 1377–1389. doi:10.1111/j.1360-0443.2007.01882.x
- Nigg, J. T. (2017). Annual research review: On the relations among self-regulation, self-control, executive functioning, effortful control, cognitive control, impulsivity, risk-taking, and inhibition for developmental psychopathology. *Journal of Child Psychology and Psychiatry*, 58, 361–383. doi:10.1111/jcpp.12675
- O’Cathain, A., Murphy, E., & Nicholl, J. (2010). Three techniques for integrating data in mixed methods studies. *British Medical Journal*, 314, 1147–1150. doi:10.1136/bmj.c4587
- Onrust, S. A., Otten, R., Lammers, J., & Smit, F. (2016). School-based programmes to reduce and prevent substance use in different age groups: What works for whom? Systematic review and meta-regression analysis. *Clinical Psychology Review*, 44, 45–59. doi:10.1016/j.cpr.2015.11.002
- Page, M. J., Shamseer, L., Altman, D. G., Tetzlaff, J., Sampson, M., Tricco, A. C., ... Moher, D. (2016). Epidemiology and reporting characteristics of systematic reviews of biomedical research: A cross-sectional study. *PLoS Medicine*, 13. doi:10.1371/journal.pmed.1002028
- Palmgreen, P., Donohew, L., Lorch, E. P., Hoyle, R. H., & Stephenson, M. T. (2001). Television campaigns and adolescent marijuana use: Tests of sensation seeking targeting. *American Journal of Public Health*, 91, 292–296.
- Panther-Brick, C., Clarke, S. E., Lomas, H., Pinder, M., & Lindsay, S. W. (2006). Culturally compelling strategies for behaviour change: A social ecology model and case study in malaria prevention. *Social Science & Medicine*, 62, 2810–2825. doi:10.1016/j.socscimed.2005.10.009
- Pieper, D., Koensgen, N., Breuing, J., Ge, L., & Wegewitz, U. (2018). How is AMSTAR applied by authors—a call for better reporting. *BMC Medical Research Methodology*, 18, 56. doi:10.1186/s12874-018-0520-z
- *Piquero, A. R., Jennings, W. G., Farrington, D. P., Diamond, B., & Gonzalez, J. M. R. (2016). A meta-analysis update on the effectiveness of early self-control improvement programs to improve self-control and reduce delinquency. *Journal of Experimental Criminology*, 12, 249–264. doi:10.1007/s11292-016-9257-z
- Protogerou, C., Fleeman, N., Dwan, K., Richardson, M., Dundar, Y., & Hagger, M. S. (2015). Moderators of the effect of psychological interventions on depression and anxiety in cardiac surgery patients: A systematic review and meta-analysis. *Behaviour Research and Therapy*, 73, 151–164. doi:10.1016/j.brat.2015.08.004
- Protogerou, C., & Hagger, M. S. (2017). Developing an integrated theoretical model of young peoples’ condom use in sub-Saharan Africa. *Australian Journal of Psychology*, 69, 130–148. doi:10.1111/ajpy.12127
- Protogerou, C., & Hagger, M. S. (2019). A case for a study quality appraisal in survey studies in psychology. *Frontiers in Psychology*, 9, 2788. doi:10.3389/fpsyg.2018.02788
- Protogerou, C., & Johnson, B. T. (2014). Factors underlying the success of behavioral HIV-prevention interventions for adolescents: A meta-review. *AIDS and Behavior*, 18, 1847–1863. doi:10.1007/s10461-014-0807-y
- Rothman, A. J., Gollwitzer, P. M., Grant, A. M., Neal, D. T., Sheeran, P., & Wood, W. (2015). Hale and hearty policies: How psychological science can create and maintain healthy habits. *Perspectives on Psychological Science*, 10, 701–705. doi:10.1177/1745691615598515
- Sandelowski, M. (1993). Theory unmasked: The uses and guises of theory in qualitative research. *Research in Nursing & Health*, 16, 213–218. doi:10.1002/nur.4770160308
- Scheibe, S., English, T., Tsai, J. L., & Carstensen, L. L. (2013). Striving to feel good: Ideal affect, actual affect, and their correspondence across adulthood. *Psychology and Aging*, 28, 160–171. doi:10.1037/a0030561
- Schuit, A. J., van Loon, A. J. M., Tijhuis, M., & Ocké, M. C. (2002). Clustering of lifestyle risk factors in a general adult population. *Preventive Medicine*, 35, 219–224. doi:10.1006/pmed.2002.1064
- Scott-Sheldon, L. A., Carey, K. B., Elliott, J. C., Garey, L., & Carey, M. P. (2014). Efficacy of alcohol interventions for first-year college students: A meta-analytic review of randomized controlled trials. *Journal of Consulting and Clinical Psychology*, 82, 177–188. doi:10.1037/a0035192

- Shea, B. J., Reeves, B. C., Wells, G., Thuku, M., Hamel, C., Moran, J., ... Henry, D. A. (2017). AMSTAR 2: A critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ*, 358, j4008. doi:10.1136/bmj.j4008
- Silva, D. A., Peres, K. G., Boing, A. F., González-Chica, D. A., & Peres, M. A. (2013). Clustering of risk behaviors for chronic noncommunicable diseases: A population-based study in southern Brazil. *Preventive Medicine*, 56, 20–24. doi:10.1016/j.ypmed.2012.10.022
- Small, M. L. (2011). How to conduct a mixed methods study: Recent trends in a rapidly growing literature. *Annual Review of Sociology*, 37, 57–86. doi:10.1146/annurev.soc.012809.102657
- Song, F., Huttunen-Lenz, M., & Holland, R. (2009). Effectiveness of complex psycho-educational interventions for smoking relapse prevention: An exploratory meta-analysis. *Journal of Public Health*, 32, 350–359. doi:10.1093/pubmed/fdp109
- Spohr, S. A., Nandy, R., Gandhiraj, D., Vemulapalli, A., Anne, S., & Walters, S. T. (2015). Efficacy of SMS text message interventions for smoking cessation: A meta-analysis. *Journal of Substance Abuse Treatment*, 56, 1–10. doi:10.1016/j.jsat.2015.01.011
- St. Amand, A., Bard, D. E., & Silovsky, J. F. (2008). Meta-analysis of treatment for child sexual behavior problems: Practice elements and outcomes. *Child Maltreatment*, 13, 145–166. doi:10.1177/1077559508315353
- *Stautz, K., Zupan, Z., Field, M., & Marteau, T. M. (2018). Does self-control modify the impact of interventions to change alcohol, tobacco, and food consumption? A systematic review. *Health Psychology Review*, 12, 157–178. doi:10.1080/17437199.2017.1421477
- Sutton, S. (2004). Determinants of health-related behaviours: Theoretical and methodological issues. In S. Sutton, A. Baum, & M. Johnston (Eds.), *Handbook of health psychology* (pp. 94–126). London: Sage.
- Tanner-Smith, E. E., & Lipsey, M. W. (2015). Brief alcohol interventions for adolescents and young adults: A systematic review and meta-analysis. *Journal of Substance Abuse Treatment*, 51, 1–18. doi:10.1016/j.jsat.2014.09.001
- Tanner-Smith, E. E., Steinka-Fry, K. T., Hennessy, E. A., Lipsey, M. W., & Winters, K. C. (2015). Can brief alcohol interventions for youth also address concurrent illicit drug use? Results from a meta-analysis. *Journal of Youth and Adolescence*, 44, 1011–1023. doi:10.1007/s10964-015-0252-x
- Terry, M. L., & Leary, M. R. (2011). Self-compassion, self-regulation, and health. *Self and Identity*, 10, 352–362. doi:10.1080/15298868.2011.558404
- *Tomko, R. L., Bountress, K. E., & Gray, K. M. (2016). Personalizing substance use treatment based on pre-treatment impulsivity and sensation seeking: A review. *Drug and Alcohol Dependence*, 167, 1–7. doi:10.1016/j.drugalcdep.2016.07.022
- Trimpop, R. M. (1994). *The psychology of risk taking behavior*. North-Holland, Amsterdam: Elsevier.
- Tugade, M. M., & Fredrickson, B. L. (2007). Regulation of positive emotions: Emotion regulation strategies that promote resilience. *Journal of Happiness Studies*, 8, 311–333. doi:10.1007/s10902-006-9015-4
- Tyson, M., Covey, J., & Rosenthal, H. E. (2014). Theory of planned behavior interventions for reducing heterosexual risk behaviors: A meta-analysis. *Health Psychology*, 33, 1454. doi:10.1037/hea0000047
- Valentine, J. C. (2009). Judging the quality of primary research. In H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.), *Handbook of research synthesis and meta-analysis* (2nd ed., pp. 129–146). New York, NY: Russell Sage Foundation.
- Verhagen, A. P., de Vet, H. C. W., de Bie, R. A., Kessels, A. G. H., Boers, M., Bouter, L. M., & Knipschild, P. G. (1998). The delphi list: A criteria list for quality assessment of randomized clinical trials for conducting systematic reviews developed by delphi consensus. *Journal of Clinical Epidemiology*, 51, 1235–1241. doi:10.1016/s0895-4356(98)00131-0
- Weir, M. C., Grimshaw, J. M., Mayhew, A., & Fergusson, D. (2012). Decisions about lumping vs. Splitting of the scope of systematic reviews of complex interventions are not well justified: A case study in systematic reviews of health care professional reminders. *Journal of Clinical Epidemiology*, 65, 756–763. doi:10.1016/j.jclinepi.2011.12.012
- Willems, Y. E., Boesen, N., Li, J., Finkenauer, C., & Bartels, M. (2019). The heritability of self-control: A meta-analysis. *Neuroscience & Biobehavioral Reviews*. doi:10.1016/j.neubiorev.2019.02.012
- Wood, W., & Neal, D. T. (2007). A new look at habits and the habit-goal interface. *Psychological Review*, 114, 843–863.
- Wood, W., & Neal, D. T. (2016). Healthy through habit: Interventions for initiating & maintaining health behavior change. *Behavioral Science & Policy*, 2, 71–83. doi:10.1353/bsp.2016.0008
- Worswick, J., Wayne, S. C., Bennett, R., Fiander, M., Mayhew, A., Weir, M. C., ... Grimshaw, J. M. (2013). Improving quality of care for persons with diabetes: An overview of systematic reviews-what does the evidence tell us? *Systematic Reviews*, 2, 26. doi:10.1186/2046-4053-2-26
- Xu, J. (2015). Designing messages with high sensation value: when activation meets reactance. *Psychology & Health*, 30, 423–440. doi:10.1080/08870446.2014.977280
- Zimmerman, R. S., Donohew, R. L., Palmgreen, P., Noar, S., Cupp, P. K., & Floyd, B. (2011). Designing media and classroom interventions targeting high sensation seeking or impulsive adolescents to prevent drug abuse and risky sexual behavior. In M. T. Bardo, D. H. Fishbein, & R. Milich (Eds.), *Inhibitory control and drug abuse prevention* (pp. 263–280). New York, NY: Springer.
- Zuckerman, M. (2007). *Sensation seeking and risky behavior*. Washington, DC: American Psychological Association.
- Zuckerman, M., Eysenck, S. B. G., & Eysenck, H. J. (1978). Sensation seeking in Europe and America: Cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology*, 46, 139–149. doi:10.1037/0022-006X.46.1.139