Supplementary Material

Methods

Patients

Patients were recruited through patient databases from earlier studies within the department of respiratory medicine, physiotherapy practices, a pulmonary rehabilitation clinic, general practitioners, newspaper and magazine advertisements and through flyers at the Maastricht university hospital between October 2017 and August 2019.

Randomization

An independent researcher randomized participants to the intervention or control group before the start of the intervention using a randomization list generated through www.randomization.com. Participants were randomized in blocks of 10 (5× intervention, 5× control). After randomizing 40 participants, the same independent researcher verified whether the age and gender distribution between the groups was similar. All researchers involved in the study remained blinded until data collection was completed.

Intervention

In the visuospatial task, participants were shown a 4×4 grid of squares, some of which flashed in blue one after the other. Participants indicated which squares lit up and in which order, by clicking the squares. In the backward digit span task, single digits were presented one by one on a computer screen, and participants reproduced the sequence in reverse order. In the letter spans task, letters were presented one by one in the centre of the screen, and simultaneously with every letter an accompanying arm lit up. After all letters and their corresponding arms had been presented, one specific arm was indicated, and participants entered the letter belonging to that arm on the keyboard of their computer.

The first session assessed working memory (WM) performance in both groups, to rule out baseline differences in WM capacity. Each task started with a sequence of three items. One item was added after two consecutive responses. The task was aborted after two consecutive incorrect responses.

In the second session, every task started with a sequence of three items to which one item was added if participants responded correctly on two consecutive trials. After two consecutive incorrect answers, the difficulty was reduced by one item on the next trial. Each session after the second was similarly increased or decreased in difficulty but started at the same difficulty level at which the previous session had ended.

Personnel

Three people were involved in data collection. All those involved held master of science (MSc) degrees and the Basic Certificate on Regulations and Organization in Clinical Studies (BROK),

which is required for those involved in running clinical trials in The Netherlands. Additionally, they were trained in the protocol of the study and the administration of the tasks before data collection began.

Goal setting

For easy interpretation and guided goal setting discussions, data was presented as a score and in graphical form. The individual Alternate Healthy Eating Index (AHEI)-2010 [1] formed the basis for the dietary component. All healthy lifestyle goals were always based on the individual participants' baseline data, so as to be feasible for every patient. It was also always discussed whether a participant perceived goals to be set as being feasible given his or her personal circumstances. The aim of this was to make reaching a goal maximally challenging but still attainable. For this reason, no uniform algorithm for determining the healthy lifestyle goals can be given. Diet-related goals could include dietary changes such as reducing red meat intake or increasing whole grain, fruit, or vegetable consumption. Physical activity was presented as daily step count and the amount of time spent in different physical activity categories (sitting / lying down, standing up and walking) in the form of graphs.

Healthy lifestyle goal recall

Participant responses were recorded in writing and scored using the procedure described by Hatchell *et al.* [2]. Field blank or no recall of the original message content was scored as 0 points, key points not directly related to the message themes as 1 point and key points directly related to the message themes as 2 points. As the correct answer to the 'procedure' question contained two elements (accelerometry and 24-hour dietary recall) the maximum score on this question was 4 points. For the 'content' question, participants could score 2 points per set goal. Their total number of points was subsequently divided by the total number of initially set goals, leading to a final maximum score of 2 for all participants, regardless of the number of initially set goals.

Cognitive stress susceptibility and perception

The socially evaluated cold pressor test was administered by an independent associate. Participants were asked to immerse their right hand up until the wrist in ice water (0-4°C) for as long as possible but for a maximum of 3 minutes. Participants' facial expression was simultaneously recorded as an additional stressor. Saliva samples to determine cortisol levels (Salivette, Sarstedt AG, Nürnbrecht, Germany) were taken immediately before and 20 minutes after the test. The latter time point was chosen as it is closest to the peak in SECPT-induced cortisol levels as reported earlier [3]. Samples were stored at -80°C until analysis. The pre-post immersion difference in cortisol levels served as outcome measure.

To determine participants' cortisol awakening response, participants were asked to take saliva samples (Salivette, Sarstedt AG, Nürnbrecht, Germany) on the morning of T2 and T3, upon waking and 30, 45 and 60 minutes after waking up. Samples were stored at -80°C until analysis. The area under the curve (AUC) [4] served as outcome measure.

Healthy lifestyle motivation

Participants' motivation towards healthy eating and exercising were measured using the Regulation of Eating Behaviours Scale (REBS) [5] and the Behavioural Regulation in Exercise Questionnaire (BREQ)-2 [6], respectively. These questionnaires investigate motivation from the perspective of self-determination theory [7]. The REBS results in six subscales (intrinsic, integrated, identified, introjected and external motivation and amotivation) with a range of 1-10; the BREQ-2 in five subscales (intrinsic, identified, introjected and external motivation and amotivation) with a range of 1-5.

Psychological wellbeing

Depressive symptomatology was assessed using the Beck Depression Inventory-II (BDI-II) [8]. Each of the questionnaire's 21 items corresponds to a symptom of depression and is answered on a scale of 0-3 as to reflect the way participants have felt for the past two weeks. Individual item scores are summed, leading to a maximum score of 63 points. A score below 13 indicates no depression, 14-19 indicates mild depression, 20-28 moderate depression, and 29 and higher severe depression [8].

Anxiety was measured using the Generalized Anxiety Disorder (GAD)-7 questionnaire [9]. It consists of seven questions answered on a scale of 0-3. Individual items are summed, leading to a maximum score of 21 points. Scores above 10 indicate the presence of a disorder [9].

Results

Healthy lifestyle motivation

The internal consistency of all subscales of the Regulation of Eating Behaviours Scale (REBS) ranged from acceptable to high except for introjected motivation at T0 and identified and introjected motivation at T3. The internal consistency of the intrinsic motivation and amotivation subscales of the Behavioural Regulation of Exercise Questionnaire (BREQ)-2 ranged from acceptable to high, but the consistency of the other scales was poorer (0.43-0.70) (see Supplementary Table 2).

Intrinsic motivation towards healthy eating showed a non-significant increase in the intervention group (p=0.113) and a non-significant decrease in the placebo group (p=0.086), leading to a significant interaction effect (p=0.021). Extrinsic motivation towards healthy eating and identified motivation towards exercising decreased significantly in both groups (p=0.020 and p=0.035, respectively) (see Supplementary Figures 1 and 2).

Psychological wellbeing

The internal consistency of the BDI and GAD-7 ranged from acceptable to high at all time points (see Supplementary Table 2).

The intervention did not affect participants' levels of depression or anxiety, but levels of depression were significantly higher in the placebo group than in the intervention group across phase 1 (p=0.006) (see Supplementary Figures 3 and 4).

Tables

Supplementary Table 1

CANTAB outcome measures

Task	Measure name	Description	Unit	Sense	Range (min-max)
MOT	Mean latency	The mean latency for a participant to correctly respond to the stimulus on screen during assessed trials	ms	—	0-6000
PAL	Total errors	The total number of times a participant selected an incorrect box when attempting to recall a pattern location, calculated across all assessed trials	#	—*	0-68
	Adjusted total errors	The number of times the participant chose the incorrect box for a stimulus on assessment problems (PALTE), plus an adjustment for the estimated number of errors they would have made on any problems, attempts, and recalls they did not reach. This measure allows comparison of performance on errors made across all participants regardless of those who terminated early versus those completing the final stage of the task.	#	—	0-70
	First-attempt memory score	The number of times a participant chose the correct box on their first attempt when recalling the pattern locations, calculated across all assessed trials	#	+	0-20
SST	Stop-signal reaction time	The estimate of time where an individual can successfully inhibit their responses 50% of the time. This covert measurement is sampled from the length of time between the go stimulus and the stop stimulus at which the participant is able to successfully inhibit their response on 50% of the trials. We can infer that this is the time before which all actions become ballistic and the participant is no longer able to cancel their action selection.	ms	—	0-500
RTI	Median simple reaction time	The median duration it took for a participant to release the response button after the presentation of a target stimulus. Calculated across correct, assessed trials in which the stimulus could appear in one location only.	ms	—	100-5100
	Mean simple movement time	The mean time taken for a participant to release the response button and select the target stimulus after it flashed yellow on screen. Calculated across correct, assessed trials in which the stimulus could appear in one location only.	ms	—	100-5100
	Median five-choice reaction time	The median duration it took for a participant to release the response button after the presentation of a target stimulus. Calculated across correct, assessed trials in which the stimulus could appear in any one of five locations.	ms	—	100-5100

Task	Measure name	Description	Unit	Sense	Range (min-max)
	Mean five-choice movement time	The median time taken for a participant to release the response button and select the target stimulus after it flashed yellow on screen. Calculated across correct, assessed trials in which the stimulus could appear in any one of five locations.	ms	—	100-5100
DMS	Correct responses	The percentage of assessment trials during which the participant chose the correct box on their first box choice. Calculated across all assessed trials (simultaneous presentation and all delays).	%	+	0-100
	Median correct latency	The median latency between the presentation of the response stimuli options and the participant selecting the correct box on their first attempt for trials containing a delay between target and response stimuli presentation. Calculated across all trials containing a delay.	ms	—	0-infinite
	Probability of error given error	The probability of an error occurring when the previous trial was responded to incorrectly. Calculated across all assessed trials (simultaneous presentation and all delays)	n/a	—	0-1
SWM	Between-errors	The number of times the participant incorrectly revisits a box in which a token has previously been found. Calculated across all assessed four, six and eight token trials.	#	—*	0-153
	Between-errors 4 boxes	The number of times a participant revisits a box in which a token has previously been found. Calculated across all trials with four tokens only.	#	—	0-35
	Between-errors 6 boxes	The number of times a participant revisits a box in which a token has previously been found. Calculated across all trials with six tokens only.	#	—	0-55
	Between-errors 8 boxes	The number of times a participant revisits a box in which a token has previously been found. Calculated across all trials with eight tokens only.	#	—	0-74
	Strategy	This measure is calculated based on the number of times a participant begins a new search pattern from the same box they started with previously. If they always begin a search from the same starting point, we infer that the participant is employing a planned strategy for finding the tokens. Therefore, a lower score indicates high strategy use (1 = they always begin the search from the same box), a high score indicates that they are beginning their searches from many different boxes.	n/a	—	1-12

Note. * Although a lower score is better, reaching a higher level (indicating better performance) is associated with increased likelihood of making mistakes. #: number; n/a: not applicable; MOT: motor orientation task; PAL: paired associates learning; SST: stop-signal task; RTI: reaction time task; DMS: delayed match-to-sample; SWM: spatial working memory.

Supplementary Table 2

Cronbach's α values for questionnaires at the different time points

Measure	T0/T1	T2	T3
REBS			
Intrinsic	0.876		0.886
Integrated	0.852		0.878
Identified	0.801		0.640
Introjected	0.513		0.461
External	0.764		0.786
Amotivation	0.720		0.800
BREQ-2			
Intrinsic	0.922		0.924
Identified	0.509		0.437
Introjected	0.586		0.682
External	0.734		0.914
Amotivation	0.583		0.695
Psychological wellbeing questionnaires			
BDI-II	0.826	0.834	0.895
GAD-7	0.868	0.771	0.790
PSS	0.802	0.738	0.823

Note. REBS: Regulation of Eating Behaviours Scale; BREQ-2: Behavioural Regulation of Exercise Questionnaire-2; BDI-II: Beck Depression Inventory-II; GAD-7: Generalized Anxiety Disorder-7; PSS: Perceived Stress Scale.

References

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