



Mental Contrasting for Health Behaviour Change: a Systematic Review and Meta-analysis of Effects and Moderator Variables

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Abstract:	<p>Mental contrasting is a self-regulation imagery strategy that involves imagining a desired future and mentally contrasting it with the present reality, which is assumed to prompt the individual to realise that action is required to achieve the desired future (Oettingen et al., 1997, 2000 and Oettingen, 2012). Recent research has combined mental contrasting with implementation intentions (MCII) ("if-then" plans; Oettingen & Gollwitzer, 2010; Oettingen, 2012), which is hypothesised to strengthen the effects. A systematic review (PROSPERO reference: CRD42016034202) with meta-analysis was conducted to evaluate the effectiveness of mental contrasting for improving health-related behaviours in adult populations, compared with control and active control groups. Searches identified twelve studies ($n = 1528$) reporting mental contrasting techniques for promoting healthy behaviours (e.g. increasing physical activity or fruit and vegetable intake) and reducing unhealthy behaviours (e.g. smoking, unhealthy snacking) across clinical, student and general populations. A meta-analysis using random effects modelling found a main effect of mental contrasting on health outcomes, adjusted Hedges' $g = 0.28$ (SE .07), 95% CI [0.13-0.43], $p < 0.001$ at up to four weeks, and an increased effect at up to three months ($k = 5$) with adjusted Hedges' $g = 0.38$ (SE 0.6), CI [0.20-0.55], $p < 0.001$. The combination of mental contrasting with implementation intentions (MCII; $k = 7$) showed a similar effect, $g = 0.28$, CI [0.14-0.42], $p < 0.001$, which did not differ from mental contrasting alone interventions ($k = 5$), 0.27, CI [0.12-0.41], $p < 0.001$. Mental contrasting shows promise as a brief behaviour change strategy with a significant small to moderate-</p>

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	sized effect on changing health behaviour in the short-term. The benefits of mental contrasting appear to be sustained over time. Analysis on a small subset of studies suggested that the addition of implementation intentions (MCII) did not further strengthen the effects of mental contrasting on health behaviours, although additional studies are needed to verify this and to establish further mediator variables.



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MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

Abstract

Mental contrasting is a self-regulation imagery strategy that involves imagining a desired future and **mentally** contrasting it with the present reality, which is assumed to prompt the individual to realise that action is required to achieve the desired future (Oettingen et al., 1997, 2000 and Oettingen, 2012). Recent research has combined mental contrasting with implementation intentions (MCII) (“if-then” plans; Oettingen & Gollwitzer, 2010; Oettingen, 2012), which is hypothesised to strengthen the effects. A systematic review (PROSPERO reference: CRD42016034202) with meta-analysis was conducted to evaluate the effectiveness of mental contrasting for improving health-related behaviours in adult populations, compared with control and active control groups. Searches identified twelve studies ($n = 1528$) reporting mental contrasting techniques for promoting healthy behaviours (e.g. increasing physical activity or fruit and vegetable intake) and reducing unhealthy behaviours (e.g. smoking, unhealthy snacking) across clinical, student and general populations. A meta-analysis using random effects modelling found a main effect of mental contrasting on health outcomes, adjusted Hedges’ $g = 0.28$ (SE .07), 95% CI [0.13-0.43], $p < 0.001$ at up to four weeks, and an increased effect at up to three months ($k = 5$) with adjusted Hedges’ $g = 0.38$ (SE 0.6), CI [0.20-0.55], $p < 0.001$. The combination of mental contrasting with implementation intentions (MCII; $k = 7$) showed a similar effect, $g = 0.28$, CI [0.14-0.42], $p < 0.001$, which did not differ from mental contrasting alone interventions ($k = 5$), $g = 0.27$, CI [0.12-0.41], $p < 0.001$. Mental contrasting shows promise as a brief behaviour change strategy with a significant small to moderate-sized effect on changing health behaviour in the short-term. The benefits of mental contrasting appear to be sustained over time. Analysis on a small subset of studies suggested that the addition of implementation intentions (MCII) did not further strengthen the effects of mental contrasting on health

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4 1 behaviours, although additional studies are needed to verify this and to establish further
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6 2 mediator variables.

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9 3 *Keywords:* mental contrasting, MCII, implementation intentions, self-regulation,
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1 MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

4 1 **Introduction**

2 Public health presents pressing challenges for health psychology, due to the rising
3 global prevalence of modifiable behavioural risk factors including obesogenic diets, a lack of
4 exercise and sedentarism, substance use, alcohol consumption, and other behaviours that
5 influence the development of preventable disease or injury (OECD, 2017; WHO, 2015).
6 Additional population challenges come from the growing prevalence of severe chronic
7 physical conditions and the accompanying need for strategies to assist the management of
8 symptoms and demands of illness. The development of effective psychological interventions
9 to promote sustained, self-initiated behaviour and health-related cognition change remain a
10 priority. Self-regulation strategies that could be implemented easily in cost-effective, scalable
11 ways in public health settings afford attractive solutions to clinicians, policy makers and
12 interventionists (NICE, 2014; **Sheeran, Harris, Vaughan, Oettingen & Gollwitzer, 2013**).
13 Among these strategies is mental contrasting, a self-regulation strategy based on imagery of
14 both the desired future and present reality. Mental contrasting involves three steps to trigger
15 active goal pursuit: (1) defining an important wish; (2) **identifying the best outcome of wish**
16 **fulfilment and fantasizing about it (defined as free flowing thoughts and images**
17 **specifying the best possible outcome)** and (3) identifying and subsequently imagining an
18 obstacle in the present reality that stands in the way of obtaining the desired future
19 (Oettingen, 2000; 2012).

20 Mental contrasting's theoretical origins lie in fantasy realization theory (Oettingen,
21 2000; 2012), which proposes mental contrasting as a self-regulation imagery tool for
22 instigating and maintaining behaviour change. Mentally contrasting future thought against the
23 present reality is hypothesised to energise people to realise their fantasies about a desired

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

feasible futures, and to de-energise them from pursuing unfeasible future fantasies (Oettingen, 2000; Oettingen, Pak, & Schnetter, 2001).

Motivational Processes of Mental Contrasting

Positive fantasies have been shown to be experienced in the moment as pleasant by engendering low energy relaxation (H.B. Kappes & Oettingen, 2011) and may also be beneficial in allowing people to focus on their needs through the mental exploration of possible futures (H.B. Kappes et al., 2012). However, there is experimental evidence to suggest that positive fantasies may hinder behaviour change; positive fantasies have been shown to decrease the available energy for addressing challenging situations and obstacles (indexed by systolic blood pressure, SBP) (Oettingen, 2012; H.B. Kappes & Oettingen, 2011; H.B. Kappes, Sharma, & Oettingen, 2013; for a review summary, see Oettingen & Cachia, 2016). Positive fantasies that are not followed by mental contrasting are theorised to result in reduced effort and failure in situations when pursuing the desired feasible future requires employing energy and effort (Oettingen et al., 2009; H.B. Kappes & Oettingen, 2011; Oettingen & Cachia, 2016). Indeed, positive future fantasies have been shown to predict people to behave as though they have already attained the imagined desired future (Oettingen & Mayer, 2002, studies 1-4). Mental contrasting is proposed to enable behaviour change by providing a specific direction via future fantasies; the obstacles enable people to maintain enough energy to obtain the desired future (Oettingen & Cachia, 2016). There is empirical evidence that mentally indulging in imagery about a desired future without performing mental contrasting depletes the energy available to achieve the individual's desired behavior change (for a review summary see Sevincer & Oettingen, 2015). Specifically, mental contrasting is theorised to conserve energy resources, which are hypothesised to permit

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 behavioral flexibility in responding to immediate environmental demands and accomplishing
2 behaviour change goals (Gendolla & Silvestrini, 2015).

3 **Non-Conscious Cognitive Processes**

4 Mental contrasting is theorised to operate through three cognitive non-conscious
5 mechanisms based on a series of experimental findings. Firstly, mental contrasting affords
6 the present reality to be interpreted as an obstacle, particularly where obstacles are perceived
7 as surmountable (A. Kappes, Wendt, Reinelt, & Oettingen, 2013). Mental contrasting also
8 helps individuals to identify other relevant obstacles (A. Kappes et al., 2013). Secondly,
9 mental contrasting has been shown to strengthen the association between the desired future
10 and present reality (A. Kappes & Oettingen, 2014). Participants in a mental contrasting
11 experimental condition demonstrated stronger future-present reality associations when they
12 saw the obstacles as surmountable, compared to insurmountable obstacles. Moreover, the
13 strength of these non-conscious associations predicted the quality of participants'
14 performance. Additionally, using a priming paradigm, mental contrasting strengthened the
15 non-conscious association between the obstacle in the present reality and the instrumental
16 behaviour to overcome the obstacle (A. Kappes, Singmann, & Oettingen, 2012). Again,
17 this effect was predicted by expectations of success; mental contrasting facilitates a strong
18 associative link between the instrumental behaviour and obstacle where expectations of
19 success were high, but not when they were low (A. Kappes, et al., 2013; Cantor, Norem,
20 Niedenthal, Langston, & Brower, 1987; Oettingen et al., 2001).

21 **Mental Contrasting Interventions**

22 There is a growing body of evidence to support the effectiveness of mental
23 contrasting as self-regulation imagery strategy for behaviour change (see review summaries
24 by Oettingen, 2012; Oettingen & Cachia, 2016). Support for mental contrasting as an

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 effective strategy that leads to selective (i.e. expectancy-based) pursuit of desired futures has
2 been replicated in both experimental and intervention studies.

3 **Mental contrasting's effectiveness has been demonstrated with a variety of**
4 **outcomes. These include cognitive (e.g. making plans), affective (e.g. anticipated**
5 **disappointment in the case of failure), motivational (e.g. determination) and**
6 **behavioural (e.g. action initiation) indices. Effectiveness has been demonstrated using**
7 **self-report, observational and experimental methods, with both immediate effects or**
8 **effects lasting several weeks (A. Kappes, et al., 2012; Johannessen, Oettingen, & Mayer,**
9 **2012; Oettingen, 2000; Oettingen, 2001; 2012; Sevincer & Oettingen, 2013).**

10 Mental contrasting's effects also have been observed in a wide variety of life domains
11 and in diverse subject matter. Most of the evidence for mental contrasting comes from the
12 achievement and interpersonal domains; for example, mental contrasting has been found to
13 support the management of everyday life (Oettingen, Mayer, & Brinkmann, 2010), to
14 facilitate integrative bargaining (Kirk, Oettingen, & Gollwitzer, 2011) and to heighten
15 creative performance (Oettingen, Marquardt, & Gollwitzer, 2012). In the health domain,
16 recent evidence supports the effectiveness of mental contrasting as an intervention for
17 promoting health protective behaviours and for managing chronic conditions (Adriaanse,
18 de Ridder, & Voorneman, 2013).

19 **Mental Contrasting with Implementation Intentions (MCII)**

20 More recently, mental contrasting has been combined with implementation intentions
21 (MCII) (Oettingen & Gollwitzer, 2010; Oettingen, 2012). Whilst mental contrasting appears
22 to assist individuals to discriminate between feasible and unfeasible wishes and to build non
23 conscious associative links between the obstacle and the instrumental behaviour to overcome
24 the obstacle (A. Kappes, et al., 2012), even with high expectations of success and strong

1 MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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4 1 goal commitment and achievement, individuals are not always successful in developing
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6 2 effective goal-directed behaviour. Individuals may forget to act, be unaware of suitable
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8 3 actions or become distracted during testing situations (Oettingen, 2012; Oettingen & Cacia,
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10 4 2016). Implementation intentions (Gollwitzer, 1999), also known as ‘if-then plans’, have
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12 5 been proposed as a means to further strengthen the associative link between the obstacle and
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14 6 instrumental behaviour (Oettingen, Sevincer, & Gollwitzer, 2018; Oettingen & Gollwitzer,
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16 7 2018). They are theorised to operate by guiding people to specify the relevant cue (e.g. ‘if I
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18 8 have the urge to snack on chocolate’) and subsequently link cues with appropriate goal-
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20 9 directed responses (e.g. ‘then I will eat a healthier alternative’). By instigating automatic
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22 10 action control when a specific cue-situation (i.e. obstacle) is encountered, there is empirical
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24 11 evidence that implementation intentions are highly effective in fostering goal attainment. The
25
26 12 efficacy of implementation intentions has been confirmed by a meta-analysis of 94 studies
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28 13 indicating a medium to large effect ($d = 0.61$; Gollwitzer & Sheeran, 2006). However, there
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30 14 are pre-requisites for their effectiveness; individuals must be committed to the overarching
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32 15 goal (Sheeran, Webb, & Gollwitzer, 2005), the situation in the ‘if’ part must describe a
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34 16 situation relevant to goal pursuit (e.g. an obstacle) and the behaviour in the ‘then’ part must
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36 17 support goal attainment.

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43 18 The majority of research to date has examined the effects of implementation
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45 19 intentions in which the researchers have guided participants’ ‘if-then’ plans (e.g. Gollwitzer,
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47 20 2014, Gollwitzer & Sheeran, 2006, Armitage, 2004). The strategy could have more far
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49 21 reaching appeal for large scale clinical and public health population research if it could be
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51 22 effectively self-administered. Mental contrasting, when combined with implementation
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53 23 intentions, may provide a solution as it is theoretically considered to facilitate people in
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55 24 identifying the situation for the ‘if’ (obstacle) part of implementation intentions, as well as
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57 25 assisting with identification of the instrumental action for the ‘then’ part of the plan through
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MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 imagery of the obstacle (A. Kappes & Oettingen, 2014; Oettingen & Gollwitzer, 2018). Thus,
2 mental contrasting with implementation intentions (MCII) entails two theoretically
3 complimentary strategies. However, a systematic review is needed to determine whether the
4 effectiveness of mental contrasting alone is greater than, or equal, to that of mental
5 contrasting with implementation intentions.

6 **Mental Contrasting with Implementation Intentions (MCII) Interventions**

7 There is an emerging body of empirical support for the effectiveness of mental
8 contrasting with implementation intentions (MCII) interventions. MCII has been shown to
9 effectively facilitate insights required for integrative bargaining more than either mental
10 contrasting or implementation intentions performed alone (Kirk, Oettingen, & Gollwitzer,
11 2013); it has also been shown to improve time management (Oettingen, H. B. Kappes,
12 Guttenberg, & Gollwitzer, 2015), to foster the effort required to study for a test (Duckworth,
13 Grant, Loew, Oettingen, & Gollwitzer, 2011), to reduce unwanted snacking habits (Adriaanse
14 et al., 2010), to reduce negative relationship behaviour and enhance positive relationship
15 behaviors (Houssais, Oettingen, & Mayer, 2013), to increase online course completion rates
16 in a sample of 17,983 learners (Kizilcec & Cohen, 2017) and to increase couples' initiation of
17 communication about a sensitive topic (Oettingen & Cachia, 2016).

18 **The Present Review**

19 There is variability in terms of the effectiveness of mental contrasting across studies
20 and differences within the way mental contrasting interventions have been tested and
21 implemented in terms of mode of delivery; and/or number of obstacles identified and the
22 length of time spent elaborating on the desired future. Furthermore, given the broader lack of
23 consensus regarding the definition of techniques used for action planning (Hagger &
24 Luszczynska, 2014), there is a need to also systematically review the literature on mental

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 contrasting as a health behaviour change intervention. Identifying the mediator and
2 moderator variables for the effects of mental contrasting on health behaviour change will help
3 to better understand the conditions, health populations or target groups that may most benefit.
4 In order to facilitate replication and to allow other researchers to build on existing studies,
5 based on Hagger and Luszczynska's (2014) criteria for developing a gold standard for the
6 use and reporting of implementation intentions, we sought to explore: (1) the conceptual and
7 operational definitions of mental contrasting and implementation intentions; (2) the format
8 and measurement of mental contrasting techniques; mode of delivery, measurement effects,
9 self-administered vs. interventionist-administered mental contrasting, goal proximity, single
10 administration vs. repetition; (3) the mechanisms and processes underpinning mental
11 contrasting techniques including the roles of habit, expectations, perceived behavioural
12 control, as well as the sustainability of behaviour change (short and medium term effects) and
13 intervention fidelity.

14 In summary, mental contrasting is theorised to operate through **mediation of the**
15 strength of the association between future and reality, as well as between the reality and
16 instrumental means, which subsequently changes how the reality is perceived as an obstacle.
17 Whilst experimental evidence suggests potential mediators and moderators for mental
18 contrasting as outlined in the discussion of mental contrasting processes, this review will
19 address the need to identify and examine those that have been tested exclusively in the health
20 domain in order to better understand how mental contrasting can be used in interventions to
21 effectively to change health behaviour.

Method

Search Strategy

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 This protocol was registered with PROSPERO reference CRD42016034202 and for
2 our full review protocol methods, see Cross and Sheffield (2016). The review has been
3 reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses
4 Protocols (PRISMA-P) guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009) and in
5 accordance with AMSTAR criteria (Shea, Grimshaw, Wells, Boers, Andersson, Hamel,
6 Porter, Tugwell, Moher, & Bouter, 2007), to allow for evaluation and to reduce the potential
7 for bias in the reporting of this review.

8 9 **Study Eligibility Criteria**

10 This review included in press and published (in English language) randomised control
11 trials of mental contrasting intervention studies of adult participants describing physical
12 health outcomes from 1995 to August 2018.

13 **Comparator or Control**

14 This review included randomised control trials studies comparing a mental
15 contrasting intervention with either passive control groups (i.e. no intervention), or active
16 control groups of indulging or dwelling only, goal irrelevant (i.e. elaborating positive
17 followed by negative past experiences) or reverse contrasting (i.e. negative elaboration
18 performed before positive) conditions. **It is noteworthy that it is not the negativity versus
19 the positivity that determines mental contrasting effects, rather it is the elaboration of
20 the negative reality performed before the elaboration of the positive future that is
21 important (Oettingen, 2012).**

22 **Outcome Measures**

23 Our primary outcome measures were physical health-related behaviour outcomes,
24 including self-report, observation, behavioural and physiological outcomes. In terms of

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 secondary outcome measures, we also sought to assess the following outcomes where they
2 were available: type of effects (i.e. classification), attrition, mediator and moderator
3 variables.

4 **Information Sources**

5 This review included comprehensive searches on the following electronic databases:
6 Scopus (1960 to present), PsycINFO (1966 to present), CINAHL (1982 to present) and Web
7 of Science Core Collection (1970 to present). For our full search strategy, see Cross and
8 Sheffield (2016) and for our search terms, see table 1 in the online supplementary materials.

9 **Screening Procedure**

10 One reviewer (AC) screened all retrieved records identified through initial searches
11 against eligibility criteria in two stages. Initial screening was based on titles, abstracts and
12 keywords and the second reviewer (DS) screened a random 20% of the total titles and
13 abstracts. The findings were discussed to reach a consensus on the studies to take forward to
14 the next stage of the review. No additional studies were added to the corpus of studies at this
15 stage. Following initial screening, full-text versions of all potentially relevant studies were
16 retrieved and reviewed independently and screened against all inclusion and exclusion
17 criteria by two reviewers (AC and DS) (see online supplementary material: figure 1 for the
18 PRISMA flowchart).

19 **Data Extraction and Selection**

20 Data extraction occurred in two stages; extracting general study data using a data
21 extraction form and assessing the quality of the review studies using the Cochrane risk of bias
22 assessment tool. Two independent reviewers (AC and DS) completed a data extraction form

1 MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE
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4 1 for each selected study. Where necessary, we attempted to contact the authors by email for
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6 2 key missing data elements.
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9 **Data Management**

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11 4 Before analysing the dataset, the following decisions were made; it was decided to
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13 5 treat the two studies within the **Sailer, Wieber, Pröpster, Stoewer, Nischk, Volk, &**
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15 6 **Odenwald (2015)** paper as separate studies. The paper described two different ward settings:
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17 7 one autonomous ward setting in which **in-patients did not receive reminders** about the
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19 8 intervention sessions, thus requiring higher demands on patients' self-regulation; and a
20
21 9 **highly-structured** ward setting in which **in-patients** received reminders about the
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23 10 intervention setting. Two studies from the final selection of papers were excluded as they did
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25 11 not meet our criteria; **study one of A. Kappes et al., (2012) did not report a physical**
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27 12 **health outcome and study two of Adriaanse et al., (2010) did not have a control group.**
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33 13 The duration of the intervention and follow up periods were calculated from the time
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35 14 when the participants received the mental contrasting inductions. The follow up period was
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37 15 defined as the period during which contact ceased with participants from the end of the
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39 16 mental contrasting induction, to the time of the measurement of the behaviour. We defined
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41 17 short-term follow up as all data collection points up to and including four weeks (or,
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43 18 alternatively we took the first measurement reported at up to four weeks after the baseline),
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45 19 and classed medium-long term follow up as >4 weeks from the main analysis point. We
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47 20 sought to retain data on the primary outcome measure only; all studies reported subjective
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49 21 measurements for primary outcome measures, with the exception of the A. Kappes et al.
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51 22 (2012) study which reported observed behaviour (stair use). **We sought to retain data on**
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53 23 **the study's primary outcome measure only; all studies reported subjective**
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55 24 **measurements for primary outcome measures, with the exception of the A. Kappes et al.**
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MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 (2012) study which reported observed behaviour (stair use). Two further studies
2 reported objective measures of Marquardt et al. (2017) (blood pressure and BMI) and
3 Christiansen, Oettingen, Dahme, & Klinger, (2010) (physical capacity) although these
4 were secondary measures and thus not included in our analysis.

Results

6 A total of 1398 potential articles were initially identified from the searches following
7 the removal of duplicates. After screening the abstracts, 27 full text articles were retrieved
8 and assessed for eligibility against the inclusion criteria. Eleven papers describing 12 studies
9 met the inclusion criteria and were included in the review for analysis (see online appendix,
10 table 2 for excluded studies, table 3 for included studies).

Study Characteristics

12 In order to better understand how mental contrasting has been operationalised,
13 interventions are reported in terms of (see online appendix table 3): (1) modes of delivery
14 (i.e. self-administration vs. interventionist-administered; the number of repetitions of the
15 intervention), (2) format of the intervention (group or individual), (3) differences in
16 operational definitions of mental contrasting and/or MCII and (4) descriptions of the
17 comparison groups used.

18 This review included a total number of 1528 adult participants (18 years or older) and
19 included a mixture of clinical settings ($k = 5$; schizophrenia inpatients, back pain outpatients,
20 primary care, stroke neurological clinic), university students ($k = 3$) and general population
21 settings ($k = 3$; members of a health insurance company, members of an angling club).
22 Sample sizes varied from 16 to 467. Studies were conducted in Germany ($k = 8$), UK ($k = 1$),
23 Netherlands ($k = 1$), Switzerland ($k = 1$) and the US ($k = 1$).

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 The duration of the administration of the mental contrasting techniques reported in the
2 review studies varied between very brief single inductions of mental contrasting to three-
3 week interventions, whereby mental contrasting was integrated within cognitive behavioural
4 therapy (CBT) problem-solving activities in a back pain management program (**Christiansen**
5 **et al., 2010**) and within the usual care of a stroke neurological rehabilitation programme
6 (**Marquardt, Oettingen, Gollwitzer, Sheeran, & Liepert, 2017**). Nine of the 12 studies
7 employed a single induction of mental contrasting at baseline. Participants were provided
8 with the freedom to set their own future wish and to specify **an outcome and** an obstacle of
9 their choice, with the exception of the A. Kappes et al., (2012) study where both the future
10 wish and obstacle were determined by the experimenter, suggesting that mental contrasting
11 can be used to overcome paternalism.

12 Only one study provided a booster follow up administration of mental contrasting
13 beyond the baseline period, where participants were asked to restate their goal at two and
14 three weeks post baseline (Sailer et al., 2015).

15 In terms of mode of delivery of mental contrasting, six of the interventions were self-
16 administered by the participant with the evaluation performed by a member of the research
17 team. The clinically-based mental contrasting interventions were facilitated by a psychologist
18 (Christiansen et al., 2010) or a health care professional (Sailer et al., 2015; Marquardt et al.,
19 2017). Two studies employed an interventionist to conduct a one-to-one health education
20 session followed by mental contrasting (**Stadler, Oettingen, & Gollwitzer, 2009; Stadler,**
21 **Oettingen, & Gollwitzer, 2010**). The timing of follow up data collection varied between
22 measurements taken directly after the administration of mental contrasting (A. Kappes et al.,
23 2012) and two years (Stadler et al., 2010).

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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4 1 Seven studies combined mental contrasting with implementation intentions (MCII),
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6 2 with five evaluating mental contrasting alone. In terms of comparator groups, only five of the
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8 3 12 studies used a passive no-intervention control. Three studies used active control groups,
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10 4 two studies used a reverse contrasting condition (whereby the individual specifies the
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12 5 negative obstacle of reality before thinking about the desired future) and three used a
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14 6 condition where individuals were instructed to indulge and dwell on the future fantasy
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16 7 without performing mental contrasting. Some studies used more than one type of comparison
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18 8 group.

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23 9 In terms of the time proximity, studies varied between requiring participants to form
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25 10 either short-term or longer-term health behaviour goals. For example, Stadler et al. (2009;
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27 11 2010) asked participants to specify a wish that they hoped to achieve in the following 24
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29 12 hours, in addition to a medium-term wish. In one instance (A. Kappes et al., 2012),
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31 13 participants were required to imagine a wish for physical activity that they hoped to achieve
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33 14 in the long-term, but they measured stair use immediately after the participant performed
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35 15 mental contrasting, thus creating a discrepancy between future-wish proximity and the
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37 16 immediacy of the outcome measure. In terms of target health behaviours, eight of the studies
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39 17 described a behaviour aimed at 'increasing' healthy behaviours (e.g. increasing physical
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41 18 activity or fruit and vegetable intake), with the remaining four targeting the reduction of
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43 19 unhealthy behaviours (e.g. reducing smoking, reducing unhealthy snacking).

20 **Intervention Fidelity**

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22 We found a general lack of reported intervention fidelity; randomisation and
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24 manipulation checks were performed in the majority of studies to check that random group
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26 allocation was successful, however only two studies reported carrying out checks with regard
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28 to whether mental contrasting had been performed (Sheeran et al., 2013, Marquardt et al.,
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MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

2017) and only two studies (Adriaanse et al., 2010; Marquardt et al., 2017) pre-registered their study protocols.

Heterogeneity

Heterogeneity was investigated using χ^2 (significance level: 0.1) and Higgins I^2 statistics. Low levels of heterogeneity were found based on the guidance in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011). The overall effect size was homogenous $Q(11) = 18.14, p < .001, I^2 = 28.3\%$, thus indicating that there are not heterogeneity issues. The imputed values within the forest plot suggest that studies with small effect sizes may be missing, hence we reported the more conservative approach of adjusted Hedges' g values.

Risk of Bias

Efforts were made to obtain and include unpublished studies and datasets by contacting key authors and browsing key conference proceedings, since exclusively including published studies risks inflation of effects given that significant results potentially are historically more likely to be published (Hopewell, McDonald, Clarke, & Egger, 2007). Publication bias was examined by a funnel plot of the effect size against reciprocal standard error; the funnel plot for the effect sizes for mental contrasting on health appear to be asymmetrical, suggesting there may be evidence of publication bias (see online appendix, figure 2). In addition, both Begg and Mazumdar adjusted rank correlation ($\tau = 0.18, p = 0.41$) and Egger's intercept (Intercept = 1.74, $t = 2.28, p = .05$) were non-significant, which indicates possible evidence of a publication bias for this data.

Mediator and Moderator Analysis

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 Overall, few studies reported moderators. Based on the limited number of included
2 trials, the available statistical power for moderator analyses was limited. We sought to
3 identify the moderators of mental contrasting health studies, i.e. variables that affect the
4 direction and/or strength of the relationship between an independent or predictor variable and
5 a dependent variable/criterion, and mediators, i.e. variables that account for the relationship
6 between mental contrasting and a dependent variable/criterion. Moderator variables found in
7 the review were: (1) the inclusion or exclusion of implementation intentions, (2) study
8 quality, (3) expectations of success, (4) perceived behavioural control, (5) intentions, (6)
9 immediacy of action and (7) habit strength. Only one of the included studies reported a
10 mediator variable of the association between the obstacle of reality and instrumental means to
11 overcome the obstacle.

12 **Confidence in Cumulative Evidence**

13 The quality of evidence for primary outcomes from each of the review studies was
14 assessed using the Grading of Recommendations Assessment, Development and Evaluation
15 (GRADE) (GRADE working group, 2007) quality domains for “blinding and allocation”,
16 “follow up and withdrawals”, “sparse data” and “other methodological concerns (e.g.
17 incomplete reporting, subjective outcomes)”. Two raters independently assessed each paper
18 against these quality domains using a scoring system in which one point denoted a
19 methodological concern against that particular quality domain. Interrater reliability was high
20 (Cohen’s $k = 0.72$; $p < 0.001$) and the discrepancies in scoring were resolved through
21 discussion (see online appendix, table 4). The overall quality for the corpus of studies was
22 judged as high to moderate quality, indicating a high to moderate level of confidence that the
23 true effect lies close to the estimate of the effect. Therefore, we did not exclude any of the
24 review studies on the basis of GRADE guidelines. Eleven of the studies used a subjective

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 retrospective questionnaire measure, with one study using observed behaviour as an objective
2 measure. Accordingly, it was not appropriate to prioritise studies by the level of evidence and
3 consequently, each study carried an equal weighting in the analysis.

4 **Meta-bias**

5 This review assessed study protocols for outcome reporting bias by judging whether
6 authors have selectively reported outcomes using the Cochrane tool for assessing risk of bias
7 (see online appendix, table 5). Two reviewers independently assessed the methodological
8 quality of the studies using the Criteria from Cochrane Handbook for Systematic Reviews of
9 Interventions (Higgins & Green, 2011). This tool evaluates the quality of allocation sequence
10 generation and concealment, blinding of participants, intervention providers and outcome
11 assessors, completeness of data, the extent to which outcomes are selectively reported, and
12 any other potential sources of bias. Each domain was assigned a risk of bias category ('low
13 risk for bias, 'unclear risk for bias' and 'high risk for bias') by each reviewer and
14 discrepancies were discussed until a consensus rating was agreed on. High agreement was
15 reached between the two reviewers, with interrater reliability of Cohen's $k = .90, p < 0.001$; a
16 third reviewer was available in case of disagreement but this was not needed.

17 **Data Synthesis**

18 Effect sizes were extracted for each study and where necessary they were calculated
19 using means, standard deviations and sample sizes at baseline and post-intervention of
20 experimental and control conditions (Decoster & Claypool, 2004). Where such statistics were
21 missing, we used F-statistics, t -values and p -values. We calculated effect sizes for two
22 studies, namely Johannessen et al. (2012) and Marquardt et al. (2017) (see supplementary
23 material, raw data table).

24 **Meta-Analysis**

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 A meta-analysis was conducted to pool effect sizes from across ten studies and a total
2 of 1528 participants, using a random-effects model. All analyses were performed using Meta-
3 Essentials (Suurmond, Van Rhee, & Hak, 2017). We calculated Hedges' g and confidence
4 intervals (upper and lower) for studies that met the principal inclusion criteria and examined
5 the effects of mental contrasting on health outcomes. Initially, we extracted data points for up
6 to four weeks follow up to investigate the impact of mental contrasting on short term
7 behaviour change. Therefore, in terms of our primary outcome measure of the impact of
8 mental contrasting on health behaviour change, a random effects model showed an overall
9 combined effect size (using adjusted Hedges' g) of $g = 0.28$ ($SE .07$) $CI [0.13-0.43]$, $p <$
10 0.001 (see Figure 3, online supplementary materials).

11 Subgroup and Sensitivity Analysis

12 Although there was homogeneity, subgroup analysis was still conducted as
13 implementation intentions are a recognised adjunct of mental contrasting. Analysis by
14 subgroups compared mental contrasting with implementation intentions studies ($k = 7$), with
15 mental contrasting alone ($k = 5$). For mental contrasting with implementation intentions
16 (MCII), there was a combined effect size of $g = 0.28$, 95% $CI [0.14-0.42]$, $p < 0.001$. This did
17 not differ from mental contrasting-only interventions, $g = 0.27$, 95% $CI [0.12-0.41]$, $p <$
18 0.001 . Finally, moderator analysis using our quality of study measure (confidence of
19 evidence) revealed that study quality was not a significant moderator.

20 Subgroup analysis was performed on studies that reported longer follow up data
21 points between four weeks to three months ($k = 5$). This revealed a combined effect size of
22 Hedges' $g = 0.38$, ($SE 0.6$), $CI [0.2-0.55]$, $p < 0.001$. Additionally, it is noteworthy that one
23 of these studies (Stadler et al., 2010) showed increasing significant benefit in favour of
24 mental contrasting in terms of increased self-reported fruit and vegetable consumption at the

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 two year follow up ($t > 3.63, p < .02$). In contrast, Marquardt et al. (2017) reported little
2 fluctuation over one year follow up.

Discussion

4 This paper describes the first systematic review and meta-analysis on the
5 effectiveness of mental contrasting for health behaviours. Overall, it was found that mental
6 contrasting has a significant and small to moderate-sized effect on changing health behaviour
7 in the short-term (i.e. up to four weeks). Subsequent analysis of a subset of studies that used a
8 longer follow up of four weeks to three-months follow up ($k = 5$) suggests that the benefits of
9 mental contrasting are sustained over time, and in some studies enhanced. Indeed, one study
10 included multiple follow up points from one week to 24 months and effects were still
11 observed at the longest follow up period (Stadler et al., 2010). Additionally, Marquardt et al.
12 (2017) found that these effects were sustained over a year with little fluctuation at each
13 fortnightly follow up point. Whereas most studies reported stable and sustained health
14 behaviour change effects of mental contrasting, Sheeran et al. (2013) found that physical
15 activity increased in mental contrasting participants from the one month follow up to the
16 seven month follow up, with no such change observed among the control group. It is
17 noteworthy that this subset of longer term follow up studies (Stadler et al., 2009; 2010,
18 Christiansen et al., 2010, Sheeran et al., 2013 and Marquardt et al., 2017) scored higher
19 quality ratings using GRADE criteria. Additionally, to test the role of early success in
20 promoting longer term behaviour change, Stadler et al. (2009; 2010) instructed participants to
21 set a goal they hoped to accomplish in the following 24 hours in addition to a longer-term
22 goal. Significant effects of self-reported behaviour change in favour of mental contrasting
23 and implementation intentions were found at two years (Stadler et al., 2010), suggesting that
24 success at 24 hours may increase the likelihood of longer term behaviour change by

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 activating high expectations of success. As participants were encouraged to use mental
2 contrasting whenever possible following the intervention, it is also possible that mental
3 contrasting requires practice and rehearsal outside of the intervention or experimental setting
4 for sustainable behaviour change to occur.

5 In terms of study characteristics, significant and comparable findings of mental
6 contrasting on health behaviour were observed regardless of the setting (general practice,
7 hospital and community) and type of study population (general population, hard to reach
8 vulnerable groups, patients with long term chronic conditions). Significant effects were found
9 across different types of health behaviours and regardless of whether the target behaviour was
10 aimed at increasing healthy behaviours (e.g. physical activity, fruit and vegetable
11 consumption) or reducing unhealthy behaviours (e.g. smoking, unhealthy snacking). The
12 effects were observed in hard to reach, vulnerable individuals and clinical populations such
13 as overweight, middle-aged fisherman of low socioeconomic status, for which mental
14 contrasting promoted physical activity (Sheeran, Harris, Vaughan, Oettingen, & Gollwitzer,
15 2013) and for patients with type two diabetes, for which mental contrasting helped
16 individuals to identify feasible wishes regarding diabetes self-management, which triggered
17 goal pursuit (Adriaanse, de Ridder, & Voorneman, 2013).

18 The meta-analysis findings were obtained using the more conservative analytical
19 approach of Hedges' g and imputed values; such findings are encouraging given the brevity
20 of the administration of mental contrasting interventions (typically less than one hour, even
21 when embedded within a 3-4 week programme; Christiansen et al., 2010) and low costs
22 associated with delivery. Effects were found for both very brief single inductions of mental
23 contrasting (e.g. one session) within experimental manipulations (e.g. A. Kappes et al., 2012;
24 Adriaanse et al., 2010) and also for where mental contrasting was embedded within longer

1 MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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4 1 term intervention programmes, such as cognitive behavioural therapy within a 3-4 week
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6 2 outpatients pain management programme (Christiansen et al., 2010). Furthermore, effects
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8 3 were significant across different modes of delivery, including self-administration and online
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10 4 interventions. As mental contrasting appears to be effective even when self-administered on a
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12 5 single occasion without additional booster sessions or reminders, this suggests that there is
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14 6 potential for the technique to be used in large scale in population public health studies or
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16 7 interventions (of a similar design to Sheeran et al., 2013).

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20 8 In terms of encouraging uptake of mental contrasting in large population studies and
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22 9 longer-term use in order to improve health outcomes and behaviours, we need consideration
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24 10 of how spontaneous mental contrasting operates through person variables of cognition and
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26 11 self-regulation, as well as cultural influences is needed. Beyond the health domain, findings
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28 12 from two recent experiments suggest that individuals who self-report high levels of self-
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30 13 regulation, high impulse control, a high need for cognition (i.e. those who enjoy and engage
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32 14 in more effortful processing, Cacioppo, Petty, & Kao, 1984) are more likely to spontaneously
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34 15 use mental contrasting (Sevincer, Mehl, & Oettingen, 2017).

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39 16 In terms of culture, there is recent evidence to suggest that MCII may be subject to
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41 17 cultural influences. In a sample of 17, 983 online learners, Kizilcec and Cohen (2017) found
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43 18 that MCII significantly increased online course completion rates for learners from
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45 19 individualist cultures where the obstacle concerned an everyday obligation. Obstacles of a
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47 20 lack of time or practical constraint were not significant as these leave relatively little freedom
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49 21 for adaptive solutions, which is consistent with the argument that MCII should only raise goal
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51 22 pursuit for surmountable obstacles (Oettingen, Pak, & Schnetter, 2001). MCII had no
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53 23 significant impact on course completion for learners from collectivist and balanced cultures.
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55 24 It is possible that collectivist wishes (e.g., a wish to complete a project for community gain)

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 work optimally within collectivist cultures, whereas individualist wishes (e.g., to complete an
2 online course) work optimally within individualist cultures. That is, when wishes match the
3 predominant values in a culture there is more freedom of action to surmount one's obstacles
4 to wish fulfilment.

5 In summary, mental contrasting is likely to be a highly engaging behaviour change
6 strategy, as individuals specify the idiosyncratic content of their desired future and negative
7 reality by providing ideas and images as a result of imagining the desired future and the
8 obstacles to goal pursuit. Unlike many other health behaviour change strategies, mental
9 contrasting does not attempt to impose cognitive contents (e.g. positive attitudes, supportive
10 norms or strong self-efficacy feelings) on the individual. Instead, it assists individuals with
11 juxtaposing imagery of what they perceive as a desirable future with the personal obstacle
12 that stands in the way of pursuing the desire future. Of critical importance is *how* people think
13 about their health goals and wishes and what influences these in terms of moderator and
14 mediator variables, rather than *what* they think about in terms of the content and valence of
15 their goal-related thoughts.

Mental Contrasting and Moderators and Mediators

Moderators

18 Moderator variables are important as they may identify who is most likely to benefit
19 from mental contrasting and in which circumstances. Moderators of mental contrasting for
20 health behaviours identified by our review included expectations of success, immediacy of
21 action, perceived behavioural control, intentions, habit strength and implementation
22 intentions (MCII).

23 **Expectations of success.** Mental contrasting activates, rather than alters the direction
24 of an individual's expectations of success (Oettingen et al., 2001; Oettingen, 2012; Adriaanse

1 MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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4 1 et al., 2010). The review studies show that teaching mental contrasting as a metacognitive
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6 2 strategy can help people to prioritize which goals to pursue and which to ignore (Adriaanse et
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8 3 al., 2010; Oettingen et al., 2012; Stadler et al., 2009; Stadler et al., 2010). When goal
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10 4 disengagement is not advisable or feasible (e.g. for the self-management of type two
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12 5 diabetes), mental contrasting can also be taught to help people pursue a desired future by
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14 6 ensuring that they hold high expectations of success. For example, in Adriaanse et al.'s
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16 7 (2013) study of mental contrasting for diabetes self-management, only participants with high
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18 8 expectations were recruited since mental contrasting is not expected to promote goal striving
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20 9 for individuals with low expectations of success, where instead it may potentially reduce goal
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22 10 striving and lead to goal disengagement. Accordingly, self-efficacy boosting interventions
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24 11 (e.g. motivational interviewing, acceptance and commitment therapy) may be beneficial for
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26 12 individuals with low expectations of success, particularly for where goal disengagement is
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28 13 not advisable nor feasible, such as in the case of health behaviour change for the purposes of
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30 14 chronic conditions self-management. Choosing wishes of high expectancy is the standard
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32 15 instruction for MC and MCII interventions when they are geared towards wish fulfillment. If
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34 16 an intervention is geared towards the prioritisation of wishes, then individuals are asked to
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36 17 choose wishes irrespective of their expectations of success. Individuals can choose wishes
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38 18 with which they have high expectations of success and apply mental contrasting, thus mental
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40 19 contrasting affords a strategy that everyone may benefit from.

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48 20 **Immediacy of action.** Mental contrasting was in an experiment found to assist
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50 21 participants to initiate behaviour change action (i.e. taking more steps towards goal pursuit)
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52 22 in proportion to their expectations of success (Oettingen et al., 2010). Participants with high
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54 23 expectations in the mental contrasting conditions were more likely to report more immediate
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56 24 goal directed action compared with those with low expectations of success, who also delayed
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58 25 their action. Oettingen et al., (2010) speculate that the prompt action in the high-expectancy

1 MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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4 1 mental contrasting participants may be beneficial in both the short and the long term, since
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6 2 more immediate action should provide more opportunities for future successes. Individuals
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8 3 who delay goal-directed action due to low expectations of success could potentially
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10 4 experience drawbacks or benefits from the delay. Whilst individuals can experience an
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12 5 increase in expectations of success, delayed action could actually be beneficial for those with
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14 6 low-expectancy in challenging circumstances where delay could avert ego-depletion
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16 7 (Baumeister, Bratlavsky, Muraven, & Tice, 1998) and subsequently lead to a negative cycle
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18 8 of unsuccessful behaviour change, or continued relapse (Bandura, 1997; Marlatt & Donovan,
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20 9 2005). Mental contrasting could also be used to or initiate behaviour change in a different life
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22 10 domain (Oettingen, et al., 2012), e.g. improving a relationship with a long-term friend.

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27 11 **Perceived behavioural control and intentions.** Both perceived behavioural control
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29 12 and intentions appear to moderate the effects of mental contrasting. Stadler et al (2010)
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31 13 reported that participants in both the control and intervention groups reported high intentions
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33 14 and perceived behavioural control to eat a healthy diet, along with positive attitudes towards
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35 15 healthy eating. Whilst such favourable conditions should increase the likelihood of behaviour
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37 16 change, and both the intervention and information-only control groups reported early success,
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39 17 only the mental contrasting group maintained their increased fruit and vegetable
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41 18 consumption. Such findings suggest that mental contrasting is more effective for long term
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43 19 sustainable behaviour change, than the mere provision of health information. Practicing MCII
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45 20 helped participants to renew goal commitment for increasing fruit and vegetable consumption
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47 21 over two years and to identify and overcome obstacles attributed to the changing seasonal
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49 22 availability and other challenging personal circumstances.

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55 23 Stadler et al. (2010) reported that MCII prompted participants to tailor the strategy to
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57 24 their personal situation by allowing them to formulate daily wishes, identify **and imagine**
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59 25 personally relevant outcomes and obstacles, and to subsequently formulate individual

1 MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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4 1 implementation intentions using personal opportunities and obstacles as cues to action. The
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6 2 authors proposed that the flexibility afforded by mental contrasting to allow personal
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8 3 tailoring may be attributable to its success. Similarly, Stadler et al. (2009) reported that
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10 4 participants in both an MCII and information-only control condition had high intentions to be
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12 5 physically active and perceived behavioral control, but only the MCII group turned these
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14 6 conditions into immediate and sustained behaviour change over 16 weeks after the
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16 7 intervention.

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20 8 Sheeran et al.'s (2013) physical activity intervention suggested that mental contrasting
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22 9 enables participants to translate their beliefs about the importance and worth of physical
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24 10 activity (i.e. instrumental attitude) into action. Instrumental attitude was not associated with
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26 11 physical activity at 7 months in the control condition, but importantly, a significant positive
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28 12 relationship was found for participants who had performed mental contrasting.

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32 13 In contrast to the other studies in the review, Adriaanse et al. (2010) found that
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34 14 intentions to reduce snacking did not moderate MCII's effects, implying that MCII has
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36 15 beneficial effects for those who strongly intend to reduce snacking, as well as those whose
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38 16 intentions are less strong. Accordingly, mental contrasting provides the free choice of wishes,
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40 17 outcomes, and obstacles to people and thus is an agent of emancipation in contrast to
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42 18 implementation intention research.

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47 19 **Habit strength.** Habit strength was not shown to predict the success of mental
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49 20 contrasting, suggesting that the strategy can effectively assist people with strong or weak
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51 21 habits (Adriaanse, et al., 2010). Rather, Adriaanse et al.'s (2010) experiment showed that
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53 22 mental contrasting is an effective strategy for helping to identify critical cues for reducing
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55 23 unhealthy snacking habits. Mental contrasting increases the clarity of critical cues in habitual
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57 24 behaviour.

1 MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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7 2 **Mediators**8
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10 3 Only one of the review studies reported a **mediator variable** (A. Kappes et al.,
11 4 2012).12
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15 5 **Strength of association between the obstacle and instrumental means.** Mental
16 6 contrasting's effectiveness is also due to the intervention conferring important self-regulatory
17 7 benefits. Mental contrasting ties thoughts about the desired feasible future to thoughts about
18 8 obstacles that represent the individual's perceptions of their reality (Oettingen & A. Kappes,
19 9 2014). When people purely indulge in fantasies about the future or dwell on the negative
20 10 reality, they fail to appreciate how the desired future and obstacles are linked and related.
21 11 Accordingly, they overlook how the present obstacles connect to the means to overcome
22 12 these obstacles. Mental contrasting provides people with a strategy to see this relationship –
23 13 that obstacles stand in the way of desires (A. Kappes et al., 2013) – and so this energizes
24 14 them to overcome the obstacles and pursue the desired future (Oettingen et al., 2009). The
25 15 strength of the association between the obstacle of reality and the instrumental means to
26 16 overcome the behaviour (A. Kappes, Singmann, & Oettingen, 2012) was found in an
27 17 experiment to **predict strengthened and enhanced goal pursuit** (i.e. an elevator perceived
28 18 as an obstacle to a physical activity goal).29
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48 19 Testing other known mediator variables of mental contrasting remains a priority for
49 20 future research within the health domain. In particular, future studies should explore further
50 21 the role of energization (which has been evaluated outside of the health domain just in terms
51 22 of systolic blood pressure) as an indicator of implicit motivation (see Sevincer, Bussatta, &
52 23 Oettingen, 2014). Physiological indices, including heart rate, systolic blood pressure and pre-
53 24 ejection period (PEP) afford relatively simple experimental ways to measure these implicit

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 processes (Oettingen et al., 2009; Gendolla & Silvestrini, 2015). Using more robust measures
2 of physiological indices, for example, cortisol, heart rate variability and cardiovascular
3 reactivity will further strengthen the empirical research base for motivational processes in
4 mental contrasting.

5 **Mental Contrasting with Implementation Intentions (MCII)**

6 A subset of the review studies identified implementation intentions as an addition to
7 mental contrasting ($k = 7$). Examining implementation intentions as a moderator of mental
8 contrasting (MCII) on health behaviour suggested that the addition of implementation
9 intentions with mental contrasting inductions has little additional impact, as the effect size of
10 MCII was comparable to that for mental contrasting alone. Our finding for the combined
11 effect sizes for both MCII and mental contrasting alone are broadly similar to other meta-
12 analyses of implementation intentions (Sheeran & Gollwitzer, 2006; Bélanger-Gravel, Godin,
13 & Amireault, 2013). Although it has been theorised that mental contrasting may guide people
14 to generate idiosyncratic obstacles and to link these with instrumental behaviours
15 consequently prompting people to form more appropriate or salient implementation
16 intentions (Oettingen, 2012), the findings of our review do not confirm that the combination
17 of mental contrasting with implementation intentions is more effective for health behaviour
18 change than mental contrasting alone. However, we are cautious in interpreting our result
19 from a small group of studies and further studies are required to assess the role of mental
20 contrasting in facilitating more successful implementation intention planning. Indeed,
21 Adriaanse et al.'s (2010) second experimental study revealed that implementation intentions
22 preceded by mental contrasting (MCII) led to more successful reduction of unhealthy
23 snacking habits than either mental contrasting or implementation intentions alone, but a
24 control group was not included and thus was excluded from our meta-analysis. Whilst we

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 found that implementation intentions and mental contrasting have small to moderate effects
2 as single self-regulatory techniques, we cannot conclude from this review that the
3 combination of mental contrasting and implementations (MCII) are more effective than either
4 technique alone in improving health behavior.

5 **Limitations of the Review Studies**

6 The main limitations of the review are (1) that the majority of studies reported
7 subjective primary outcome measures and (2) the exclusion of studies that were not
8 specifically related to health behaviour change, but may still have broad implications for
9 health.

10 Within our review focusing on mental contrasting's effectiveness for health outcomes,
11 it is important to note that these studies mainly used subjective primary outcome measures, so
12 the findings may only be extended to self-reported accounts of behaviour change at this time.
13 Kappes et al. (2012)'s study was the one exception to this, reporting experimental findings of
14 observed stair use immediately after performing mental contrasting. Whilst Christiansen et al.
15 (2010) included objective measures of physical capacity, with significant strong effects
16 favouring mental contrasting for lifting and ergometer tests in a sample of participants with
17 chronic back pain as a secondary outcome, a priori we chose to solely use primary outcome
18 measure data in the review, which in this instance was a self-reported pain disability score.
19 Additionally, our review excluded studies which did not specify a health behaviour and so
20 there are other mental contrasting studies in existence that may have broad relevance to
21 health. For example, mental contrasting improves time management (Duckworth et al., 2013,
22 Oettingen, Mayer, & Brinkmann, 2010; Oettingen, Kappes, Guttenberg & Gollwitzer, 2015).
23 The broad nature of this intervention could be applied to health behaviours, for example time

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 management may facilitate scheduling time for physical activity in the day, for prompting
2 adherence of taking medication or for medical appointment attendance.

3 The review highlights the need for more mental contrasting and MCII replication
4 studies from different research groups in a variety of settings with different participant target
5 groups to allow replication and to strengthen the case for the efficacy of mediator and
6 moderator variables. This would also help to address the issue of publication bias found in
7 the review. Furthermore, study power may explain the failure to find moderating and
8 mediating effects of mental contrasting on health that can be explored in sub analyses. The
9 review describes studies of mental contrasting interventions that have taught participants how
10 to use and apply the strategy in order to change behaviour; none of the studies in this review
11 of health studies examined the spontaneous use of mental contrasting, although its efficacy
12 has been demonstrated in other **domains** (Servincer & Oettingen, 2013; Servincer, Schlier, &
13 Oettingen, 2015; Servincer, Mehl, & Oettingen, 2017; Kappes, Oettingen, Mayer, & Maglio,
14 2011) and this remains a priority for future research.

15 Additionally, none of the review studies were able to measure whether the desired
16 future primes obstacles to its realization, nor have they assessed the role of energization
17 during and following mental contrasting, which have been assessed in other life domains (A.
18 Kappes & Oettingen, 2014, Oettingen et al., 2009) but remain important limitations in the
19 field of mental contrasting research into health behaviours. Integration of laboratory tests of
20 the mechanisms and moderators of mental contrasting, with longitudinal tests of mental
21 contrasting remain a priority for future research.

Conclusions

22 Mental contrasting is a low intensity technique according to the Health Behaviour
23 Change Competency Framework (Dixon & Johnston, 2010), which suggests the results also
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MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 have clinical importance for mental contrasting as a low cost, low response burden brief
2 intervention. Stadler et al.'s (2009) MCII intervention to increase fruit and vegetable
3 consumption demonstrated a positive effect for the MCII condition from four weeks up to 24
4 months, compared with the information only control group who returned to baseline levels.
5 These results were obtained even without contact or MCII booster sessions between four and
6 24 months. Furthermore, the Christiansen and colleagues (2010) study shows that physical
7 activity can be enhanced in chronic back pain patients by teaching them MCII in an hour.
8 Mental contrasting is flexible in nature, allowing the user or clinician to choose a target
9 behaviour; it can also be self-administered and self-monitored. As they can be tailored to a
10 health behaviour, once mastered, individuals can use the technique in other domains of their
11 life as their effectiveness has also been demonstrated in time management, education and
12 business. Additionally, Johannessen, Oettingen, and Mayer (2012) suggest that the effects of
13 mental contrasting may be transferable; participants setting a feasible and important dieting
14 wish (thus ensuring expectations of success were high) using mental contrasting not only
15 reduced their calorie consumption over a two week period, but having learned to use the
16 strategy, they were also able to successfully increase their physical activity levels. Thus,
17 mental contrasting is likely to appeal to both behaviour change researchers and practitioners
18 alike as they require minimal training and can be used by a variety of health care
19 professionals. Such findings are encouraging given the utility of mental contrasting is not
20 limited to the use of theory, particular settings, modes of delivery or specific programme
21 durations.

22 In conclusion, this is the first review to systematically identify and evaluate the
23 effectiveness of mental contrasting as a self-regulatory imagery technique to change health
24 behaviours. Our analyses show promising findings for a low-cost brief goal **pursuit**

1 MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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For Peer Review Only

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Running head: MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

Appendices

Table 1
Search criteria and search terms used

Intervention	Study type	Outcomes
mental* contrast*, mental* contrast* and self-regulation, Mental* contrast* Imp* intention*, MCII and self- regulation, mental* contrast*and goal*, mental* contrast*and goal setting, mental* contrast* and goal pursuit, mental* contrast* and goal projection, mental* contrast* and goal attainment, mental* contrast* and Expectancy, mental* contrast* and fantasy and future and behaviour change, mental* contrast* and fantasy and future and behavior change	Clinical trial [pt], randomly [ab], randomized [ab], trial [ti], clinical trials	mental* contrast* and health, mental contrasting (exp) and health, MCII and health, mental* contrast* and behaviour*, mental* contrast* and behavior*, mental contrasting (exp) and behaviour, mental contrasting (exp) and behavior*, MCII and behaviour*, MCII and behavior*

Note. This was the search strategy for MEDLINE and was revised appropriately for each database searched, including PsychINFO, PsychArticles, Web of Science, PubMed Central, PubMed Central (Europe), ASSIA, CINAHL plus, ScienceDirect, and EBSCO through to August 2018.

Key: [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]; [tw=title, ab=abstract, exp=explode

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

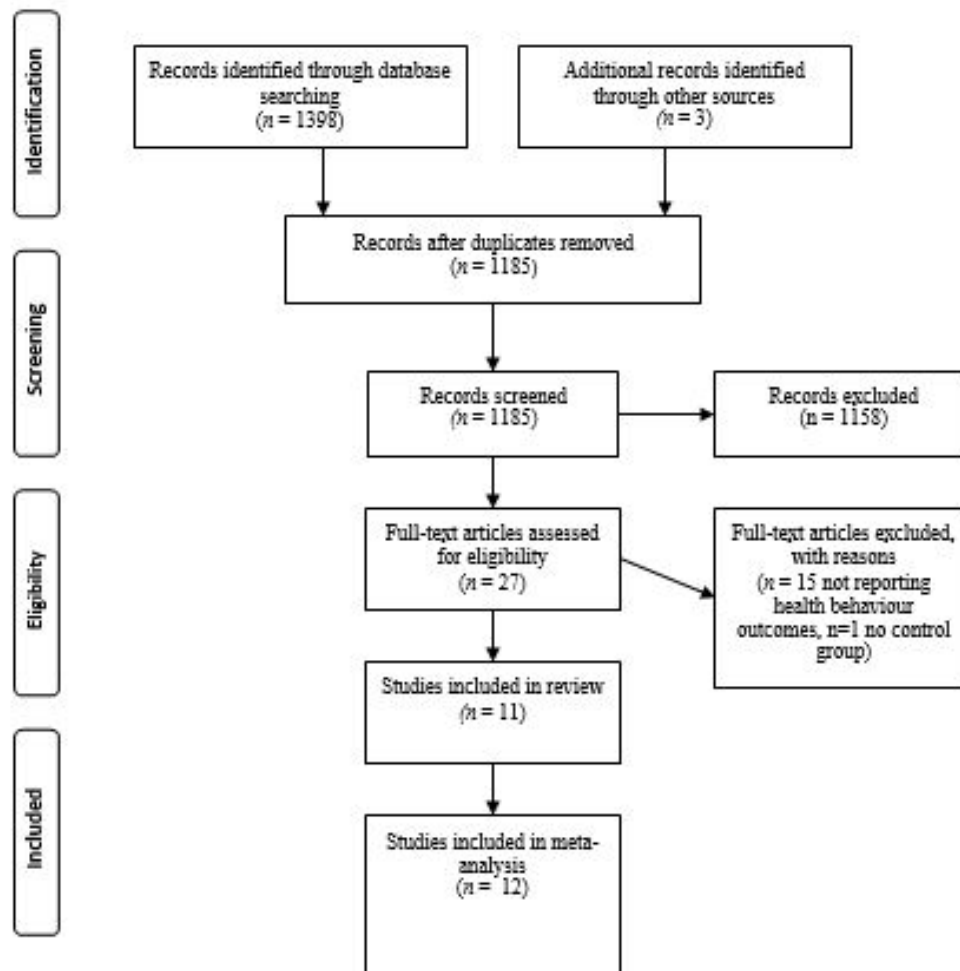


Figure 1. PRISMA flow chart of search results

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

Table 2

Citations of full text articles retrieved but rejected for not including physical health behaviour outcomes (n=13)

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MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

Appendix D

Table 3

Summary of studies included in the review

Reference	Target behaviour	Outcome measure	Intervention	Participants	Data collection points	Main findings
Johannessen et al., (2012)	Reducing consumption of high calorie foods	Self-report consumption of high calorie foods at two weeks (more/less/same)	Mental contrasting Control: indulging or no instructions control Mode of delivery: self-administered Duration of intervention delivery: single administration; participants were required to write most important dietary wish that they hoped to achieve over the next two weeks.	Participants: (n = 66; 36 Intervention (MC), 30 control), M age= 19.6 years, (SD = 1.01) Setting: University students, United States	Follow up: two weeks. Measured (1) self-report consumption of low medium and high calorie food categories – ‘less/ as usual/more’ compared with their behaviour before the intervention (2) researchers estimated overall calorie intake (3) self-report participation in 18 categories of physical activity by indicating ‘more/less usual/same	Intervention: M = -216, SD = 116. Control: M = -112, SD = 119.
Stadler et al. (2010)	Increase fruit and vegetable intake	Daily diaries, servings of fruit and vegetables per day	MCII + Education leaflet + diary, formed three implementation intentions, behavioural	Participants: n = 255 women aged 30-50 Setting: Germany,	Follow up: 4 weeks, 24 months after the intervention. Behavioural diary for	T = 0.00* Intervention: M = 26.68

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

			rehearsal of MCII during group session (long term wish, plus wish to complete in next 24 hours) Control: education leaflet only + completed diary, no leaflet no diary control Mode of delivery: Interventionist within a group setting Duration of intervention: MCII set at baseline, 2 hour group meeting at baseline by interventionist (single administration of MC)	members of health insurance company	7 consecutive days at baseline and all follow up points recording servings of fruit and vegetables (correlates highly $r = .66$ with a validated food frequency questionnaire). Dietary knowledge measure.	Control: $M = 25.11$. Moderators: MCII, intention, perceived behavioural control
Adriaanse et al. (2010)**	Reducing unhealthy snack intake over one week	Self-report questionnaire (success in diminishing habit), Cronbachs alpha = .67 not validated	Intervention: MCII Control: II; MC Mode of delivery: self-administered Duration of intervention: single lab administration Asked to name most unhealthy snacking habit, expectations of success questions, baseline	Participants: University Students, $n = 51$, M age = 20.76 years ($SD = 2.18$) Setting: Netherlands	Follow up: one week later	$F(2,47) = 3.51$, $p < 0.05$ Moderators: MCII, habit strength, intention, expectation of success

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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Christiansen et al. (2009)	Pain reduction	Pain disability questionnaire (Hannover Activities of daily Living score).	Intervention: MCII with cognitive behavioural therapy to enhance goal attainment, work with psych to achieve goal over the two weekly sessions, alongside usual outpatients back pain programme Control group: usual care standard outpatients back pain program and to implement their goal in two weeks Baseline: 2x 30 min sessions on day 3 and 9, one to one sessions of problem solving strategies	Participants: Chronic Back pain outpatients, $n = 60$ (M age = 48 years; $SD = 9$) Setting: Germany Mode of delivery: CBT delivered by psychologist	Follow ups: 3 weeks after discharge, 3 months	$F(2,58) = 4.28, p = 0.05, d = 0.404$. Intervention: discharge $M = 69.6, (SD = 13.4)$. Follow up $M = 74.7, (SD = 16.8)$. Control: discharge $M = 70.6, (SD = 17.1)$, follow up $M = 68.1, (SD = 23.7)$. Moderator: MCII
Sheeran et al. (2013)	Increase physical activity	Self-report PA levels, Godin et al., (1986) measure of PA, measured instrumental attitudes (importance and worth of PA),	Mental contrasting Control: passive control, completed TPB only (at baseline) Mode of delivery: self-administered, also chose goal and obstacle Duration of	$n = 467$ (358 at one month) overweight, low SES males, Setting: UK, Angling club, M age = 53.88 ($SD = 12.42$)	Follow up: one and 7 months	$F(1,465) = 3.84, p = 0.05$ and $F(1, 465) = 6.93, p = .009$ Intervention: $M = 4.91 (SD = 1.97)$

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

		Theory of Planned Behaviour	intervention: single administration			Control: $M = 4.02$, ($SD = 2.38$). Moderators: MCII, intention, perceived behavioural control
Stadler et al. (2009)	Increase physical activity	Measure: behavioural diary	Intervention group: MC and II with interventionist (chosen by participant). Repeated four times; 2 x long term wish 2 x goal for next 24 hours; Control: Information group Mode of delivery: Interventionist administered Duration: single administration at baseline intervention session, MCII Repeated 4 times, 2 x long terms wish 2 x goal for next 24 hrs	Participants: $n = 256$ women, 30-50 years, members of a health insurance company Setting: Germany	Follow up: 1 st , 4 th , 8 th , 16 th Week after baseline session Behavioural diary for 7 consecutive days at baseline and all follow up points reporting total activity in past 7 days, moderate-vigorous activity during leisure time and as active travel	Week 1 $d = 0.43$, week 16 $d = 0.47$ Intervention: 1 week follow up $M = 102.86$ CI (81.6-126.59), 16 weeks $M = 102.86$, CI (81.60-126.59) Control: 1 week $M = 55.50$, CI (41.37-71.71), 16 weeks $M = 96.06$, CI (69.61-126.79) Moderators: intention, perceived behavioural control, MCII

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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Oettingen, et al. (2010)	Reduction in smoking (commitment in terms of the reported immediacy of acting on fantasies)	Commitment in terms of immediacy of action i.e. when and how many steps they took to reducing smoking	Duration of intervention: single administration. Mental contrasting of positive future with negative reality Control: Two positive future conditions: elaborating positive future only and elaborating negative reality only) Three negative future conditions: referred to a negative future suffering from the disadvantages of prolonged cigarette consumption (mental contrasting of negative future with positive reality, elaborating negative future only and elaborating positive reality only).	Participants: n = 70 University Students M age = 22 years (SD = 2.77) Setting: Germany	Follow up: 2 weeks after MC participants had to write down whether they had undertaken steps towards reducing their cigarette consumption and exact date(s) of when they had acted on the most challenging step. In line with Oettingen et al. (2001), the authors counted the number of days that elapsed until participants acted on this step. To assess the significance of the step, two independent raters coded whether the step appeared to have minor or major consequences for cigarette reduction.	$F = 0.00^{***}$ Moderator: expectations of success, immediacy of action
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MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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3	Sailer et al.	Increase PA	Self-report	Intervention: MCII	Participants:	Follow up: four weeks
4	(2015)***	(jogging)	questionnaire	(read information text	study 1, 20;	Autonomous =
5	Study 1)	Outcome	(PANS, BDI,	and work through	study 2, 16. <i>M</i>	$F(1,24) = 5.72,$
6	autonomous	measure: a)	IPAQ)	MCII with therapist,	age = 30.89, (<i>SD</i>	$p = 0.25.$
7	ward	attendance (% of total		specifying three	= 11.41).	Structured = F
8	Study 2)	sessions) and b)		positive outcomes	Diagnosis of	$(1,24) = 0.65, p$
9	highly	persistence (% of weeks		associated with	Schizophrenia	= .428
10	structured	participant		attending the exercise	and interested in	Moderators:
11	ward MCII	attended at least		sessions and	jogging	MCII.
12		one of two		identifying the most	Setting:	
13		jogging sessions		significant obstacle	Psychiatric	
14				and devising a	inpatients wards	
15				strategy. Wrote down	in Germany and	
16				an 'if-then' plan three	Switzerland	
17				times. Duration of		
18				intervention: single		
19				administration of MC		
20				but scheduled jogging		
21				sessions of 30 mins		
22				over four weeks.		
23				Booster session of		
24				rewriting goal at		
25				weeks 2 and 3.		
26				Control group: read		
27				information text, wrote		
28				goal intention at		
29				baseline and weeks 2		
30				and 3.		
31				Mode of delivery:		
32				Goal set by therapist in		
33				control condition–		
34				attend jogging		
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MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	Kappes et al. (2012) ****	Increase physical activity (Assessed expectations of improving fitness)	Observed stair use	Mental contrasting Control: reverse contrasting Duration of intervention: single administration. Mode of delivery: researcher instructed participants to elaborate an idiosyncratic outcome of desired future; researchers generated the obstacle – daily conveniences, e.g. an elevator)	Participants: University students $n=87$ ($n= 65$ Female), M age = 22.7 years, ($SD = 3.8$) Setting: Germany.	Follow up: none, observed stair use immediately after the priming task and intervention	$F(1,83) = 6.27$, $p = 0.01$ Moderator: expectations of success Mediator: association between the obstacles of reality and instrumental means (obstacle-behaviour associations)
22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42	Adriaanse et al., (2013)	Diabetes self-care	Self-report Diabetes and Self-Care Activities questionnaire score	Intervention: Mental contrasting Control: indulging and fantasizing about positive future mean BMI 31.7 ($SD = 5.19$), Mean duration of DM2 = 5.81 years ($SD = 3.74$) Mode of delivery: self-administered Duration of intervention: single administration of MCII at baseline	Adults with Type 2 Diabetes (DM2), $n = 64$ (BMI 25+, high expectations of weight loss but having difficulties, M age = 61.05 years ($SD = 7.31$)) Setting: General Practice, Netherlands.	Follow up: one month, Diabetes Self-care activities measure 10 items of self-report behaviour in the last 7 days	$F(1,62) = 3.84$, $p = 0.05$ Intervention: $M = 5.39$ ($SD = 1.05$). Control: $M = 5.24$ ($SD = 0.95$). Moderator: expectations of success

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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Marquardt et al. (2017) *****	Physical activity	Baeke inventory questionnaire (Baeke et al., 1982)	Intervention: MCII + structured information Control: structured information, unstructured information (treatment as usual- traditional stroke prevention intervention) Mode of delivery: administered by interventionist Duration: Single administration of MCII. 3 weeks of 2 x 1 hour lessons per week (=6 hours total).	Participants: $n = 183$ stroke survivors (M age = 57 years; body mass index: $M = 30$). 4 week = 44 (control) and 101 (intervention). Setting: three neurological hospitals, Germany)	Follow up: 0, 10, 20, 30, 40, and 50 weeks	Intervention: $M = -65.5$ ($SD = 24.8$). Control: $M = -57.9$, ($SD = 23.5$). Moderator: MCII.															

Key: MC= mental contrasting; II= implementation intentions; MCII= mental contrasting with implementation intentions, PA=physical activity, DM2= type II diabetes mellitus, PANS=Positive and Negative Syndrome scale, BDI=Beck Depression Inventory, IPAQ=International Physical Activity Questionnaire. Notes: *no difference detected but not reported, so $F=0.00$ or $t=0.00$ used in the analysis. **study 2 data used only, as study 1 did not meet the inclusion criteria (no control group). ****studies 1 (autonomous ward) and 2 (highly structured ward) entered individually into the review due to the differences in ward setting. In study two, participants received reminders about the sessions but not in study 1 ****excluded study 1 as it did not meet the principal inclusion criteria of having a health outcome (associative strength between expectancy of success vs obstacle-behaviour priming study). *****the diary data was used for the primary outcome measure data.

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

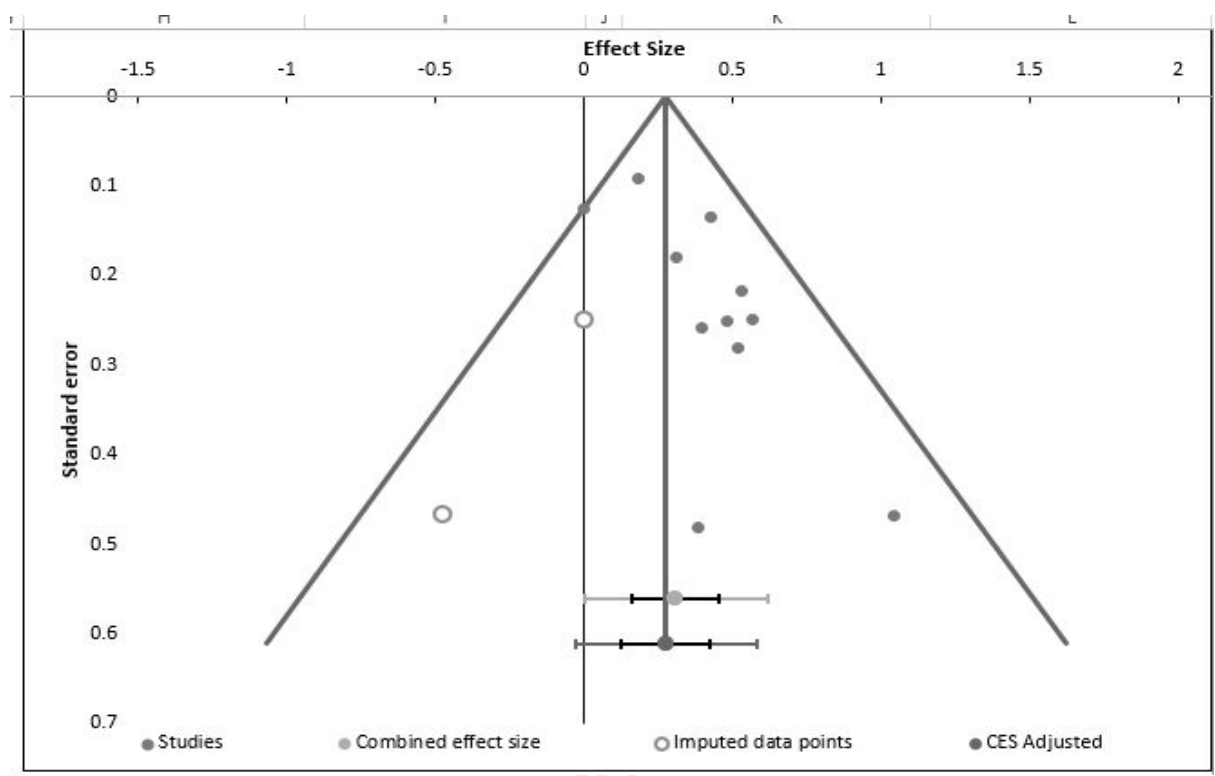


Figure 2. Funnel plot of Heterogeneity for the effects of mental contrasting on health behaviour (up to four weeks follow up)

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MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

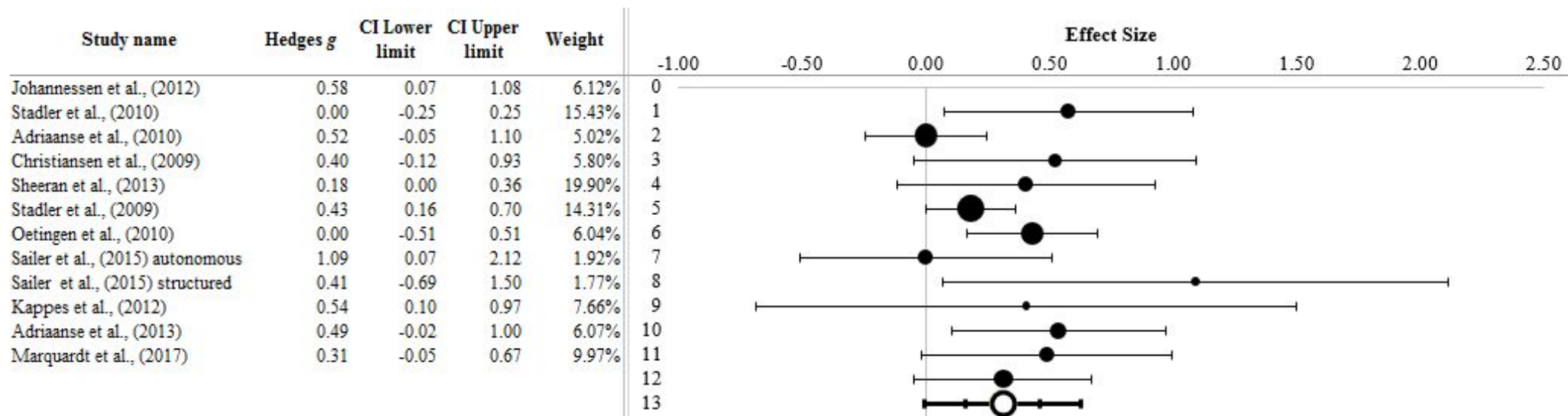


Figure 3. Effect sizes, confidence intervals and forest plot of effect sizes for the impact of mental contrasting on health behaviour (up to four weeks follow up)

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

Table 4

Inter-rater GRADE analysis of quality scores

Article	Blinding process	Allocation process	Follow up and withdrawals	Sparse data	Other methodological concerns	Final score (denoting number of concerns)
Johannessen et al., (2012)		X				1
Stadler et al., (2010)						0
Adriaanse et al., (2010)		X				1
Christiansen et al. (2010)						0
Sheeran et al. (2013)						0
Stadler et al. (2009)						0
Oettingen et al. (2010)	X	X				2
Sailer et al. (2015)						0
Kappes et al. (2012)	X				X	2
Adriaanse et al. (2013)	X				X	2
Marquardt et al. (2017)						0

Key: X = concern with item. Score: 0 = no problems, 1 = problem with one element, 2 = problems with two elements.

MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

Table 5

Independent-rater checks using the Cochrane tool for assessing bias

Reference	Adequate random sequence generation?*	Allocation concealment?	Blinding of participants and personnel? **	Blinding of outcome assessment?	Incomplete outcome data addressed?	Free of selective reporting	Free of other sources of bias? ***
Johannessen et al. (2012)	L	L	U	L	L	L	L
Stadler et al. (2010)	L	L	H	L	L	L	L
Adriaanse et al. (2010)	L	L	U	L	L	L	L
Sheeran et al. (2013)	L	L	L	U	L	L	L
Stadler et al. (2009)	L	L	H	L	L	L	L
Oettingen et al. (2010)	U	L	U	L	L	L	L
Sailer et al. (2015)	L	L	U	L	U	L	L

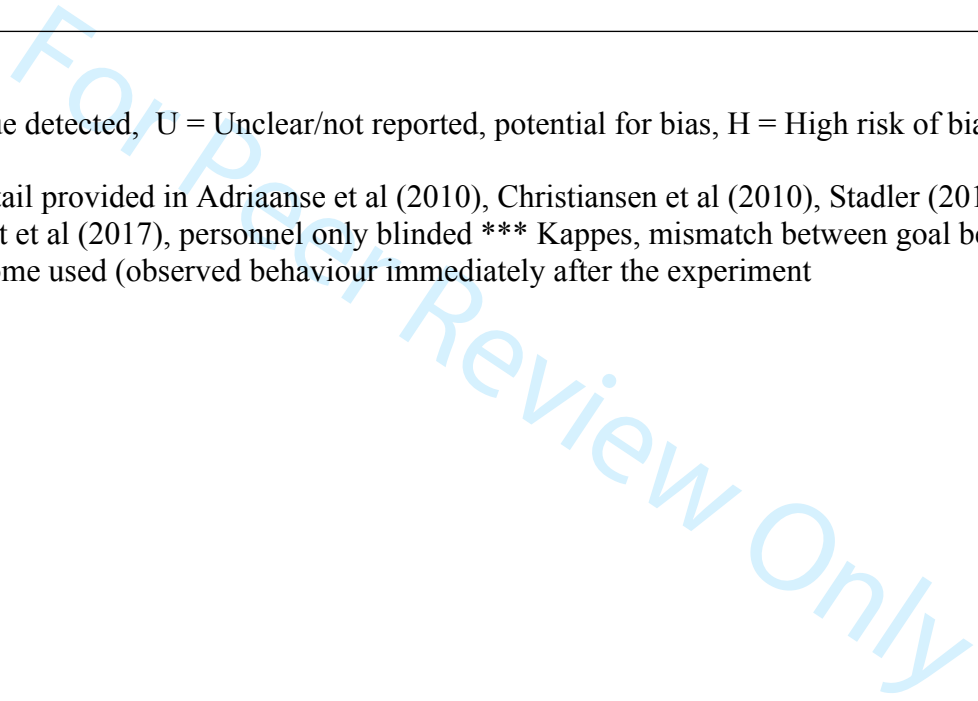
MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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3	Kappes et al.	L	L	U	L	L	L	L
4	(2012)							
5	Adriaanse et al.	U	L	L	L	L	L	L
6	(2013)							
7	Marquardt et	L	L	L	L	L	L	L
8	al. (2017)							
9								
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14	Key: L = Low risk of bias, no issue detected, U = Unclear/not reported, potential for bias, H = High risk of bias							
15	Notes:							
16	* No randomisation procedure detail provided in Adriaanse et al (2010), Christiansen et al (2010), Stadler (2013), Sailer (2015), Kappes (2012**							
17	Stadler et al (2009) and Marquardt et al (2017), personnel only blinded *** Kappes, mismatch between goal behaviour (increase long term							
18	physical activity levels) and outcome used (observed behaviour immediately after the experiment							
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46	Sensitivity: Internal							

Key: L = Low risk of bias, no issue detected, U = Unclear/not reported, potential for bias, H = High risk of bias

Notes:

* No randomisation procedure detail provided in Adriaanse et al (2010), Christiansen et al (2010), Stadler (2013), Sailer (2015), Kappes (2012** Stadler et al (2009) and Marquardt et al (2017), personnel only blinded *** Kappes, mismatch between goal behaviour (increase long term physical activity levels) and outcome used (observed behaviour immediately after the experiment



MENTAL CONTRASTING FOR HEALTH BEHAVIOUR CHANGE

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	Study name	Total samp	Experiment	Control san	Experiment	Experiment	Control Me	Control Std
1	Johanness	66	36	30	-216	116	-112	119
2	Adriaanse	64	32	32	5.39	1.05	5.24	0.95
3	Kappes et	87	45	42				
4	Oettingen	70	23	47				
5	Sheeran et	467	234	233	4.91	1.97	4.02	2.38
6	Stadler et	255	126	129	26.68		25.11	
7	Adriaanse	51	26	25				
8	Christiane	60	30	30	69.6	13.4	70.6	17.1
9	Sailer et al.	20	12	8				
10	Sailer et al.	16	7	9				
11	Stadler et	227	104	123				
12	Marquardt	145	101	44	-65.57	24.89	-57.9	23.55

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F value	T value	Cohens d	Moderator (Mediator coding)
			expectations of success
	3.84		expectations of success
	6.27		expectation between the obstacles of reality and instrumental means
	0		expectations of success, immediacy of action
	3.84		MCII, intention, perceived behavioural control
		0	MCII, intention, perceived behavioural control
	3.51		MCII, habit strength, intention, expectation of success
		0.404	MCII
	5.72		MCII
	0.65		MCII
		0.43	intention, perceived behavioural control, MCII

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