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Online cognitive behavioral therapy and problem-solving therapy for depressive symptoms: Exploring mechanisms of change

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ABSTRACT

The purpose of this study was to evaluate treatment specificity and potential mediators of two online therapies for depressive symptoms. We conducted a randomized controlled trial in which 263 participants were randomized to online cognitive behavioral therapy (CBT), online problem-solving therapy (PST) or a waiting list control group. Both treatments were more effective than the control group in reducing dysfunctional attitudes, worry, negative problem orientation and enhancing feelings of control. No differences between the treatments were found on each of the potential mediators. Furthermore, results suggest that dysfunctional attitudes, worrying, a negative problem orientation and perceived control all played a mediating role in CBT as well as in PST. Our findings suggest that regardless of the theoretical background to the therapy, the psychological processes necessary for symptom reduction seem to be comparable.

1. Background

Several forms of psychotherapy that have been subjected to empirical study have been shown to produce therapeutic change with depressed adults (Lambert, 2004). However, little is known about how or why treatment works. The psychological processes responsible for therapeutic change are often referred to as mediators. A mediator is an intervening variable that may account (statistically) for the relationship between the independent and dependent variable (Kazdin, 2007). There are several reasons why studying mediators is important. First of all, mediation analyses provide a test of the theoretical mechanisms that are assumed to underlie intervention effects. Identifying mediators and mechanisms of therapeutic change is also important for improving therapeutic techniques and maximizing treatment effectiveness. Furthermore, by understanding how treatment works, identifying moderators of treatment, variables on which the effectiveness of a given treatment may depend, will be facilitated.

Psychotherapy may be based on different theoretical frameworks; however, psychotherapy research is currently dominated by cognitive behavioral therapy (CBT) approaches. Cognitive behavioral interventions are based on the notion that cognitions play a central role in the etiology and maintenance of depression. Therefore, cognitive theory predicts that greater changes in cognitions occur during the course of cognitive therapy than during other interventions and that changes in depression-related cognitions mediate treatment changes in depressive symptomatology (Beck, Rush, Shaw, & Emery, 1979). Comparison studies show, however, that cognitive change can be a product of other therapeutic treatments, apart from CBT (Beevers & Miller, 2004; DeRubeis et al., 1990; Simons, Garfield, & Murphy, 1984; Zeiss, Lewinsohn, & Munoz, 1979). Findings are reinforced by a meta-analysis that concluded that cognitive change is no greater as a result of CBT than as a result of drug treatment or other therapies (Oei & Free, 1995). Also, in a component analysis of CBT, it was found that full combination CBT was no more effective for changing cognitions or reducing depression than behavioral activation alone or automatic thoughts treatment (Jacobson et al., 1996).

The results about the mediating role of cognitions for CBT are mixed. A recent review evaluating cognitive processes in cognitive therapy for depression indicates that most research generally supports cognitive mediation (Garratt & Ingram, 2007). The question of cognitive mediation in this review was framed as 'do changes in cognition as a function of cognitive therapy predict changes in depression?' Another review concluded that there is little empirical support for the role of cognitive change as causal in the symptomatic improvements achieved in cognitive behavior therapy (Longmore & Worrell, 2007). One study supporting the mediating role of negative cognitions during cognitive therapy showed, for example, that changes in cognitions for those treated

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with cognitive therapy predicted changes in depressive symptoms, while this was not the case for those who received pharmacotherapy (DeRubeis et al., 1990). In adults at risk for depression, changes in cognitions appear to mediate changes in depressive symptom level (Allart-van Dam, Hosman, Hoogduin, & Schaap, 2003; Munoz et al., 1995). In another study, it was found that an extreme responding style on cognitive measures predicted early relapse in residual depression, rather than the specific content of cognitions (Teasdale et al., 2001). According to the authors this is indicative of a "black and white" thinking style that both mediates relapse and responds differentially to treatment with cognitive therapy. A further study suggests that problem-solving appraisal might play a mediating role in CBT for depression reduction (Chen, Jordan, & Thompson, 2006).

Another perspective for examining depression has been the problem-solving framework that states that depression can be activated by the interaction of stressful events and/or problems and various problem-solving deficits (Nezu, 1987). Hence, if people learn new skills to cope with their problems it is assumed that their symptoms will improve. Problem-solving therapy (PST) is a treatment, in which the role of the patient in getting better is emphasized. Patients are trained to regain a sense of control of their live (Mynors-Wallis, 2005).

Does problem-solving work by learning problem-solving techniques and regaining control? The literature aimed at establishing empirical evidence for the theoretical underpinning of PST is very scarce and shows mixed results. For example, one study reported that PST did not result in a quicker or greater resolution of the patients' perception of the severity of their problems or in a greater sense of perceived control and self-control compared with medication (Mynors-Wallis, 2002). Other studies did demonstrate an association between improvements in problem-solving ability, a more internal locus of control and improvement in depression (Alexopoulos, Raue, & Arean, 2003; Arean et al., 1993; Nezu, 1986; Nezu & Perri, 1989).

There are, however, no studies that evaluate the role of cognitions as a mediator for PST and the role of problem-solving skills as a mediator for CBT. In fact, it is argued that several therapies for depression, although not specifically based on problem-solving principles, may in fact serve to actually increase patients' problem-solving skills, e.g. by including a truncated version of problem-solving therapy. For example, providing social skills training as part of a CBT programme to depressed patients may also serve to increase patients' problem solving by providing alternative methods of interacting with others. And cognitive techniques may serve to help depressed persons better define and formulate problem situations, as well as to decrease the cognitive distortions that might inhibit effective problem-solving attempts (Nezu, 1987).

Until now, no studies have evaluated which psychological processes are responsible for the therapeutic change in Internet-based self-help. Internet-based self-help has been found to be effective in the treatment of depression (Spek et al., 2007). Just as in face-to-face therapy, it is currently dominated by CBT approaches. Insight into the active mechanisms of Internet-based self-help is important as the Internet is becoming an increasingly valuable medium and an effective way for treating different kinds of psychological disorders. This study is aimed at examining potential mediators during Internet-based therapy for depressive symptoms.

In the current study, we compared online PST and online CBT with a waiting list control group for participants with depressive symptoms. In a previous paper, we demonstrated that both therapies are effective in reducing depressive symptoms. No significant differences in effectiveness between the two self-help interventions were found (Warmerdam, van Straten, Twisk, Riper, & Cuijpers, 2008). The comparison of the two treatments based on two different theoretical frameworks, allows us to compare the ways in which these treatments work by studying possible mediating variables. We tested whether four treatment-specific factors would account for the depression-reducing effects of the CBT and PST interventions, compared with a waiting list control group. The treatment-specific behaviors included dysfunctional attitudes, worrying, diverse problem-solving skills and perceived control. We further examined the temporal patterns of change in potential mediators and depressive symptomatology for all groups.

2. Method

2.1. Participants

A comprehensive description of the participants and the procedures can be found in (Warmerdam, van Straten, & Cuijpers, 2007). Participants were recruited through advertisements in daily and weekly newspapers and via the Internet. All adults aged 18 years and older with depressive symptoms willing to participate in a self-help course, were eligible for this study. The main inclusion criterion was the presence of depressive symptoms as indicated by a score of 16 or more on the Center of Epidemiologic Studies Depression – Scale (CES-D) (Bouma, Ranchor, Sanderman, & Van Sonderen, 1995). Other inclusion criteria were: sufficient knowledge of the Dutch language, Internet access and having an e-mail address. No exclusion criteria were defined.

A total of 263 participants were randomized to one of the three conditions: Internet-based CBT ($n = 88$), internet-based PST ($n = 88$) and a waiting list control group (WL, $n = 87$).

2.2. Interventions

2.2.1. PST

Our PST intervention is a Dutch adaptation of Self-Examination Therapy from Bowman (Bowman, Scogin, & Lyrene, 1995). We added more information, examples, exercises and forms. PST consisted of three steps. First the subjects described what really matters to them. Second they wrote down their current worries and problems. They divided these problems into three categories (a) unimportant problems (problems unrelated to the things that matter to them), (b) solvable problems, and (c) problems which cannot be solved (e.g. the loss of a loved one). For each of these three types of problem a different strategy is proposed to solve the problems or to learn to cope with the unimportant and unsolvable ones. The core element of PST is to address the solvable problems by the following six-step procedure: describing the problem, brainstorming, choosing the best solution, making a plan for carrying out the solution, actually carrying out the solution, evaluation. During the third and the last step, the subjects made a plan for the future in which they described how they will try to accomplish those things that matter most to them. The course took 5 weeks and consisted of one lesson a week.

2.2.2. CBT

The CBT intervention was developed by the Trimbos Institute – The Netherlands Institute of Mental Health and Addiction. This intervention is based on the "Coping with Depression" course (CWD) (Lewinsohn, Antonuccio, Breckenridge, & Teri, 1984), Dutch version (Cuijpers, Bonarius, & Van den Heuvel, 1995). CWD is a highly structured psycho-educational form of cognitive behavior therapy for depression. Theoretically, this course is based on the social learning theory according to which depression is associated with a decrease in pleasant and an increase in unpleasant person-environment interactions. People's problems are viewed as behavioral and cognitive patterns which can be unlearned or relearned.

Like CWD, CBT in this study included psycho-education and focused on skills such as relaxation, cognitive restructuring (including worrying), social skills and how to increase the number of pleasant events. The intervention made use of text, exercises, audio and video fragments. CBT consisted of eight lessons, one lesson a week. Twelve weeks later, a follow-up lesson took place.

2.2.3. Support

Subjects in both intervention were supported through e-mail during the intervention period by e-mail. Support was directed at helping the participant to work through the intervention, and not at developing a therapeutic relationship, or giving direct or individual advice on how to cope with depressive symptoms or other problems. The content of the feedback consisted of three aspects: showing empathy by acknowledging that the coach had read the assignments; being positive by giving compliments on what the participant had done; and giving suggestions on how to continue with the course. Every week, a standardized e-mail was sent to the participants. This e-mail communicated the lesson of that week and the date on which the assignments were to be sent to their coach. Participants received feedback within three working days. The average therapist time spent on each participant for providing feedback and answering questions via e-mail is estimated at 20 minutes per week.

2.3. Outcome measures

All participants were contacted for outcome assessments at 5 and 8 weeks after the start of the interventions. All questionnaires were administered online.

2.3.1. Depressive symptoms

The Center for Epidemiological Studies Depression Scale (CES-D, Dutch version; (Bouma et al., 1995) was the primary outcome measure for depressive symptoms. The CES-D is widely used for identifying people with depressive symptomatology. The CES-D consists of 20 items and the total score varies between 0 and 60 with higher scores indicating more depression.

2.3.2. Dysfunctional cognitions

The Dysfunctional Attitudes Scale (DAS) is a 40-item self-report measure designed to assess cognitive vulnerability to depression (Weismann, 1979). The DAS is one of the most widely used questionnaires to measure cognitions in relation to depression. Scores range from 40 to 280. The Dutch version of the DAS showed good reliability and satisfactory validity (Raes, Hermans, Van den Broeck, & Eelen, 2005).

2.3.3. Worrying

Worrying was measured by the Penn State Worry Questionnaire (PSWQ). The PSWQ (Meyer, Miller, Metzger, & Borkovec, 1990) is a 16-item self-report inventory. Scores range from 16 to 80 with higher scores representing more worry. De PSWQ showed good reliability in normal and clinical populations (Kerkhof et al., 2000).

2.3.4. Problem-Solving skills

The Social Problem-Solving Inventory-Revised (SPSI-R) developed by D'Zurilla, was used for measuring problem-solving skills. This questionnaire was designed to measure people's ability to resolve problems of everyday living. The SPSI-R contains 52 items and consists of the following five scales: Positive Problem Orientation (PPO), Negative Problem Orientation (NPO), Rational Problem Solving (RPS), Impulsivity/Carelessness Style (ICS) and Avoidance Style (AS). Alphas for these five scales ranged from 0.76 to 0.92 and test–retest reliability ranged from 0.72 to 0.88 (D'Zurilla, Chang, Nottingham, & Faccini, 1998).

2.3.5. Perceived control

We assessed perceived control with the Mastery Scale (Pearlin & Schooler, 1978). This scale has 7 items regarding how much an individual perceives having control over things in his or her life. Items are rated on a 4-point scale with higher scores indicating greater perceived control. The questionnaire has good psychometric properties (Pearlin et al., 1978).

2.4. Statistical analysis

Baseline differences in demographic and potential mediators were investigated using Chi-square tests, *t*-tests and analysis of variance (ANOVA). Attrition was defined as completing none or one of the two post-treatment measures.

Mediated treatment effects were assessed following the traditional requirements for testing mediation (Baron & Kenny, 1986). First, treatment condition should predict change in the outcome. Second, treatment condition should predict change in the potential mediator. Third, change in the mediator should be significantly associated with change in the outcome. Fourth, the effect of treatment condition on change in the outcome should be attenuated when change in the mediator is statistically controlled. The last two steps are estimated in the same equation. The Sobel test was used to ascertain whether the indirect effect from condition to depression differed significantly from zero.

Mediation analyses were performed using Linear Mixed Modeling (LMM) and based on the intention-to-treat sample. LMM includes incomplete cases in the analysis and employs restricted maximum likelihood estimation to calculate parameter estimates. LMM assumes that missing data are missing at random. Time was treated as a continuous covariate. Treatment condition was included as a fixed effect and the intercept as a random effect. We used the 8 weeks measurement as the post-treatment assessment for both CBT and PST. Alpha was set at 0.05. Between-group effect sizes were calculated according to Cohen's *d*. Effect sizes of 0.8 can be assumed to be large, while effect sizes of 0.5 are moderate, and effect sizes of 0.2 are small (Cohen, 1988). Reported effect sizes are based on participants who completed questionnaires.

We examined the relationship between early change in the potential mediators and subsequent change in depression. The 5 weeks measurement represented mid-treatment. Therefore, we computed change scores in depression scores from mid-treatment to post-treatment and we computed change scores in the mediator between baseline and mid-treatment. For each mediator, we used multiple regression to predict late change in depression from early change in the mediator.

3. Results

3.1. Participants

The average age of the participants at baseline was 45 years (SD = 12.1). Most participants were female (71%) and the majority (91%) had been educated at a medium or higher level. Almost all participants were Dutch (92%). There were no statistically significant differences between the three groups with respect to the demographics. The mean score of the participants on the CES-D at baseline was 31.7 (SD: 7.5, median: 31.0). There were no statistically significant differences between the three groups at baseline with respect to depressive symptoms or potential mediators (Table 1).

Table 1
Descriptive statistics at each assessment.

Variable and treatment condition	baseline			5 weeks			8 weeks		
	M	SD	*N*	*M*	SD	*N*	*M*	SD	*N*
Depression									
CBT	31.2	7.5	88	22.8	9.2	61	19.0	9.8	51
PST	31.9	7.4	88	19.6	9.1	52	19.8	10.0	51
WL	32.1	7.5	87	25.2	9.2	71	25.0	11.4	71
Dysfunctional attitudes									
CBT	152.5	30.6	85	131.9	31.7	59	127.7	33.5	51
PST	159.7	37.0	88	130.7	33.2	51	128.5	32.3	51
WL	153.8	33.4	85	148.0	35.4	70	145.1	37.3	69
Worrying									
CBT	58.2	10.1	83	50.6	15.0	58	46.1	14.3	50
PST	59.5	11.1	85	42.8	13.1	49	45.8	14.0	50
WL	61.8	11.4	84	56.8	15.3	67	56.3	14.9	66
Perceived control									
CBT	22.7	3.8	83	20.5	4.6	58	19.7	4.1	50
PST	23.3	4.2	85	19.9	4.6	49	20.0	4.6	50
WL	23.2	3.8	84	22.5	4.2	67	22.9	4.2	65
Positive problem orientation									
CBT	8.8	2.9	82	9.6	3.0	58	9.7	2.9	50
PST	9.1	3.3	85	10.4	2.9	50	10.4	3.1	50
WL	8.6	2.4	85	9.0	3.0	67	8.8	2.8	66
Negative problem orientation									
CBT	23.4	6.0	82	20.1	6.5	58	18.0	6.6	50
PST	23.3	7.1	85	17.7	6.8	49	16.6	5.9	50
WL	23.8	6.0	85	21.7	6.7	67	21.4	7.1	66
Rational problem solving									
CBT	37.1	11.8	82	38.7	11.2	58	38.0	11.9	50
PST	39.9	11.2	85	44.1	12.3	49	43.7	10.5	50
WL	37.0	10.2	85	37.9	10.6	67	37.7	11.1	66
Avoidance									
CBT	13.4	5.5	82	11.4	4.8	58	11.1	4.7	50
PST	13.1	5.6	85	10.2	5.2	50	9.5	4.9	50
WL	13.4	5.6	85	12.3	5.4	67	12.9	5.5	66
Impulsivity/Carelessness									
CBT	17.2	6.5	82	15.8	5.4	58	16.0	5.9	50
PST	15.7	5.8	85	14.6	5.7	49	14.4	6.0	50
WL	16.4	5.8	85	15.5	5.8	67	16.3	5.9	66

Abbreviations: CBT = cognitive behavior therapy, PST = problem-solving therapy, WL = waiting list control group.

3.2. Treatment adherence and attrition

Of those participants assigned to CBT, 63 (71.6%) participants completed at least half of the intervention while 34 (38.6%) completed the whole course. With PST, 49 (55.7%) participants completed three or more sessions and 33 (37.5%) finished the whole course.

Attrition rates for the full sample were 30% at 5 weeks and 34% at the 8 weeks assessment. Reasons for the high level of attrition were unknown. Some participants dropped out because of other treatment, feeling better, lack of time, and problems understanding the computer program. The majority did, however, not specify any reason. Attrition rates were lower in the control group than in both intervention groups at all assessments (t_{5wk}WL: 18%, $n = 16$, t_{5wk} CBT: 31%, $n = 27$, t_{5wk} PST: 41%, $n = 36$, $\chi^2(2, 263) = 10.58$, $p = 0.01$; t_{8wk} WL: 18%, $n = 16$, t_{8wk} CBT: 42%, $n = 37$, t_{8wk} PST: 42%, $n = 37$, $\chi^2(2, 263) = 14.47$, $p = 0.001$). Responders were more likely to have been born in the Netherlands (95%, $n = 161$) than non-responders (87%, $n = 82$, $\chi^2(1, 263) = 5.55$, $p = 0.02$), they were older (46.6 compared to 41.9 years, $t(259) = -2.91$, $p = 0.004$), and had lower scores at baseline on negative problem orientation ($t(250) = 2.10$, $p = 0.037$) and avoidance style ($t(250) = 2.99$, $p = 0.003$).

3.3. Association between treatment and depression

As previously reported, CBT and PST participants reported greater reductions from baseline to post-treatment in CES-D scores (CBT: $d = 0.54$, PST: $d = 0.47$) than WL participants (Warmerdam et al., 2008). Thus, the first requirement for a test of mediation was fulfilled.

3.4. Association between treatment and mediating variables

According to the second step, treatment condition should predict change in the potential mediator. First, we assessed the difference between each of the interventions and the waiting list (Table 2). Participants who received either CBT or PST improved more than participants on the waiting list on dysfunctional attitudes, worrying, perceived control and a negative problem orientation.

No differences were found between any of the interventions and the waiting list condition on rational problem solving and impulsivity/carelessness. For positive problem orientation and avoidance style, the results showed that only PST participants improved significantly more than the waiting list participants. Furthermore, no differences were found between CBT and PST on each of the potential mediating variables.

3.5. Association between treatment and depression after controlling for mediating variables

The last two steps of mediation involved regressing depression scores on possible mediators and treatment condition to assess whether the effect of treatment condition on depression scores was significantly attenuated after controlling for the mediator. Table 3 summarizes regression coefficients of the interaction between condition and time after adding one of the potential mediators.

Table 2
Estimated effects from baseline to 8 weeks on potential mediators.

Variable	Group × Time		Effect size	
	β	*t*	*p*	*d* (95% CI)
Dysfunctional attitudes				
CBT vs. WL	−2.14	−4.19	<0.001	0.50 (0.24–0.77)
PST vs. WL	−2.72	−5.30	<0.001	0.48 (0.23–0.74)
Worrying				
CBT vs. WL	−0.83	−3.05	0.002	0.71 (0.43–0.98)
PST vs. WL	−1.07	−3.92	<0.001	0.73 (0.45–1.00)
Perceived control				
CBT vs. WL	−0.32	−3.73	<0.001	0.74 (0.48–1.01)
PST vs. WL	−0.33	−3.89	<0.001	0.67 (0.38–0.97)
Positive problem orientation				
CBT vs. WL	0.08	1.47	0.143	0.31 (0.04–0.58)
PST vs. WL	0.11	1.97	0.050	0.55 (0.26–0.84)
Negative problem orientation				
CBT vs. WL	−0.33	−2.77	0.006	0.51 (0.24–0.79)
PST vs. WL	−0.42	−3.53	<0.001	0.73 (0.48–0.97)
Rational problem solving				
CBT vs. WL	0.09	0.48	0.630	0.03 (−0.27–0.32)
PST vs. WL	0.23	1.23	0.219	0.54 (0.28–0.80)
Avoidance				
CBT vs. WL	−0.16	−1.83	0.069	0.35 (0.10–0.61)
PST vs. WL	−0.20	−2.28	0.023	0.67 (0.40–0.94)
Impulsivity/Carelessness				
CBT vs. WL	−0.10	−1.08	0.280	0.05 (−0.22–0.32)
PST vs. WL	−0.02	−0.17	0.862	0.32 (0.04–0.60)

Abbreviations: CBT = cognitive behavior therapy, PST = problem-solving therapy, WL = waiting list control group.

Table 3
Regression coefficients for Group × Time interaction with depressive symptoms as the dependent variable.

Potential mediator	CBT vs. WL		PST vs. WL	
	Group × Time		Group × Time	
	β	p	β	p
	−0.62	<0.001	−0.63	<0.001
Dysfunctional attitudes	−0.30	0.089	−0.24	0.188
Worrying	−0.27	0.107	−0.15	0.377
Perceived control	−0.25	0.146	−0.21	0.230
Negative problem orientation	−0.35	0.041	−0.25	0.155
Avoidance			−0.44	0.018

Abbreviations: CBT = cognitive behavior therapy, PST = problem-solving therapy, WL = waiting list control group.

For CBT, the Sobel test indicated significant mediation for dysfunctional attitudes ($Z = -3.96$, $p < 0.001$), worrying ($Z = -3.04$, $p = 0.002$), perceived control ($Z = -3.45$, $p < 0.001$) and a negative problem orientation ($Z = -2.71$, $p = 0.007$). When dysfunctional attitudes was added to the equation, the effect of CBT on depression was no longer significant ($\beta = -0.30$, $p = 0.089$). Also worrying and perceived control attenuated the path between treatment and depression (respectively $\beta = -0.27$, $p = 0.107$ and $\beta = -0.25$, $p = 0.146$). Adding a negative problem orientation still resulted in a significant group × time interaction ($\beta = -0.35$, $p = 0.041$) which means that a negative problem orientation partially mediated the path from treatment to depression.

After these separate analyses for each mediator, we moved on to multiple mediation. We found that when the four mediators were entered simultaneously, the path from dysfunctional attitudes to depression was no longer significant ($\beta = 0.02$, $p = 0.150$) while the other mediators significantly predicted depression (worrying: $\beta = 0.23$, $p < 0.001$, perceived control: $\beta = 0.55$, $p < 0.001$, negative problem orientation: $\beta = 0.28$, $p < 0.001$). Controlling for worrying, perceived control and a negative problem orientation, reduced the interaction coefficient by 81%, from −0.62 to −0.12. This means that the reduction of depression is mostly explained by improvement in worrying, perceived control and a negative problem orientation.

For PST, the Sobel test indicated significant mediation for dysfunctional attitudes ($Z = -4.87$, $p < 0.001$), worrying ($Z = -3.89$, $p < 0.001$), perceived control ($Z = -3.55$, $p < 0.001$), a negative problem orientation ($Z = -3.41$, $p < 0.001$) and avoidance ($Z = -2.15$, $p = 0.032$). After accounting for dysfunctional attitudes the path from group to depression ($\beta = -0.24$) was no longer significant ($p = 0.188$). Controlling for worrying also resulted in a non-significant group × time interaction ($\beta = -0.15$, $p = 0.377$). Adding perceived control and a negative problem orientation to the equation also reduced the effect of PST on depression (respectively $\beta = -0.21$, $p = 0.230$ and $\beta = -0.25$, $p = 0.155$). The effect of PST on depression was partially mediated by avoidance ($\beta = -0.44$, $p = 0.018$).

Multiple mediation showed that worrying, perceived control and a negative problem orientation significantly predicted depression (respectively: $\beta = 0.24$, $p < 0.001$, $\beta = 0.55$, $p < 0.001$, $\beta = 0.27$, $p < 0.001$) while attitudes and avoidance did not (attitudes: $\beta = 0.02$, $p = 0.154$, avoidance: $\beta = 0.03$, $p = 0.693$). Adding worrying, perceived control, and a negative problem orientation simultaneously, totally explained the effect of PST (from −0.63 to 0.01).

3.6. Relationship early change in potential mediators and late change in depression

To examine the relationship of change in the potential mediators and change in depression, we calculated correlations between these measures. First, we computed correlations between change in depression and change to the specific variables during the first 5 weeks (Table 4). Correlations between depression and each of the specific variables were low to moderate and in the expected direction.

Then we calculated correlations between change to the specific measures during the first 5 weeks and change in depression during the last 3 weeks (Table 4). Most correlations were not significant, except for dysfunctional attitudes during CBT and rational problem solving during PST. Greater decrease in dysfunctional attitudes during the first 5 weeks corresponded with smaller decrease in depressive symptom scores in the last 3 weeks during CBT. As early change in attitudes was negatively related to late depression change, no additional regression analysis was performed. For PST, greater increase in rational problem solving during the first 5 weeks corresponded with greater decrease in depressive symptom scores in the last 3 weeks. Regression analysis showed no significant effect for change in rational problem solving as a predictor for change in depression.

The percentage of improvement occurring in the first 5 weeks was calculated. Of the total improvement in depressive symptoms during CBT, PST and WL, 69%, 100% and 97%, respectively, took place in the first 5 weeks.

4. Discussion

The purpose of this study was to contribute to research on mechanisms of change in psychological treatment for depressive symptoms. We compared two theoretically different treatments, online CBT and online PST, with a waiting list control group. The first requirement of testing mediation was met, as we found in a previous study that both treatments were significantly more effective in reducing depression than a waiting list control group (Warmerdam et al., 2008). The current study showed that both treatments were more effective than the control group in reducing dysfunctional attitudes, worry, negative problem orientation and enhancing feelings of control (second requirement). No differences between the treatments were found. In the third and fourth step of the mediation analysis, we demonstrated that therapeutic change during CBT and PST could be due to changes in attitudes, worry, a negative problem orientation and perceived control. Avoidance also formed a potential mediator for PST.

In view of the fact that both treatments were more effective in reducing dysfunctional attitudes, worry, a negative problem orientation and in increasing feelings of control than the control group, it is not surprising that these target behaviors played a mediational role in both CBT and PST. The results are in line with other studies that supported the role of cognitions and perceived control as a mediating variable (Alexopoulos et al., 2003; Allart-van Dam et al., 2003; Munoz et al., 1995). This study also showed that

Table 4
Correlations between change in potential mediator and change in depression.

Variable	ΔM_{t0t5} with ΔD_{t0t5}			ΔM_{t0t5} with ΔD_{t5t8}		
	CBT	PST	WL	CBT	PST	WL
Dysfunctional attitudes	0.63**	0.50**	31**	−0.33*	−0.11	0.03
Worrying	0.59**	0.53**	41**	−0.13	−0.08	−0.23
Mastery	0.46**	0.50**	42**	−0.18	0.21	−0.21
Negative problem orientation	0.46**	0.53**	51**	−0.14	−0.04	−0.10
Positive problem orientation	−0.19	−0.13	−0.22	0.03	0.10	0.07
Rational problem orientation	−0.20	−0.21	−0.27*	−0.07	−0.31*	0.04
Avoidance	0.34**	0.38**	0.23	0.09	−0.06	−0.16
Impulsivity/Carelessness	0.35**	0.08	0.22	−0.03	−0.09	−0.07

ΔM_{t0t5}: change in mediator in the first 5 weeks. ΔD_{t0t5}: change in depression in the first 5 weeks.
ΔD_{t5t8}: change in depression in the last 3 weeks.

dysfunctional attitudes are a potential mediator for PST and perceived control for CBT – a finding one would not expect when considering the theoretical background of both therapies. Worry and a negative problem orientation are both cognitive processes and negatively affect-laden which could explain their possible mediating role.

How to explain that we found the same mediators for both treatments from a theoretical point of view? One possibility is that the changes in mediators are proxies for another process that leads to changes in depression. These processes could be common non-specific therapy factors, like expectations and credibility about the therapy. These processes could also be other, more fundamental, cognitive processes for which the exact constructs needs to be defined. Bandura's article on self-efficacy is also relevant in this context. Bandura argued that changes achieved by different forms of treatment, derive from a common cognitive mechanism, i.e., self-efficacy expectations. Expectations of self-efficacy are assumed to affect both initiation and persistence of coping behavior resulting in psychological changes (Bandura, 1977).

Inferring from the work of Borkovec, Newman, Pincus, and Lytle (2002), another possibility is that the different components of CBT and PST work on different aspects of depression. Depression consists of interacting physiological, affective, behavioral, and cognitive aspects. Any treatment which effectively targets one of these aspects may lead to a change in all of them (Borkovec et al., 2002). For example, CBT in this study works directly on the behavioral and the cognitive aspects thereby leading to change in affective and physiological aspects which eventually results in change in the outcome. Likewise, PST produces change in the behavioral aspects but also leads to corresponding changes in the cognitive, affective and physiological aspects, resulting in depression change.

If all the mediators were considered at the same time, only worry, perceived control and a negative problem orientation remained significant mediators of the effect of both CBT and PST on depressive symptoms. This implies that the change of attitudes may not have such a strong impact on depression as the change in worry, feelings of control and a negative view of problem solving. This assumes that all constructs were measured well. However, the removal of dysfunctional attitudes from the final model could be a statistical artefact due to differences in psychometric properties of the measures. It should also be noted that in practice these different psychological mechanisms change simultaneuously making it difficult to analyse the effect of one mediator while keeping the other mediators constant.

The finding that early change in dysfunctional thinking was negatively related with late depression change is remarkable but understandable. As most of the improvement in depressive symptoms took place during the first 5 weeks, there was not much improvement to be left for the last 3 weeks. The rapid improvement in depressive symptoms at the start of treatment is in line with previous research (Ilardi & Craighead, 1994). The present findings are, however, inconsistent with (DeRubeis et al., 1990) who found that changes from intake to mid-treatment on three of the four cognitive measures (one of which was the DAS) predicted reductions in depression scores from mid-treatment to the end of cognitive treatment. The difference in results could be explained by the timing of the mid-treatment assessment which was being conducted later in our study (at 5 weeks, while mid-treatment represented 4 weeks). The length of the treatment could also be an explanation, as there is more time to improve with longer treatments.

There are some limitations that should be noted. An important limitation is that with our design we cannot differentiate between cause and effect. Thus, skill changes could be mediators or could simply be symptoms of depression reflective of the multidomain improvements associated with reduced depression levels. A more rigorous test of mediation would require that changes in the specific variables temporally precede changes in the outcome variables. Also for CBT, the measurement at 5 weeks was too late to assess whether changes in mediators preceded changes in depression. Most of the improvement in depression had already taken place at 5 weeks.

The second limitation concerns the measured variables. All measures are self-reported and we didn't assess other possible mediators like automatic thoughts, social skills, activity level, non-specific variables and variables related to the treatment format. For example, Persons & Burns (1985) reported that changes in mood across individual psychotherapy sessions were strongly correlated with changes in automatic thoughts during sessions. It's recommended that future trials should measure more possible mediators and depression outcomes repeatedly across time to assess whether changes in mediators temporally precede changes in the outcome variable.

Another limitation concerns attrition. The high attrition rate is a general problem in Internet interventions (Eysenbach, 2005). We could find no indications for selection bias since we could not demonstrate clear baseline differences on the clinical outcome measures between participants who completed questionnaires and participants who did not (Warmerdam et al., 2008). The bias that may have been introduced was accounted for by performing maximum likelihood estimation for missing data which is a highly recommend method (Schafer & Graham, 2002).

Two of the strengths of this study were the measurement of more diverse potential mediators and the measurement at 5 weeks to analyze temporal changes of potential mediators and depression. Most studies that attempt to uncover mediation focus on cognitive variables, especially dysfunctional attitudes and automatic thoughts. This study evaluated dysfunctional attitudes but also worry, perceived control and various problem-solving skills. Regarding the mid-treatment assessment during CBT, this evaluation gave some insight into the temporal changes of depression over time. However, to test whether changes in mediators precede changes in depression, requires the assessment of both mediators and outcome variables at the beginning of the treatment.

In sum, this study showed that both online CBT and online PST have significant effects on dysfunctional attitudes, worry, a negative problem orientation and perceived control, with low to moderate effect sizes. We found no evidence that online therapies based on different theoretical backgrounds work through different psychological mechanisms. What exactly the working mechanisms are for online CBT and PST remain to be solved. It's recommended that future studies focus more on non-specific factors as most of the improvement takes place in the early stages of treatment.

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