The effects of attentional bias modification on rumination and worry about current concerns: a case-series

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Abstract

Rumination and worry are thinking styles closely associated with depression and anxiety, and there is evidence to suggest that an attentional bias towards negative stimuli plays a role in these associations. A hypothesis arising from the attentional bias literature is that depressive rumination results from an impaired ability to disengage attention from self-referent negative thoughts, and that reducing this bias will reduce rumination and depressive symptoms. A broader theory proposes that rumination is the result of discrepancies between perceived and expected progress towards goals. Current concerns are mental states representative of such goal progress discrepancies. The current study tests the disengagement hypothesis within this goal progress theory of rumination. It aims to reduce attentional bias to towards negative words and words associated with an unresolved current concern, and detect corresponding reductions in rumination, worry, mood and symptoms of anxiety and depression. Participants were 12 (10 female) university students or staff scoring low for depressive symptoms but high for trait rumination and/or trait worry. Attentional bias was measured using a dot-probe task. Attentional bias modification training (ABMT) consisted of a modified dot-probe task. Stimuli were negative–neutral word pairs, and neutral words paired with words associated with a current concern chosen by each participant. Using a multiple baseline case-series design, each participant completed between 25–35 dot-probe sessions at home, a minimum of 8 sessions also included ABMT. There were no significant post-training effects on trait rumination, trait worry, and symptoms of depression and anxiety. Randomisation tests showed no significant post ABM reduction in attentional bias towards negative words, attentional bias towards current concern words, rumination towards the concern, positive affect, negative affect or depressive symptoms. The limitations of the dot-probe task are discussed and the cost-effectiveness of ABMT as psychological therapy evaluated.

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Introduction

Anxiety and depression are major challenges to public health and are commonly co-morbid (Kessler, DuPont, Berglund & Wittchen, 1999), with mixed depression and anxiety were reported as being present in 9.0% of English adults in the most recent household survey (McManus, Meltzer, Brugha, Bebbington & Jenkins, 2009). Whilst this reflects a level of stability in prevalence over the preceding 7 years, Mathers and Loncar (2006) project that in 2030 unipolar depression will be the second most common cause of disability-adjusted life years. Based on 2007 prevalence rates, McCrone, Dhanasiri, Patel, Knapp and Lawton-Smith (2008) estimate that the combined cost of depression and anxiety services in England in 2026 will be £5 billion, with lost employment bringing the total cost to £26.4 billion. To address these issues, McCrone et al. (2008) recommend expanding provision of evidence-based interventions in primary care settings with a focus on the most cost-effective means of delivery, such as Internet delivered cognitive behavioural therapy (I-CBT).

Despite their strong evidence-base, pharmacological and psychological treatments are only partially effective. Combinations of these treatments are effective at treating depression in about 33% of cases (Andrews, Issakidis, Sanderson, Corry & Lapsley, 2004), and CBT, the gold standard psychological treatments, has response rates of 50% or less for treating anxiety disorders (Schneider, Arch & Wolitzky-Taylor, 2015). In England in May 2015, 96.1% people referred for a course of psychological therapy waited less than 18 weeks for treatment (HSIC Community and Mental Health Team, 2015), which is an improvement on the British average waiting times of six to nine months in 2007 (Haliwell, Main & Richardson, 2007). However, there are high costs associated with delivering psychological therapies and some evidence that the efficacy of CBT for treating depression is falling (Johnsen & Friborg, 2015).

Technological advances may improve cost-effective treatment delivery. I-CBT is a viable treatment for adults with depression and some anxiety disorders (Arnberg, Linton, Hultcrantz, Heintz & Jonsson, 2014), and mobile apps including real-time monitoring of mood and behaviour could also contribute (Cuijpers, 2015). More

research is required to ascertain whether this potential can be realised in practice. An expanded understanding of the role played by cognitive mechanisms such as attention and memory in mood disorders is reflected in the greater precision of newer treatments. For example, Mindfulness Based Cognitive Therapy (MBCT) is a treatment which specifically targets depressive relapse (Segal, Williams & Teasdale, 2012), which is common and becomes increasingly likely with each depressive episode (Haliwell et al., 2007). The most effective new treatments for depression and anxiety are likely to draw on evidence which explicates the role that cognitive mechanisms play in these common disorders, and computer tasks offer one cost-effective means of delivery.

Rumination is a repetitive thinking style closely linked to depression and anxiety, which in turn are associated with psychological distress and physical health difficulties. A more precise definition of rumination distinguishes unconstructive repetitive thoughts associated with depression and anxiety, from more constructive forms of repetitive thought which support planning, problem solving, and healthy self-reflection (Watkins, 2008). Whilst there is broad consensus regarding the role played by rumination, the ten models and five measures reviewed by Smith and Alloy (2009) demonstrate that "there is no unified definition [...] or standard way of measuring it" Smith and Alloy (2009, p. 117). Response styles theory (RST; Nolen-Hoeksema, 1991) considers rumination to be a particular response to depressed mood where a person tends to focus on "causes, consequences and symptoms of one's negative affect" (Smith & Alloy, 2009, p. 117) thereby prolonging low mood and depressive episodes. The Ruminative Responses Scale (RRS) (Treynor, Gonzalez & Nolen-Hoeksema, 2003), derived from RST, is considered the gold standard trait measure of rumination, containing sub scales which can distinguish maladaptive rumination in the form of 'depressive brooding' from the more adaptive 'reflective pondering'. In support of RST, dysphoric mood is significantly increased by a rumination induction and significantly decreased by a distraction induction, in dysphoric but not in non-dysphoric participants (Nolen-Hoeksema, Wisco & Lyubomirsky, 2008). However, the positive effects of distraction are temporary (Nolen-Hoeksema et al., 2008), and alternative models of rumination may suggest more

effective ways to reduce its occurrence.

The goal progress theory of rumination (Martin & Tesser, 1996) is one such model, which proposes that rumination is initiated by unexpected progress (more or less) towards a goal[1]. This account draws on ideas from control theory (Carver & Scheier, 1982) in that goal discrepancies represent system states outside of desirable thresholds which cognitive process try to restore through feedback mechanisms. Rumination is in essence this deployment of attention, memory and consciousness, and will remain present until goal progress becomes satisfactory, the goal is perceived as being met, or is abandoned. For Martin and Tesser (1996, p. 7), rumination is "a class of conscious thoughts that revolve around a common instrumental theme and that recur in the absence of immediate environmental demands requiring the thoughts". A concept closely related to unresolved goals is the 'current concern', which Klinger and Cox (2011, p.14) define as "the state of an individual between the two time points of becoming committed to pursuing a particular goal and either attaining it or giving it up". Current concerns link goal progress to rumination in that they increase an individual's sensitivity to "notice, recall, think about, dream about and act on cues associated with the goal pursuit" (Klinger & Cox, 2011, p.2). Similarly, negative affect draws attention towrads unsatisfactory goal progress (Martin & Tesser, 1996).

Worry is a thought process with both similarities and differences to rumination. Borkovec, Robinson, Pruzinsky and DePree (1983, p. 10) define worry as "a chain of thoughts and images, negatively affect-laden and relatively uncontrollable". Whilst some studies associate depression with rumination and worry with anxiety, measures of rumination and worry are highly correlated (Smith & Alloy, 2009). One distinction is the prevalence of past events in ruminative thought content, and the contrasting dominance of future events in the case of worry (Papageorgiou & Wells, 2004; Watkins, Moulds & Mackintosh, 2005). McLaughlin, Borkovec and Sibrava (2007) supported this general distinction, however they also found that induced rumination began as

[1] An extension of the model draws on parallel distributed processing to explain discrepancies arising amongst *concurrent* goals (Martin & Tesser, 2006).

past-focused before displaying a linear trend towards thoughts about the present and finally the future. Whilst rumination is linked to depression levels and predicts the onset of depressive episodes, it also predicts symptoms of anxiety (Nolen-Hoeksema, 2000). Both forms of repetitive negative thought regularly occur in the same individual, suggesting a common underlying processes (at least in non-clinical populations) (Watkins et al., 2005), and is consistent with the common co-morbidity of anxiety and depression (Kessler et al., 1999). Studies which have directly compared rumination and worry point towards similar cognitive impairments, such as reduced cognitive control (Beckwe, Deroost, Koster, De Lissnyder & De Raedt, 2014). In summary, the content of worrisome and ruminative thoughts may differ, but may result from similar cognitive processes.

The mechanisms underlying rumination are less well understood than their affective consequences (Koster, De Lissnyder, Derakshan & De Raedt, 2011). For example, it remains unclear whether rumination is an automatic or consciously controlled process (Smith & Alloy, 2009). Nevertheless, numerous studies indicate that a range of cognitive deficits associated with anxiety and depression may also play a role in rumination. These include biases of attention, memory, interpretation and emotional association, and inhibitory control deficits (Andrew Mathews & Macleod, 2005). Attentional bias is a disproportionate attentional sensitivity to particular stimuli, be they internal thoughts or external cues (Williams, Watts, MacLeod & Mathews, 1997), and one unresolved hypothesis is whether depressive rumination is caused, at least in part, by an impaired ability to disengage attention from negative thoughts (Koster et al., 2011). Disruption in attention-focusing ability is also a cognitive correlate of worry (Borkovec et al., 1983). The causal direction between rumination and attentional bias is also unclear (Koster et al., 2011). Morrison and O'Connor (2008) showed that negative mood combined with a rumination induction decreased bias towards positive word stimuli, whereas a distraction induction increased this bias. However, these inductions found no such causal relationship between rumination and decreased bias towards negative words, the relationship required to support the disengagement

hypothesis. Other studies do indicate this reciprocal causal link between negative attentional bias and rumination. In a double-blind, randomised controlled with individuals having mild to severe depressive symptoms, Yang, Ding, Dai, Peng and Zhang (2015) demonstrated that reducing attentional bias towards sad words led to reductions in rumination and depressive symptoms, and that the reductions in depressive symptoms was mediated by reduced rumination.

If cognitive biases underlie emotional disorders, then cognitive bias modification (CBM) offers potential treatments (Hertel & Mathews, 2011). The dot-probe task (MacLeod, Mathews & Tata, 1986) is the gold-standard measure of attentional bias, using differences in response times to visual stimuli having differing affective valence, such as negative and neutral word pairs. Participants respond to a probe which appears at one or the other location of the previously displayed stimuli. The dot-probe has two advantages over variants of the Stroop task, in which response time differences are considered to represent interference between naming a word's colour, and affective or cognitive bias resulting from reading the word. First, concurrent presentation (colour and word) in the Stroop makes it unclear whether competition is between attention or response selection (MacLeod, 1991). By temporally separating the stimulus from the probe, the dot-probe may be a more pure measure of attentional bias. Second, the dot-probe is easily adapted to modify attentional bias, by manipulating the probe location to train attention towards, or away from particular stimuli. Numerous studies have indicated that attentional bias modification (ABM) may be an effective treatment for anxiety (Hakamata et al., 2010) and more recently ABM has been shown to reduce depressive symptoms (Yang et al., 2015). Critics of CBM argue that the effect sizes are too small to be clinically relevant (Cristea, Kok & Cuijpers, 2015). However, advocates argue that this critique is based on a meta-analysis which didn't differentiate ABM from other forms of CBM, didn't focus on a single psychological dysfunction (anxiety), or didn't analyse studies which demonstrate both attentional bias change *and* corresponding symptom change (MacLeod & Clarke, 2015). In demonstrating the mediating role of rumination in reducing depressive symptoms, Yang et al. (2015) met

both of these final criteria.

Previous research examining rumination towards current concerns has used the emotional Stroop (Williams et al., 1997), a less pure measure of attentional bias than the dot-probe, and one which is unable to also modify attentional bias. The current study measures attentional bias using the dot-probe, before testing the effects of ABM training (ABMT) designed to reduce vigilance towards negative words, and words associated with a current concern. This can be considered a test of the attentional disengagement hypothesis (Koster et al., 2011), specifically in relation to the goal progress theory of rumination (Martin & Tesser, 1996). The study also aims to replicate and extend the findings of Yang et al. (2015), by testing whether ABM can reduce rumination and depressive symptoms in a non-clinical sample. Given the various conceptualisations of rumination, Smith and Alloy (2009) recommend using multiple outcome measures. The difficulties in distinguishing rumination from worry, and the common co-morbidity of anxiety and depression also suggest multiple measures are appropriate. The current study measures the effects of ABM on daily rumination and mood, and on measures of rumination, worry, anxiety and depressive symptoms over longer periods. This novel use of ABMT offers the potential to offer a personalised, cost-effective treatment for anxiety and depression. Specific hypotheses were:

1. Attentional bias towards negative words will reduce after ABMT.

2. Attentional bias towards ideographic words associated with a current concern will reduce after ABMT.

3. Trait worry, rumination over the previous month, and symptoms of anxiety and depression over the previous 2 weeks will reduce after ABMT.

4. After ABMT, state rumination, negative affect and depressive symptoms will reduce, and state positive affect will increase.

Method

Design

The small number of participants in this study reflects its exploratory nature, and the effort required to keep participants engaged in a long-term training regime. A randomised, single-case series design (Bulté & Onghena, 2008) was chosen to allow statistical inference in spite of this small N. This design compares a series of baseline (phase A) measures against those after a treatment intervention[2] (phase B) (Bulté & Onghena, 2008). Overall, this can be considered a non-concurrent, multiple baseline replication across participants (P. J. Watson & Workman, 1981). That is to say, there were multiple participants[3], who started the study at different times, and each participant's transition to phase B was chosen randomly in advance. Based on previous research (Yang et al., 2015), 8 ABMT sessions were considered necessary in order to detect training effects. A minimum of 8 measurement times (MTs) in phases A and B, and a total of 35 MTs results in 20 possible transition points. This provides randomisation tests with sensitivity to detect significant differences at p=.05 for each participant[4] (Bulté & Onghena, 2008; Onghena & Edgington, 2005).

Participants

Participants were recruited using the University of Exeter school of Psychology research participation system, on-campus posters, departmental email lists and University Facebook groups. People were invited to evaluate a computer-based task with the potential to reduce rumination towards an unresolved problem of their own choosing. A maximum payment of £20 was offered for completion of all 35 sessions. Other requirements were fluency in English, normal or corrected to normal vision, access to a home computer, and no concurrent psychotherapy or psychotropic medication.

Screening instruments (PHQ-8 (Kroenke et al., 2009), Ruminative Responses Scale (RRS; Treynor et al., 2003), and Penn State Worry Questionnaire (PSWQ;

[2]The treatment in the current study being ABMT.

[3]A 'series' of 'cases'.

[4]Assuming the participant completes all sessions.

Meyer, Miller, Metzger & Borkovec, 1990)) were created using Lime Survey (LimeSurvey Project Team / Carsten Schmitz, 2015) and completed online. People with mild depression or above (PHQ-8 < 11) were excluded. Inclusion criteria were high trait rumination (RRS ≥ 53), and/or high trait worry (PSWQ ≥ 55). The RRS and PSWQ cut points were calculated to place participants in the top 33% of these measures, based on a sample of 210 University of Exeter undergraduate students measured on RRS ($M = 46.9$, $SD = 12.7$) and PSWQ ($M = 48.2$, $SD = 14.9$) (Moberly & Dickson, 2015).

Figure 1 summarises the recruitment procedure. Fifteen people (12 female) met the screening criteria and offered to participate; 6 members of staff, 5 postgraduate students, 2 undergraduate students, 1 recent graduate, and 1 partner of an undergraduate student. At screening, these 15 participants had a mean PHQ-8 score of 4.9 (SD=1.7), a mean RRS score of 47.3 (SD=10.5), and a mean PSWQ score of 63.7 (SD=8.3). There were no outliers (> 3SD) on these measures. The mean age of participants was 31.4 years ($SD = 10$ years). A detailed ethical submission was approved by the University of Exeter, School of Psychology Ethics Committee (appendix I).

Measures and Materials

All self-report measures were created using Lime Survey (LimeSurvey Project Team / Carsten Schmitz, 2015) and completed online. Ecological validity was good, with all except the pre self-report measurements taken outside of a laboratory environment.

Pre–Post self-report measures. The following measures were taken before the first and after the last dot-probe/ABM sessions (appendix A).

RRS. The Ruminative Responses Scale (RRS) is a 22 item measure of trait rumination, with items rated 1–4. The RRS is valid and reliable, having Cronbach's α of .85 (Treynor et al., 2003). RRS questions were asked in relation to the previous 4 weeks, to correspond approximately with the month before the study (pre) and time within the study (post).

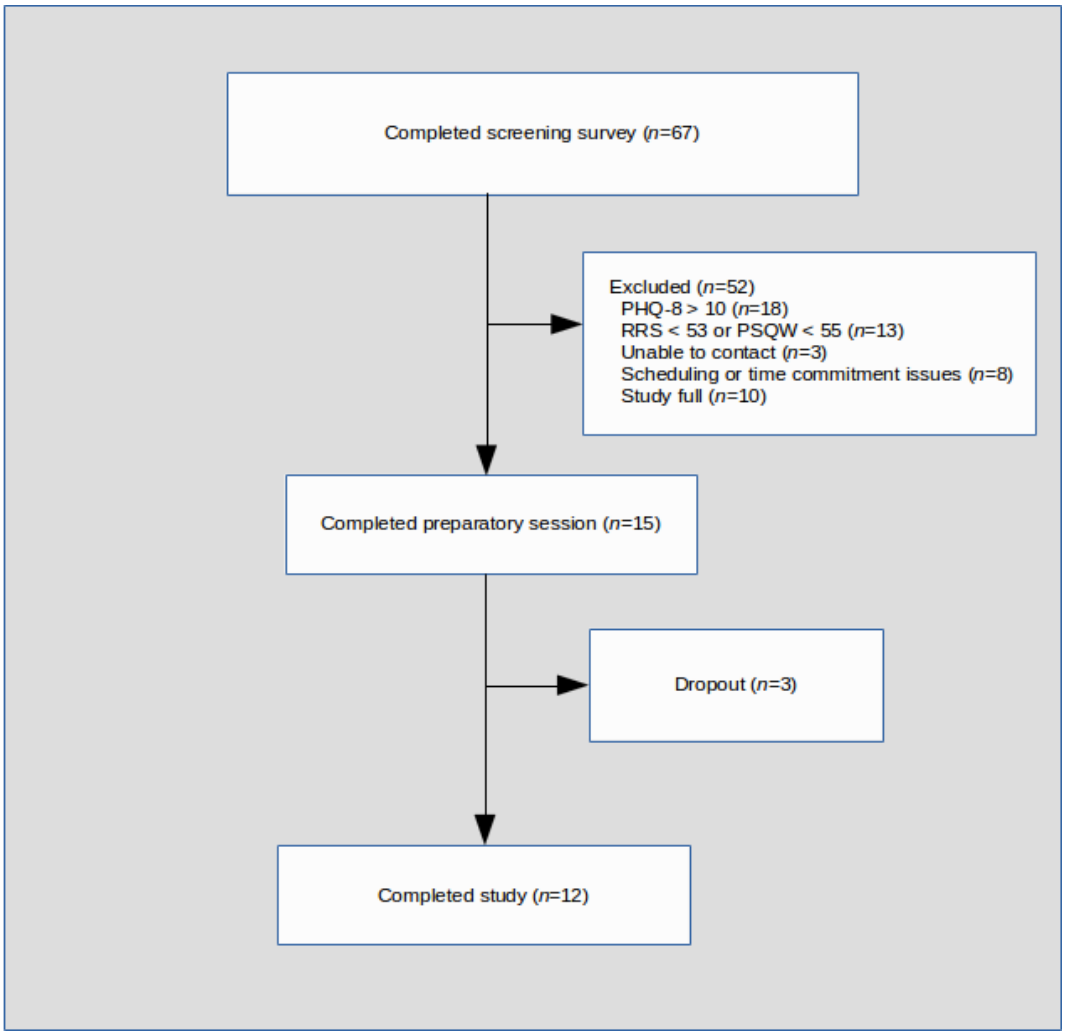


Figure 1. Recruitment flowchart

GAD-7. The GAD-7 is a 7 item measure of Generalised Anxiety Disorder (GAD) symptoms, with items relating to the previous 2 weeks, and scores rated 0–3. The GAD-7 is an efficient, internally reliable (Cronbach's $\alpha > .85$) tool for assessing GAD severity in clinical research, with good test-retest reliability (Spitzer, Kroenke & Williams, 2006).

PHQ-9. The 9 item Patient Health Questionnaire Depression (PHQ-9) is a brief, reliable (Cronbach's $\alpha > .85$) and valid measure of depression severity (Kroenke, Spitzer & Williams, 2001). Items are rated 0–3, and questions relate to the previous 2 weeks.

PSWQ. The 16 item Penn State Worry Questionnaire (PSWQ) is an internally consistent measure of trait worry with good test-retest reliability (Meyer et al., 1990).

Items are rated 1–5.

Daily measures. The following measures were taken approximately every 24 hours, except where sessions were postponed.

GRS. The Goal Rumination Scale (GRS) is a 7 item measure of state rumination towards a specific goal (Schultheiss, Jones, Davis & Kley, 2008). Items are rated 1–7, with items 5–7 reversed. Reliability of the GRS is good (Cronbach's α = .87), based on a single sample of $N = 101$. Questions on the GRS were asked in relation a "problem" rather than a "goal" and in relation to the last 24 hours.

PANAS-SF. The 10 item, short form Positive and Negative Affect Schedule (PANAS-SF, Mackinnon et al., 1999) measures positive affect (PA, Cronbach's α=.78) and negative affect (NA, Cronbach's α=.87). Items are rated 1–5. Although the PANAS PA scale has significant negative correlations with depression measures (D. Watson, Clark & Tellegen, 1988), the PANAS-SF PA items ('determined', 'alert', 'inspired', 'enthusiastic', 'excited') do not represent the negative pole of positive affect. Therefore, to improve detection of our hypothesised change in depression, we added items 'sad' and 'depressed' to the PANAS-SF. Items 'anxious' and 'worried' were added to assess our hypothesised changes in anxiety but excluded from analyses due to their positive correlation with NA[5]. Questions on the PANAS-SF were asked in relation to the last 24 hours.

Procedure

Preparatory session. Participants met the researcher at the University of Exeter to complete the initial 1 hour preparatory session. After giving informed, written consent, they completed baseline measures for RRS, PHQ-9, GAD-7 and PSWQ online. Using a procedure based on Roberts, Watkins and Wills (2013), the participant

[5]Of the four items added to the PANAS-SF, 'sad' and 'depressed' correlated strongly with each other weakly with PA items and moderately with the NA scale. Items 'anxious' and 'worried' were moderately correlated with NA, but not as highly as the NA scale itself (appendix B). Given these findings and that PANAS is an established measure, we analysed three mood variables: positive affect (PA scale), negative affect (NA scale) and depressive symptoms ('sad' and 'depressed' items).

was instructed to select an unresolved current concern which they rated on a 5 item scale, with items rated 1–9. The concern was accepted if ratings for the questions "How much you have been thinking about it over the last week?" and "How much does it bother you now?" were > 5, and the concern was considered unlikely to resolve within the following 5 weeks. Each participant's preferred concern met these criteria. Participants wrote a short statement summarising their concern and recorded the length of time that it had been bothering them. They then generated their I-words (appendix E) and completed a dot-probe practice block[6]. Participants were given help installing the computer task, a task information sheet (appendix F) and a printed calendar for managing their daily sessions, on which they wrote an implementation intention (Gollwitzer, 1999) to encourage session completion. The experimenter then prepared the files required for the computer task and emailed them to the participant.

Daily sessions. Participants were instructed to complete all experimental sessions on a computer at their home. Each day, the experimenter sent participants a templated email containing instructions on how to complete the session (appendix G). Participants began each session by completing the dot-probe task (phase A) or the ABMT, followed by the dot-probe (phase B). Dot-probe blocks took approximately 5 minutes to complete and ABMT blocks approximately 15 minutes.

Using Lime Survey, participants uploaded their task data, recorded whether their concern was still unresolved and complete PANAS-SF and GRS measures. The experimenter periodically sent additional emails to motivate participants by notifying them of their progress, to ensure their well-being if 3 consecutive sessions were skipped, and to prepare them for the slightly longer task when transitioning to phase B. Participants provided post-intervention RRS, PHQ-9, GAD-7 and PSWQ measures using the Lime Survey website within approximately 12 hours of completing the final session. On exiting the study, all participants were emailed debrief information (appendix H) and information about sources of support appendix J and were paid for

[6]Dot-probe practice blocks used N-word block 7 (appendix C and a set of I-word pairs generated by the experimenter.

their participation.

Experimental stimuli. Negative-Neutral (N-word) pairs differed significantly on valence but were matched for frequency, imageability, familiarity, number of characters and number of syllables (appendix C). Ideographic word sets (I-words) were the 6 words rated by participants as most likely to induce rumination about their chosen current concern, from a maximum of 10 self-generated words. The experimenter chose I-word pairs by selecting neutral words matched for frequency, imageability, familiarity, word length and number of syllables (appendix D). In order to detect *generalised* changes in attentional bias in relation to N-word emotional valence, rather than changes in bias to specific N-word stimuli (See, MacLeod & Bridle, 2009), phase B dot-probe blocks only contained N-words not previously exposed in any preceding ABM block. An example randomisation schedule and associated stimulus allocation is shown in table 1.

Dot-probe task. Our version of the dot-probe task[7] (figure 2) used two sets of visual word-pair stimuli and was based on Yang et al. (2015). Dot-probe blocks consisted of 96 trials. Each trial began with an 25 x 25 pixel (7 pixel thick) white fixation cross centred on a black screen. After 500ms, this was replaced by a word pair from the current stimulus set. One word from the pair appeared above the fixation cross location and one below. Word pairs were 125 pixels high with a vertical space between the upper and lower words such that the stimuli subtended a visual angle of approximately 2°. Neutral words appeared with equal frequency at the upper or lower positions. After 1250 ms, the word pair was replaced by either a greater than (>) symbol or less than (<) symbol at a random letter location within one of the previous word locations. As our aim was to guarantee attentional engagement with word stimuli, this exposure duration was chosen as being slightly higher than the 1000 ms in which vigilance for negative words has been shown to be positively correlated with measures of

[7]The dot-probe task was developed using OpenSesame, an open-source experiment builder for the social sciences (Mathôt, Schreij & Theeuwes, 2011). OpenSesame was chosen as a package which was relatively easy to install on Windows, Macintosh (OSX $\geq$ 10.9) and Linux operating systems, thereby eliminating any dependencies on a web server for software development or data collection. Installation instructions for were created using screen capture software and uploaded to YouTube.

Pre			Phase A								Phase B									Post
RRS										ABM[b] N-words:	1–6	1–12	1–18	1–24	1–30	1–36	1–42	1–48	1–54	RRS
PSWQ	dot-probe[a]	N-words	1–6	7–12	13–18	19–24	25–30	31–36	37–42	43–48	7–12	13–18	19–24	25-30	31–36	37–42	43–48	49–54	55–60	PSWQ
PHQ-9		I-words	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	1–6	PHQ-9
GAD-7		Session	1	2	3	4	5	6	7	8	9–11	12–14	15–18	19–21	21–23	24–26	27–29	30–32	33–35	GAD-7

Table 1

Example randomisation schedule showing stimulus allocation and block order where phase A = 8 sessions and phase B = 27 sessions. In phase A, dot-probe blocks consisted of 12 word pairs; the 6 I-word pairs and 6 N-word pairs. Session 1 used pairs 1–6 from the 66 N-word set, session 2 used pairs 7–12, and so on. Thus, bias associated with the participant's ideographic words was measured at every session, whereas the more general negative valence associated with N-words was distributed across measurement times. In phase B, dot-probe measurement was preceded by ABM blocks containing only N-words. To guarantee enough stimuli when randomisation resulted in a long phase B, the same 6 N-words were used for 3 consecutive ABM training sessions. N-words from previous ABM blocks were included in subsequent ABM blocks. For example, the first 3 ABM blocks used N-words 1–6 and the subsequent dot-probe used N-words 7–12. The fourth ABM block used N-words 1–12 and the subsequent dot-probe used N-words 13–18, and so on. A random draw was used to select the 192 stimuli for each ABM session. As with phase A, the 6 I-words were present in every dot-probe block.

[a]96 trials [b]192 trials

depressed mood and vulnerability (B. Bradley, Mogg & Lee, 1997). Furthermore, attentional biases are more frequently observed when self-relevant negative information is presented for longer durations (Koster et al., 2011), and attentional biases in depression are critically dependent on longer (1000 ms) exposure durations (Donaldson, Lam & Mathews, 2007). Probes appeared with equal frequency at upper and lower locations. Valid keyboard responses were greater than (>) and less than (<). The probe remained on the screen until the participant pressed a valid key. A correct response was recorded if the key-press matched the probe symbol. There was no feedback for incorrect responses. A blank screen with a random inter-trial interval (ITI) between 100-500ms followed each trial. Participants were instructed to respond as quickly and accurately as possible.

Attentional bias assessment. After removing inaccurate trials or those with response times (RTs) exceeding 3 standard deviations beyond the mean, attentional bias scores were calculated from the remaining RTs using the equation

$$Attentional\ bias\ score = [(NuPl + NlPu) - (NuPu + NlPl)]/2 \quad (1)$$

where N = Negative word, P = Probe, u = upper, l = lower (B. Bradley et al., 1997). A bias towards negative words is reflected in longer latencies for probes at the opposite location (left-hand side of equation (1)) and shorter latencies for probes at the same location (right-hand side of equation (1)). Therefore, more positive scores reflect an attentional bias towards (i.e. vigilance for) negative words relative to neutral words, whereas more negative scores indicate avoidance (B. Bradley et al., 1997).

ABMT. The ABMT task used three minor adjustments to the dot-probe paradigm to $modify$, rather than measure attentional bias. First, there were double the number (192) of trials in each block. Second, only N-word pairs were used as stimuli. Finally, probes in ABM trials always appeared at the neutral word location. Thus, correct responses required repeated orientation of attention away from the negative word in the pair.

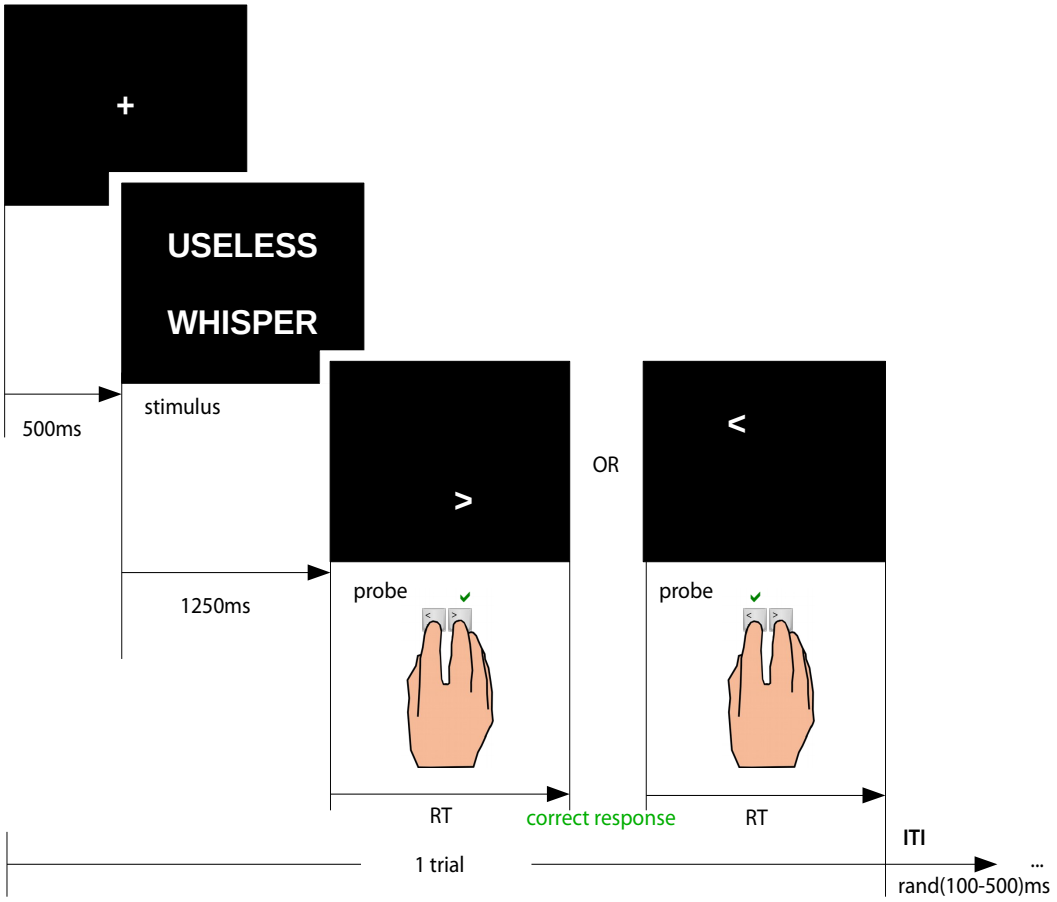


Figure 2. Example dot-probe trial for a right-handed participant, in which the negative word (USELESS) appears at the upper location, and the neutral word (WHISPER) appears at the lower location. Correct responses are shown for a subsequent probe appearing at either the upper or lower location.

Analyses

Data were analysed using using R version 3.1.0 (R Core Team, 2014)[8].

[8]Additional R packages used for analyses were `corrplot` (Wei, 2013), `lsr` (Navarro, 2015), `pwr` (Champely, 2015), `psy` (Falissard, 2012), `SCMA` (Bulté, 2015), `SCRT` (Bulté & Onghena, 2015a) and `SCVA` (Bulté & Onghena, 2015b). Minor modifications were made to the `SCVA` package to standardise y-axis ranges and to plot central tendency, trend and variance lines on the same graph.

Pre–Post comparisons

The small N meant that pre-post comparisons were underpowered except for large effects, so our primary analyses were visual inspection and randomisation tests of daily session measurements. Nevertheless, two-tailed, paired samples t-tests were used to compare participants' pre and post ABMT measures of rumination (RRS), depression (PHQ-9), anxiety (GAD-7) and worry (PSWQ). Whilst these tests were potentially underpowered, it was noted that the significant post training effect sizes found by Yang et al. (2015) were medium (d=.49) for RRS, large (d=1.50) for depression using BDI-II (Beck, Steer & Brown, 1996) and large (d=.88) for anxiety using STAI-T (Spielberger, 1983).

Daily sessions

Each participant's daily session data was analysed visually and using randomisation tests comparing phase A and B measures of attentional bias (I-words and N-words), state rumination (GRS) and mood (PANAS-SF). Randomisation is a nonparametric approach which allows inferential statistics to be calculated using data from a single-case series (Bulté & Onghena, 2008). In an AB design, the phase sequence (baseline followed by intervention) is fixed, therefore it is the point at which phase A transitions to phase B which is randomised. Under the null hypothesis, a test statistic for a particular set of observations would not differ systematically as a function of where the transition from A to B occurs. Randomisation tests hold the observation scores constant and calculate the test statistic for all possible transition permutations. Once sorted, the p value is the proportion of test statistics greater than or equal to the observed test statistic (Onghena & Edgington, 2005). All randomisation tests were two-tailed (test statistic = |`A-B`|). In addition to the single-case randomisation tests, a meta-analysis (Onghena & Edgington, 2005, p.64) was carried out across all participants for each outcome measure[9]. With 12 participants, this increases power to detect significance above p=.05 (Onghena & Edgington, 2005, p.64), even though

[9]Meta-analyses were conducted using the R package `SCMA` (Bulté & Onghena, 2013).

sensitivity at the case level was below p=.05 for participants who completed less than 35 sessions. The meta-analysis used an additive approach, which has a greater probability of yielding significant results when there are treatment effects (Edgington, 1972). Percentage of nonoverlapping data (PND) was used as a measure of effect size[10]. PND is frequently used in single-subject research, and is the percentage of treatment phase observations that do not overlap data in the baseline phase (Scruggs & Mastropieri, 2013)[11]. There was no missing data for daily measures, as all survey questions were mandatory.

Results

Three participants withdrew from the study; one before completing any sessions due to concerns that the study would worsen their social anxiety, another who found the time commitment too great after 5 sessions, and the third after 24 sessions when a holiday meant that they would be unable to complete sufficient phase B sessions. Dropout was not predictable for these participants as their screening scores were not atypical. For the remaining participants, dot-probe/ABM accuracy was above our *apriori* inclusion threshold of 75% (table 2). The current concern chosen by each participant at the preparatory session remained unresolved throughout the study.

Pre–Post Measures

Comparisons between outcome measures pre and post ABMT are summarised in table 3. There were no outliers (> 3SD) on GAD-7, PHQ-9, PSWQ or RRS scores before or after ABMT. Cronbach's α was acceptable for GAD-7 and PSWQ, good for PHQ-9 and and excellent for RRS. There were no significant pre-post ABMT differences

[10]PND was calculated using the R package `SCMA`, using `PND-` for N-words, I-words, NA and depressive symptoms as the treatment should cause these measures to drop, and `PND+` for PA as the treatment should result in an increase in positive affect.

[11]Scruggs, Mastropieri, Cook and Escobar (1986) consider treatments with PND scores $\geq$ 90% as highly effective, scores of 70%–90% as fair, scores of 50%–70% as questionable effects, and scores $<$ 50% as unreliable.

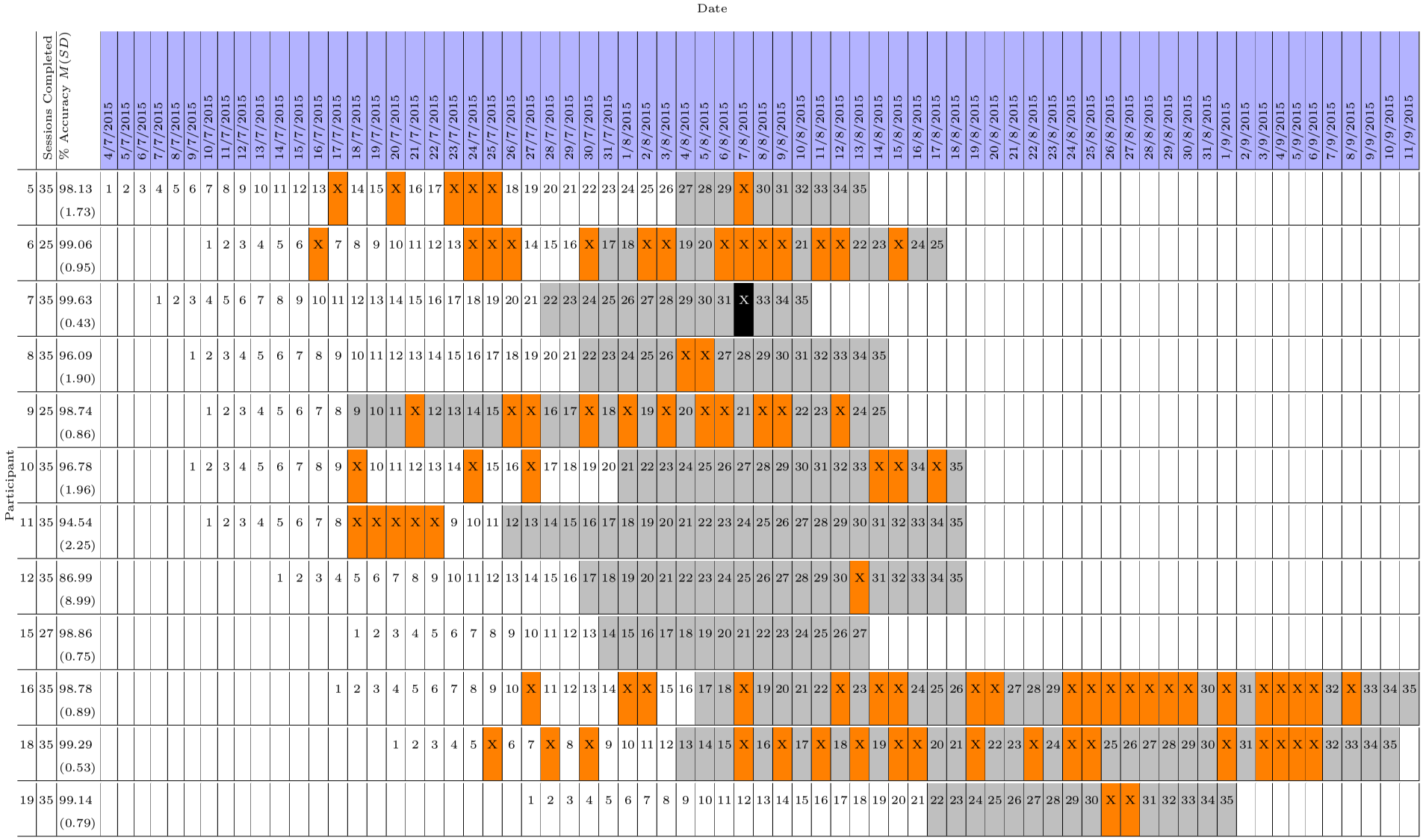


Table 2

Number of sessions completed, overall dot-probe/ABM accuracy and session completion pattern for each participant. Key: n = phase A (baseline), n = phase B (ABM), X = postponed session, X = corrupt task data.

(all Ps $> .05$) on any of these outcomes.

Table 3

Pre–post ABM training comparisons of trait anxiety (GAD-7), depression (PHQ-9), trait worry (PSQW) and trait rumination (RRS).

	Pre		Post						
Measure	$M(SD)$	Cronbach's α	$M(SD)$	Cronbach's α	t	df	p	$CI_{95\%}$[a]	Cohen's d[b]
GAD-7	8.00(3.07)	.75	8.67(3.87)	.81	-1.08	11	.305	[-2.03, 0.70]	.22
PHQ-9	6.83(4.34)	.80	6.83(5.70)	.89	0.00	11	1.000	[-3.32, 3.32]	.00
PSWQ	47.33(8.16)	.77	46.83(9.22)	.81	0.34	11	.743	[-2.77, 3.77]	.06
RRS	47.67(11.87)	.92	45.67(13.72)	.94	0.76	11	.462	[-3.77, 7.77]	.17

[a]Confidence interval represents difference in pre and post measures. [b]Cohen's d calculated using standard deviation of pre measures.

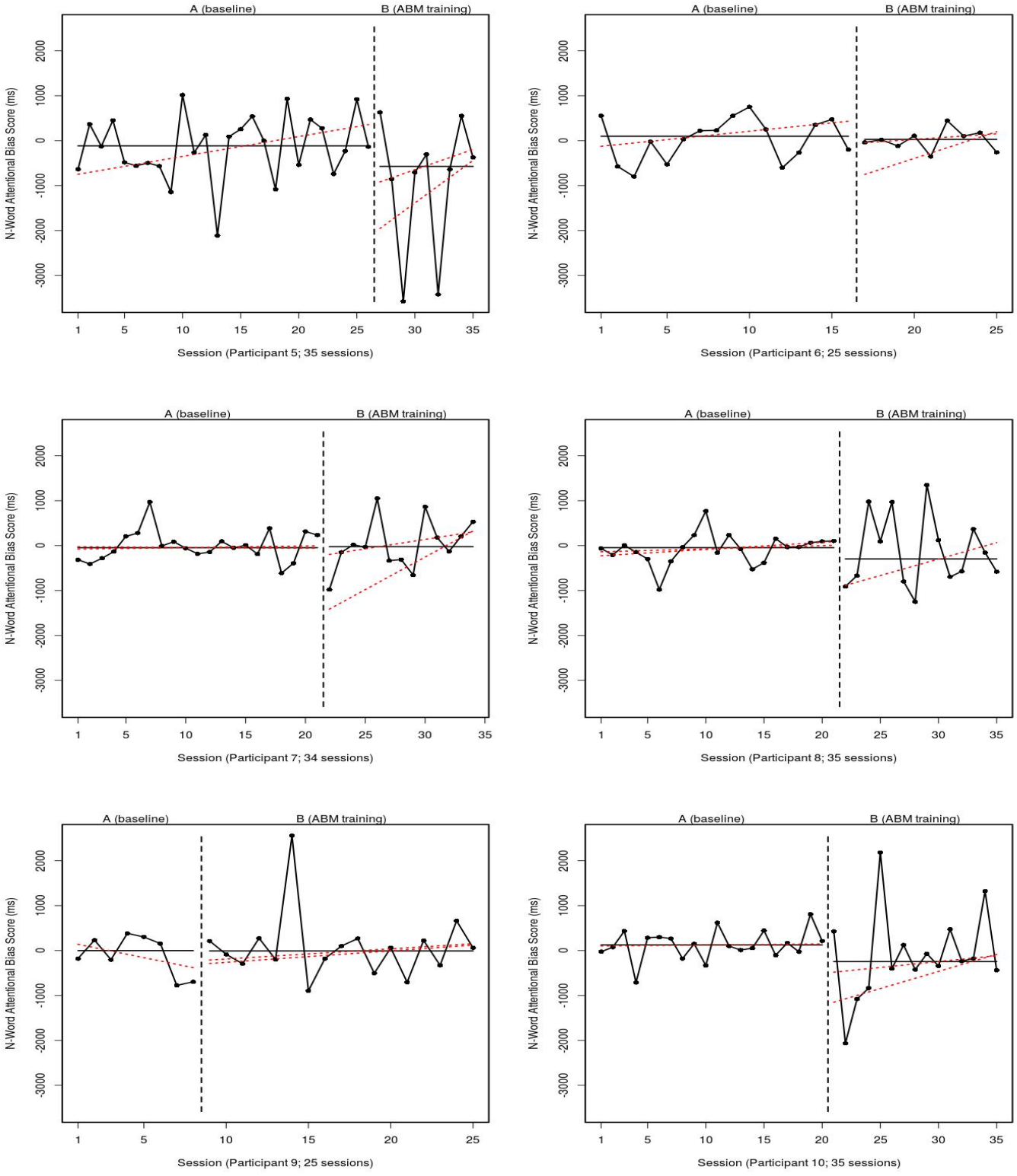
Visual Analyses

Visual analyses commonly examine post-treatment changes in central tendency and linear trends (Morley & Adams, 1991). In the following graphs, the broadened median (BMED) is used as a measure of central tendency as it is both sensitive to a reasonable proportion of the data, and resistant to outliers in relatively small samples (Morley & Adams, 1991). We expected to see visual differences in BMED in the hypothesised direction for each outcome[12]. Plotting linear trends in central tendency reduces visual bias when estimating trends from raw data points (due to outliers). The trend lines in following graphs were plotted using the split middle method (Morley & Adams, 1991)[13]. We expected to see changes in trend in the hypothesised direction for each outcome.

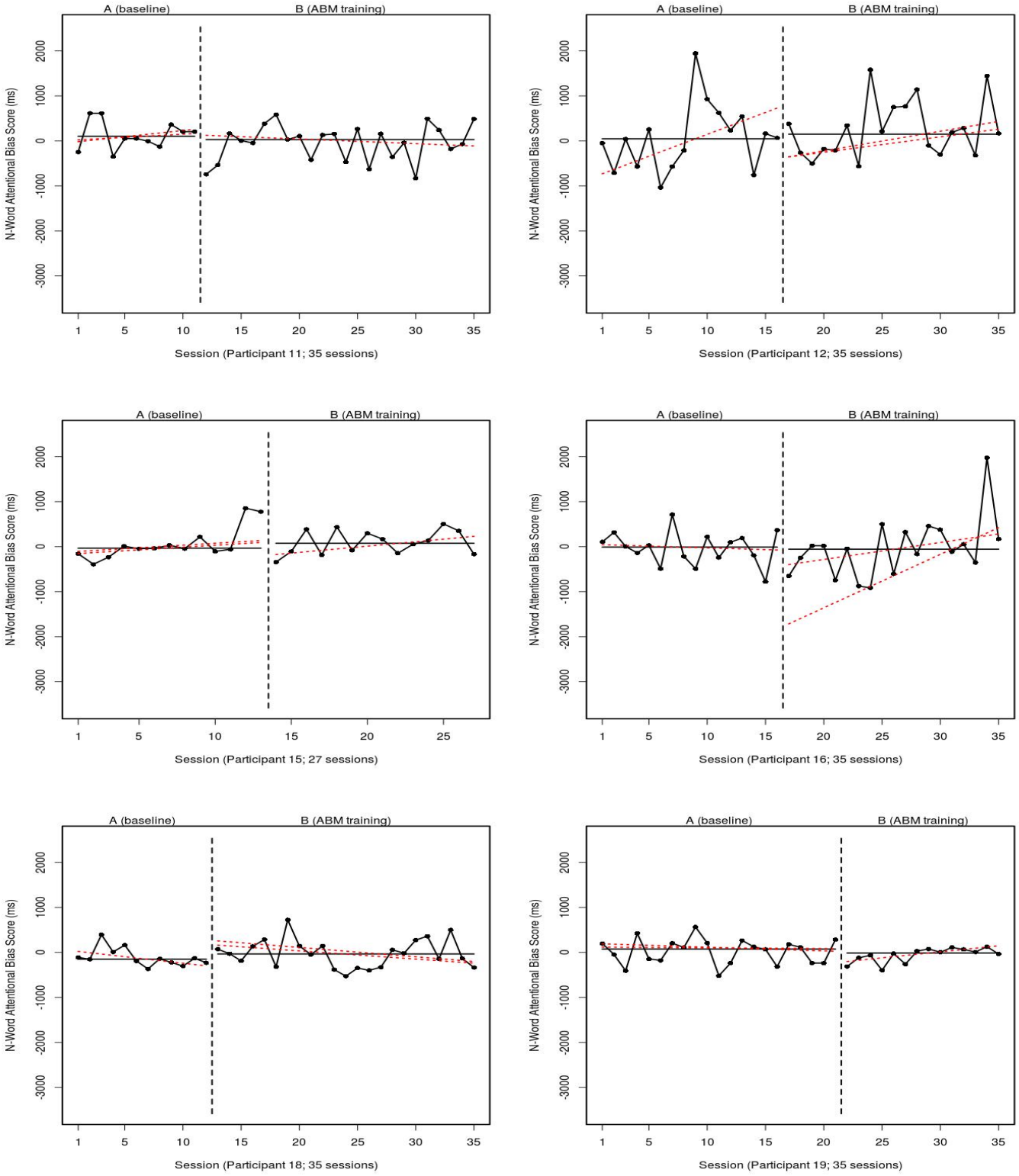
[12]On the attentional bias graphs, the change in BMED between phases A and B is visually small relative to the variability due to outliers for some participants.

[13]This robust method results in two lines where there are an odd number of points in a phase. Poor alignment between these lines indicates a poor fit (Morley & Adams, 1991).

N-word attentional bias. Changes in attentional bias for N-word pairs are summarised in fig. 3a and fig. 3b. Our hypothesis predicted more negative N-word scores in phase B (i.e. increased avoidance). All participants had an initial BMED score close to 0, indicating a lack of any large attentional bias in either direction. Relative to phase A, 7 participants (5, 6, 8, 10, 11, 16 and 19) had more negative BMED scores, although participant 5 had 2 large, negative scores. In phase A, linear trends in score increased for 7 participants (5, 6, 8, 11, 15 and notably 12), decreased for 4 participants (9, 16, 18 and 19) and remained flat for 2 participants (7 and 10). Relative to phase A, of the phase B trends which were a good fit, participant 11 reversed in the hypothesised direction, 3 (participants 8, 12 and 15) continued in the same direction, and 2 (participants 9 and 19) reversed contrary to the hypothesised direction. In summary, there was no clear support for our hypothesised decrease in N-word bias score.



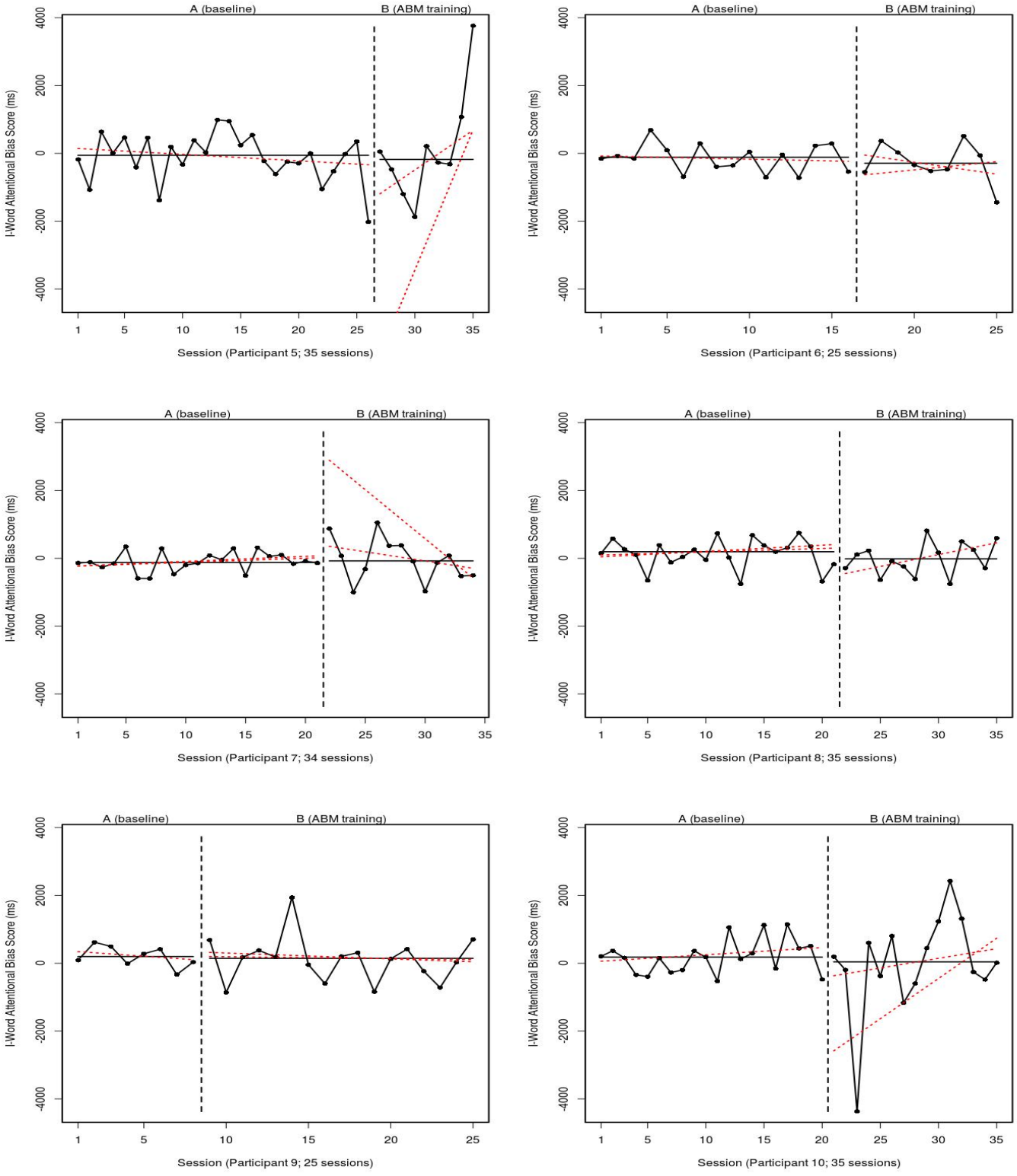
(a) N-word attentional bias scores for participants 5–10.



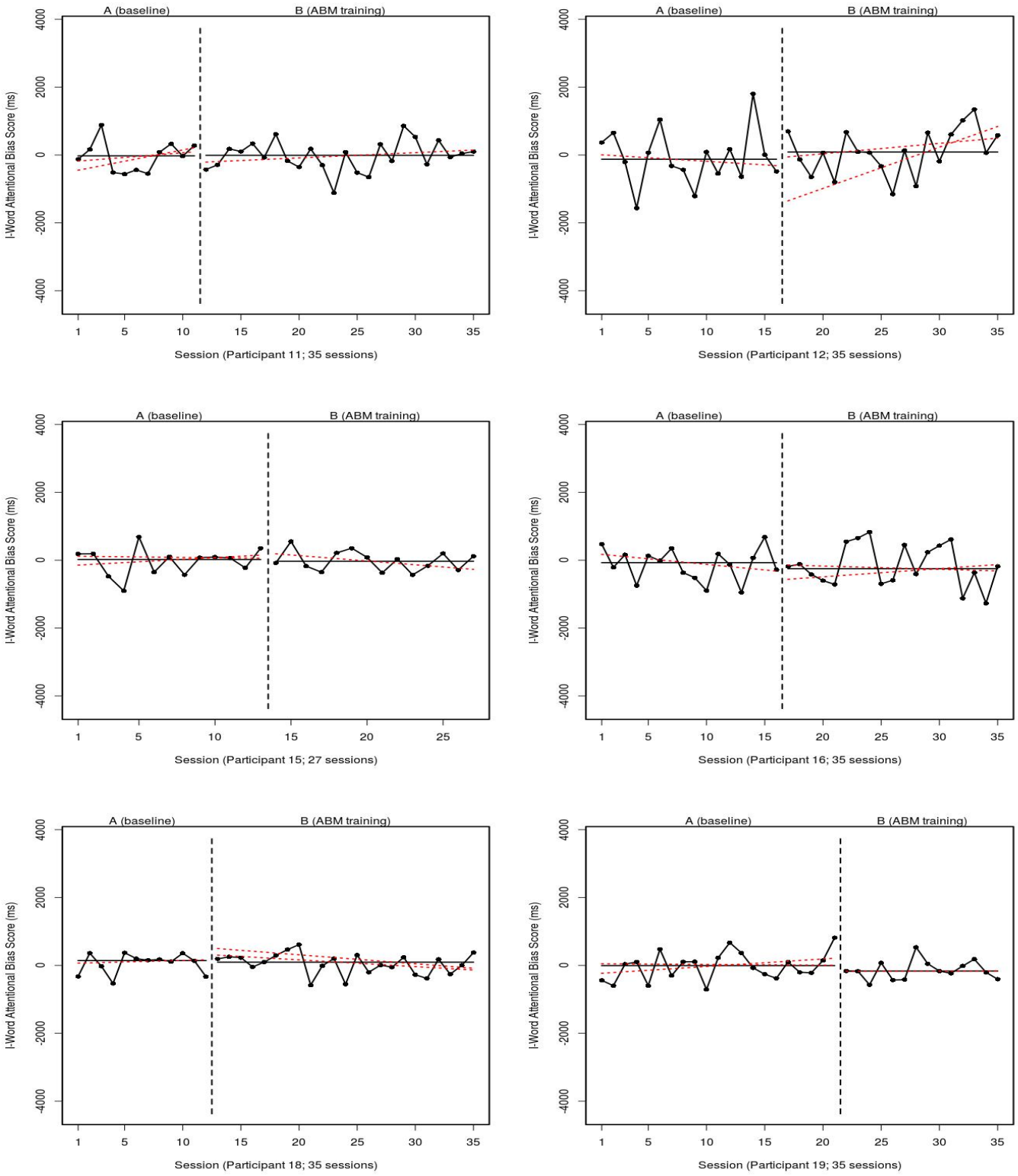
(b) N-word attentional bias scores for participants 11, 12, 15, 16, 18 and 19.

Figure 3. N-word attentional bias scores. Dashed line = phase transition. — broadened median, ···· split middle linear trend.

I-word attentional bias. Changes in attentional bias for I-word pairs are summarised in fig. 4a and fig. 4b. As with N-words, our hypothesis predicted more negative scores in phase B (i.e. increased avoidance) and there were no large initial attentional biases in either direction. Relative to phase A, 9 participants (5, 6, 8, 9, 10, 15, 16, 18 and 19) had more negative BMED scores. Of the linear trends in phase A which were a good fit, 6 (participants 7, 8, 10, 18 and 19) increased and 5 (participants 5, 6, 9, 12 and 16) decreased. Of the trends in phase B which were a good fit, relative to phase A, 2 (participants 18 and 19) became more negative and 2 (participants 8 and 9) continued in the same direction. In summary, there was evidence to support our hypothesised decrease in I-word bias score in BMED, but not the linear trends.



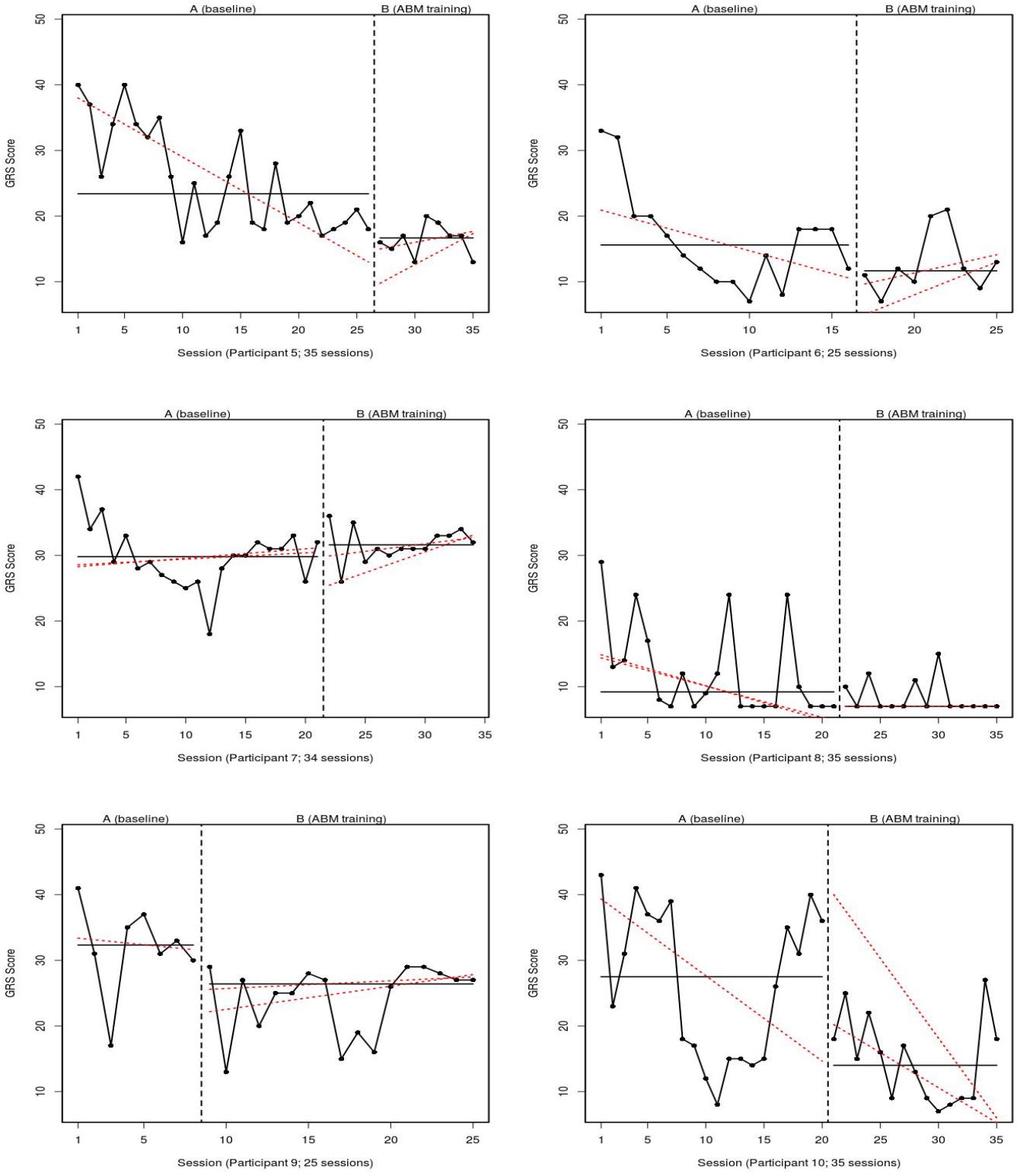
(a) I-word attentional bias scores for participants 5–10.



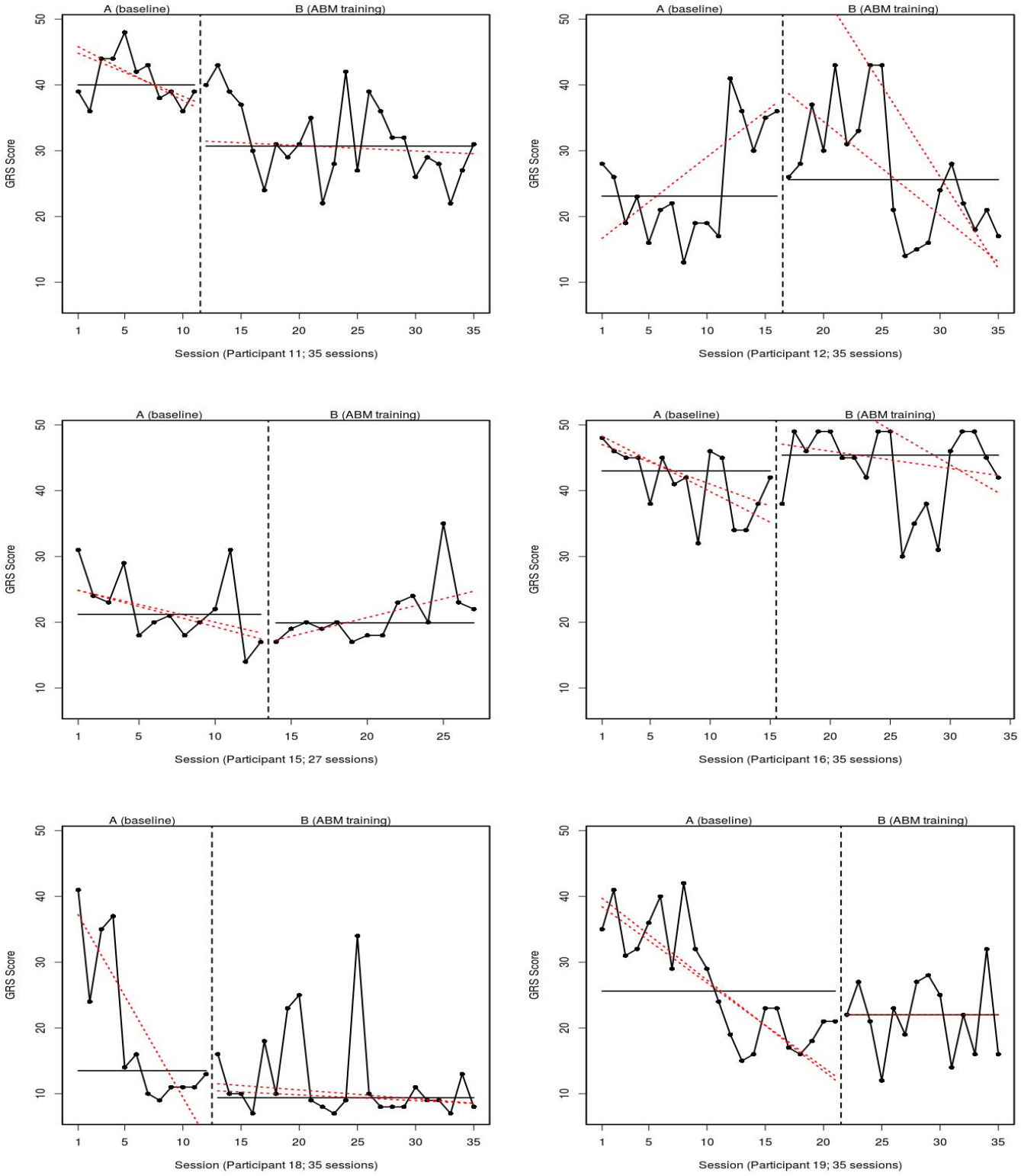
(b) I-word attentional bias scores for participants 11, 12, 15, 16, 18 and 19.

Figure 4. I-word attentional bias scores. Dashed line = phase transition. — broadened median, ···· split middle linear trend.

State rumination (GRS). Changes in GRS scores are summarised in fig. 5a and fig. 5b. Relative to phase A, 9 participants (5, 6, 8, 9, 10, 11, 15, 18 and 19) had lower phase B BMED GRS scores, indicating our hypothesised reduction in rumination towards their chosen concern. These reductions were largest in participants 10, 5 and 11, although initial GRS was high in participant 11. Phase A GRS showed a downward trend for 10 participants, being especially steep in participants 5, 10, 18 and 19. Participant 12 showed a steep linear increase in phase A. Of the linear trends in phase B, 7 were a poor fit. The phase A downwards trends reduced in phase B for participants 8, 11, 18 and 19, becoming slightly positive for participant 15. In summary, the BMED changes supported our hypothesised decrease in GRS scores.



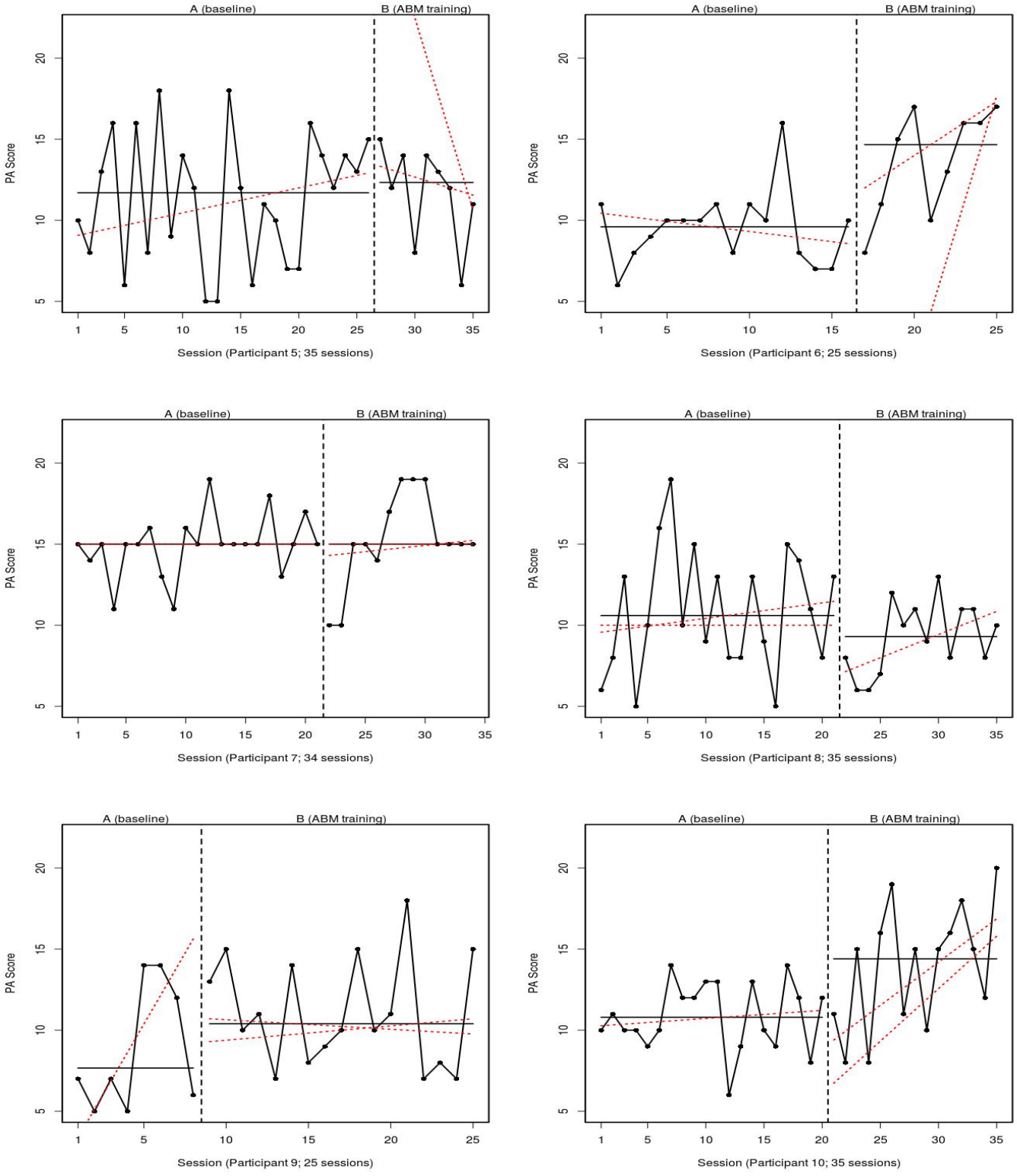
(a) GRS scores (range 1–49) for participants 5–10.



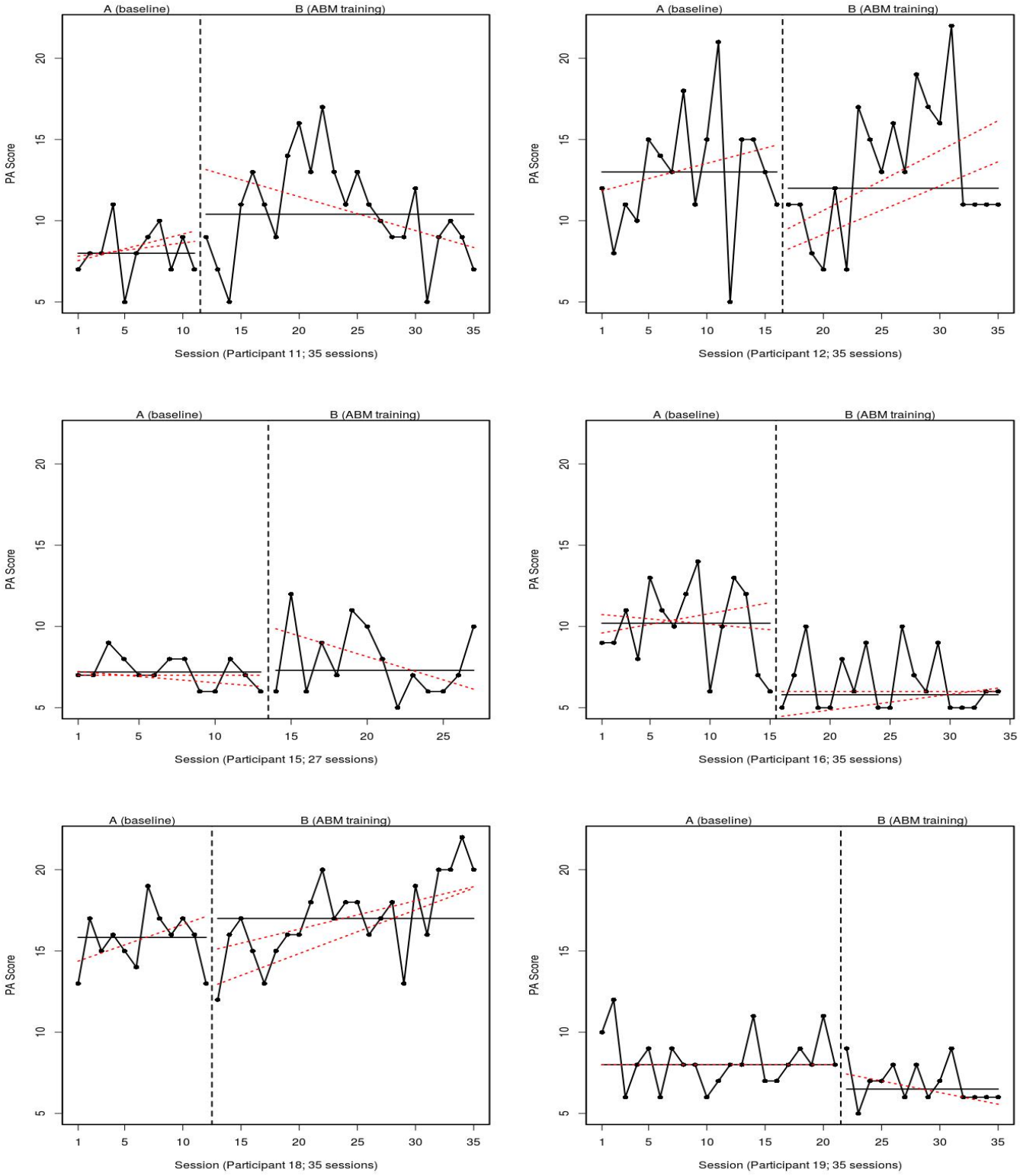
(b) GRS scores (range 1–49) for participants 11, 12, 15, 16, 18 and 19.

Figure 5. GRS scores. Dashed line = phase transition. — broadened median, ···· split middle linear trend.

Positive Affect (PA). Changes in PA scores are summarised in fig. 6a and fig. 6b. We hypothesised that PA would increase in phase B. Relative to phase A, 7 (participants 5, 9, 10, 11, 15, 18 and notably 6) phase B BMED PA scores increased, 3 participants (8, 12 and 19) decreased slightly, participant 16 decreased more markedly and participant 7 remained stable. Where there was a linear fit, phase A PA showed an upward trend for 5 participants (5, 9, 10, 11 and 18) being especially steep for participant 9, a downward trend for 2 participants (6 and 15) and was relatively stable for 2 participants (7 and 19). Where there was a linear fit in both phases, trends continued in the same direction for participants 11 and 15, and became more negative for participant 19. In summary, there was no clear support for our hypothesised increase in PA.



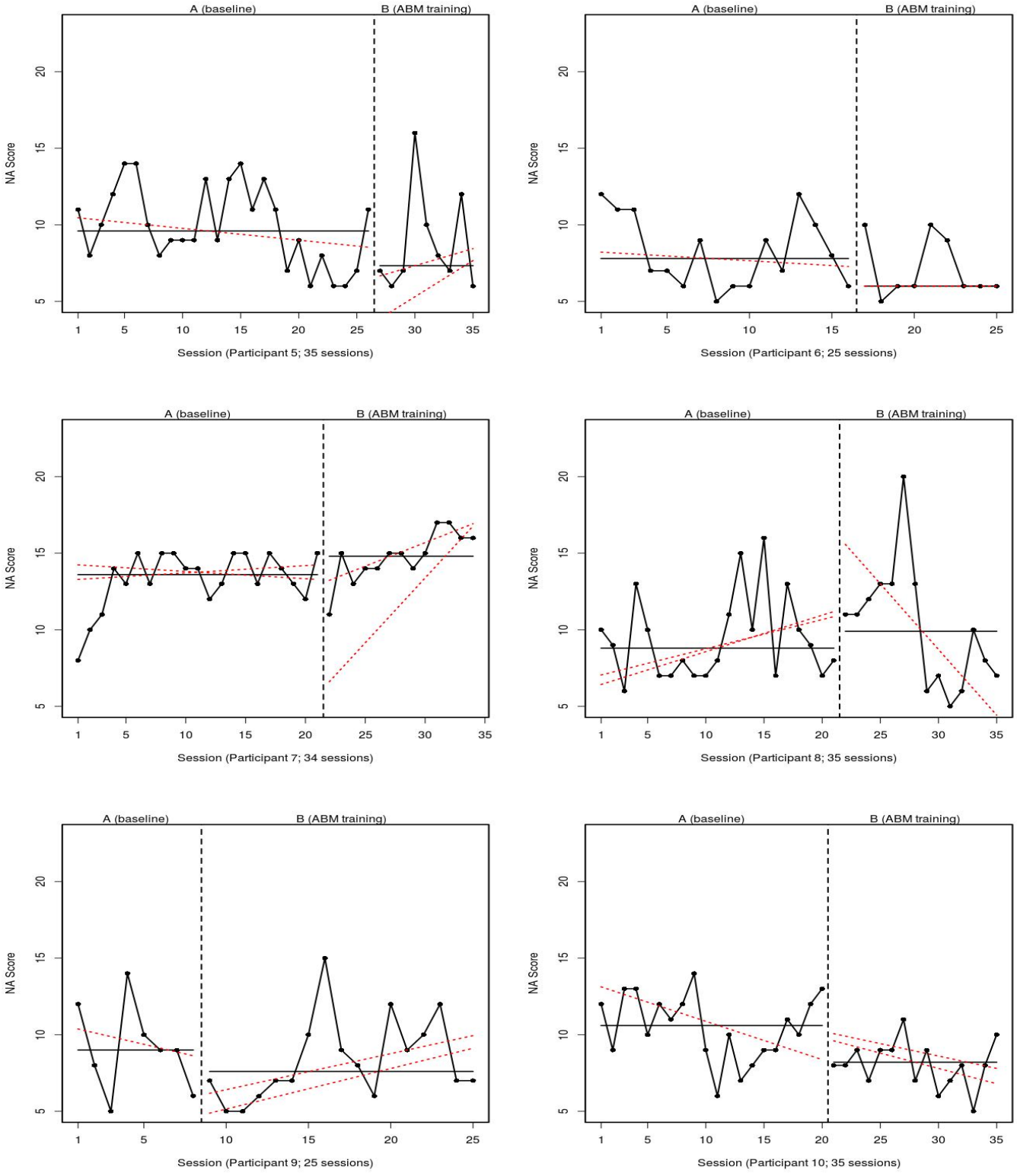
(a) PA scores (range 1–25) for participants 5–10.



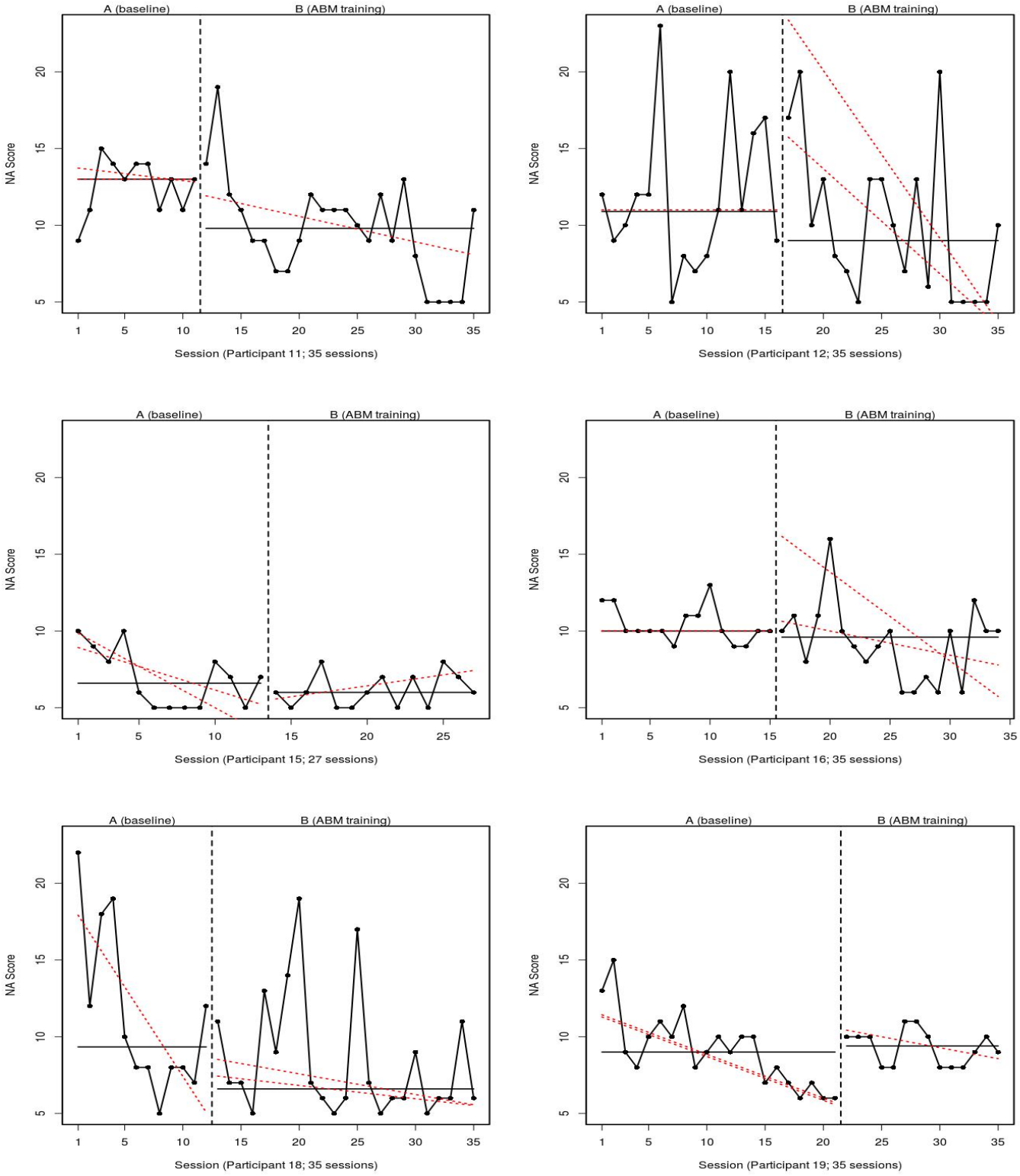
(b) PA scores (range 1–25) for participants 11, 12, 15, 16, 18 and 19.

Figure 6. PA scores. Dashed line = phase transition. — broadened median, ···· split middle linear trend.

Negative Affect (NA). Changes in NA scores are summarised in fig. 7a and fig. 7b. We hypothesised that NA would decrease in phase B. Relative to phase A, 9 (participants 5, 6, 9, 10, 11, 12, 15, 16 and 18) BMED phase B NA scores decreased. Where there was a linear fit in phase A, 6 participants (5, 6, 9, 10, 11, 18 and 19) showed an downward trend (participant 18 being especially steep), participant 15 showed an upward trend and the trend was relatively flat for participants 12 and 18. Where there was a linear fit in both phases, trends slowed for participants 6, continued for participant 11, and reversed sharply from positive to negative for participant 8. In summary, the BMED changes supported our hypothesised decrease in NA scores.



(a) NA scores (range 1–25) for participants 5–10.

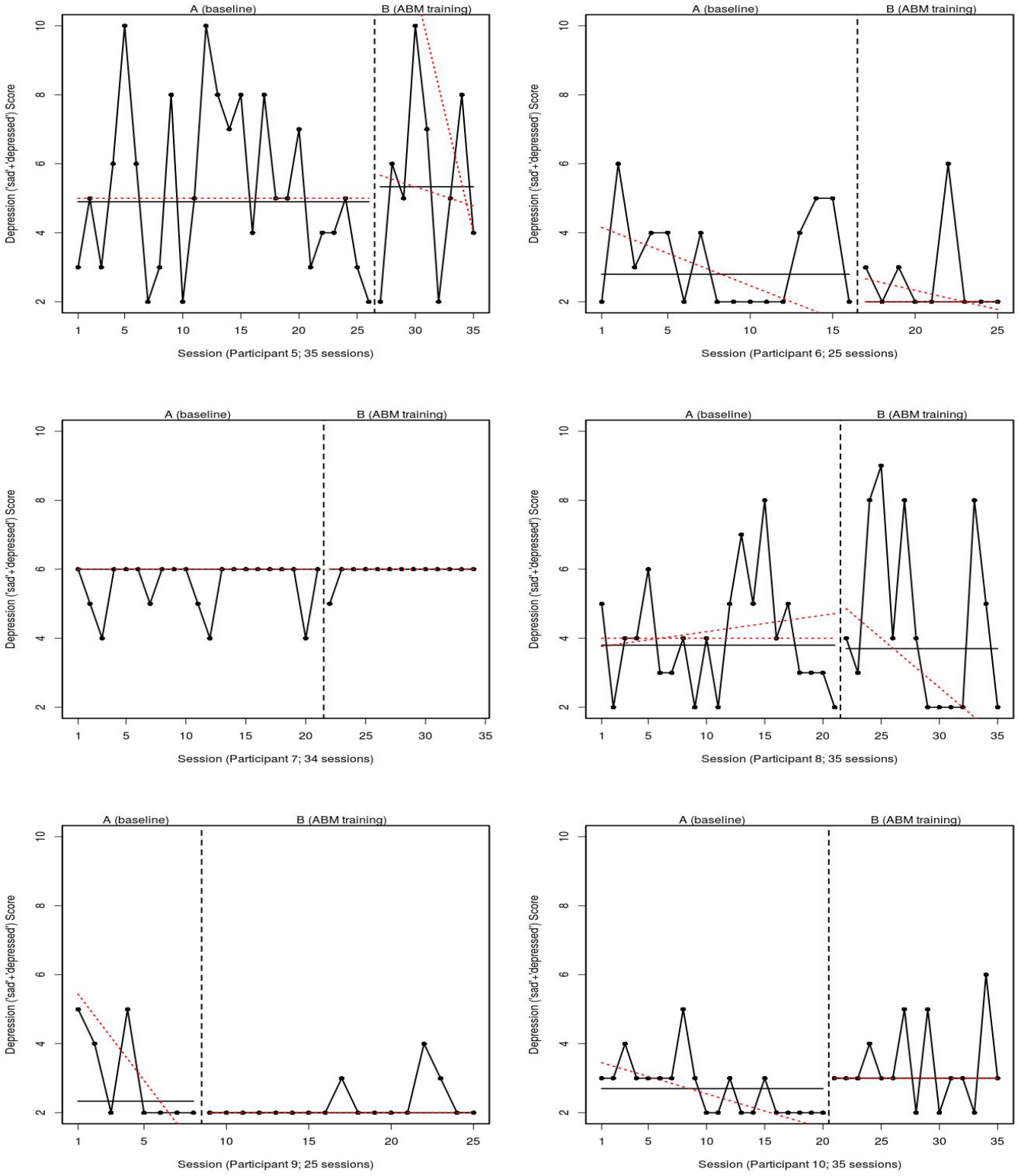


(b) NA scores (range 1–25) for participants 11, 12, 15, 16, 18 and 19.

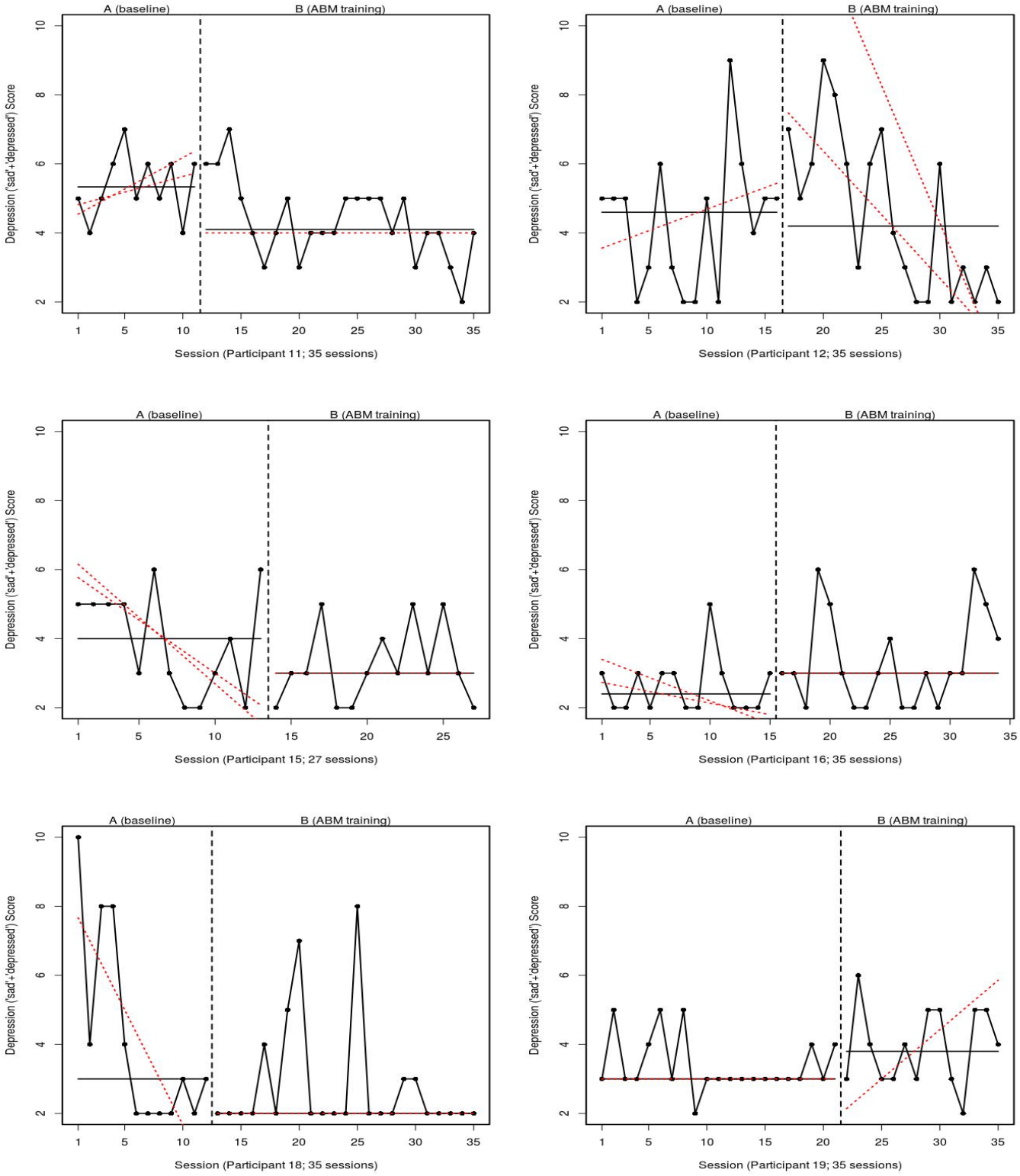
Figure 7. NA scores. Dashed line = phase transition. — broadened median, ···· split middle linear trend.

Depression. Changes in depression[14] scores are summarised in fig. 8a and fig. 8b. Initial depression scores were moderate to low for all participants. We hypothesised that depression would decrease in phase B. Relative to phase A, 7 (participants 6, 8, 9, 11, 12, 15 and 18) BMED phase B depression scores decreased, 4 (participants 5, 10, 16 and 19) increased, and 1 (participant 7) remained the same. Where there was a linear fit, phase A NA showed an downward trend for 4 participants (6, 9, 15, 18) being especially steep for participants 9 and 18, an upward trend for participant 12 and was relatively flat for 3 participants (5, 7 and 19). Where there was a linear fit in both phases, trends continued in the same direction for participants 7 and 10, stabilised close to the bottom of the scale for participants 9, 15 and 18, and increased sharply for participant 19. In summary, there was no clear support for our hypothesised decrease in depression score.

[14]For brevity, the two-item measure of *depressivesymptoms* is henceforth referred to as depression.



(a) Depression scores (range 1–10) for participants 5–10.



(b) Depression scores (range 1–10) for participants 11, 12, 15, 16, 18 and 19.

Figure 8. Depression scores. Dashed line = phase transition. — broadened median, ···· split middle linear trend.

Inferential Statistics

N-word and I-word attentional bias. N-word and I-word randomisation tests and meta-analysis results are summarised in table 4. Although there was a reduction in attentional bias for I-words for 7 participants (6, 8, 9, 10, 16, 18 and 19), none of the differences were significant (all Ps $< .05$). The meta-analysis across participants was also non-significant ($p = .806$). There was a reduction in attentional bias for N-words in 7 participants (5, 6, 8, 10, 11, 16 and 19), although the difference was only significant ($p = .05$) for participant 11 with an unreliable effect ($PND = 29.17\%$). The meta-analysis across participants was non-significant ($p = .434$).

Rumination (GRS). State rumination (GRS) randomisation tests and meta-analysis results are summarised in table 5. Although there was a reduction in GRS score 9 participants (5, 6, 8, 9, 10, 11, 15, 18 and 19), none of the differences were significant (all Ps $< .05$). Increases in GRS for participants 6, 12 and 16 were also non-significant. The meta-analysis across participants was also non-significant ($p = .563$).

Mood (PA, NA, depression). Mood variable (PA, NA and depression) randomisation tests and meta-analysis are summarised in table 6. There was a non-significant increase in PA for 9 participants (5, 6, 7, 9, 10, 11, 12, 15 and 18). Taking our inferential statistics are authoritative, then contrary to the hypothesised increase in PA, participant 8 showed a significant decrease ($p = .05$). Decreases in PA for participants 16 and 19 were non-significant, as was the meta-analysis across all participants for PA ($p = .167$). Although there was decrease in NA for 9 participants (5, 6, 9, 10, 11, 12, 15, 16 and 18), none of the differences were significant (all Ps $< .05$). Increases in NA for participants 7, 8 and 19 were also non-significant, as was the meta-analysis across all participants for NA ($p = .801$). Depression scores decreased in 5 participants (6, 9, 11, 15 and 18) and increased in 7 participants (5, 7, 8, 10, 12, 16 and 19), however all differences were non-significant (Ps $< .05$), as was the meta-analysis ($p = .187$).

Table 4

Randomisation tests and meta-analysis for I-word and N-word dot-probe scores[a]*. Values in* ***bold*** *indicate reductions in attentional bias after ABM training.*

		I words				N words			
		A	B			A	B		
Participant	Sessions	$M(SD)$	$M(SD)$	p[b]	PND	$M(SD)$	$M(SD)$	p[b]	PND
5	35	-119.35(705.02)	106.94(1605.23)	.200	0.00	-141.37(713.43)	**-966.94(1528.88)**	.100	22.22
6	25	-137.00(410.27)	**-275.17(582.41)**	.500	11.11	26.59(476.47)	**9.56(238.87)**	.900	0.00
7	34	-100.48(284.07)	-54.23(627.51)	.789	15.38	-9.43(344.32)	19.73(565.87)	.632	15.38
8	35	132.24(434.06)	**-16.86(479.84)**	.200	0.00	-77.24(340.69)	**-124.54(799.88)**	.400	7.14
9	25	197.88(313.23)	**110.56(682.30)**	.600	23.53	-97.75(447.21)	72.00(749.83)	.400	5.88
10	35	187.45(505.43)	**-27.03(1503.11)**	.450	20.00	127.33(334.13)	**-103.17(987.63)**	.100	20.00
11	35	-44.45(455.67)	-26.81(439.53)	.800	8.33	125.18(316.53)	**-45.56(398.11)**	.050	29.17
12	35	-75.66(818.89)	97.03(674.28)	.750	0.00	56.38(743.17)	254.16(631.97)	.650	0.00
15	27	-49.27(415.06)	-22.64(294.00)	.833	0.00	63.08(363.34)	93.39(270.90)	1.000	0.00
16	35	-129.56(478.75)	**-153.39(619.33)**	.750	10.53	-31.44(373.03)	**-43.08(657.57)**	1.000	10.53
18	35	53.88(299.62)	**47.04(311.81)**	.900	8.70	-107.42(209.46)	-22.91(317.86)	.200	13.04
19	35	-29.71(411.13)	**-139.39(289.72)**	.100	0.00	19.36(283.11)	**-57.18(161.21)**	.400	0.00
			p_{meta}[c]	.806				.434	

[a]For both I-words and N-words, more negative scores indicate avoidance, and more positive scores vigilance. [b]p value from randomisation test (Bulté & Onghena, 2008) [c]Meta-analytic p value (Onghena & Edgington, 2005).

Table 5

Randomisation tests and meta-analysis for GRS.[a] *Values in* ***bold*** *indicate changes in hypothesised direction.*

		A	B		
Participant	Sessions	$M(SD)$	$M(SD)$	p[b]	PND
5	35	25.35(7.82)	**16.33(2.40)**	.900	33.33
6	25	16.44(7.50)	**12.78(4.74)**	.600	0.00
7	34	29.86(4.86)	31.69(2.63)	.368	0.00
8	35	12.33(7.08)	**8.43(2.56)**	.750	0.00
9	25	31.88(7.04)	**24.12(5.34)**	.100	17.65
10	35	26.60(11.48)	**14.80(6.42)**	.350	6.67
11	35	40.73(3.77)	**31.67(6.03)**	.400	70.83
12	35	25.06(8.40)	26.84(9.58)	.800	0.00
15	27	22.15(5.37)	**21.07(4.60)**	.583	0.00
16	35	41.40(5.07)	43.47(6.27)	.158	10.53
18	35	19.33(11.80)	**12.04(6.86)**	.350	34.78
19	35	26.67(8.81)	**21.71(5.82)**	.800	14.29
			p_{meta}[c]	.563	

[a]Cronbach's α: median = .83, range = .46–.91 [b]p value from randomisation test (Bulté & Onghena, 2008) [c]Meta-analytic p value (Onghena & Edgington, 2005).

Table 6

Randomisation tests and meta-analysis for positive affect (PA), negative affect (NA) and depression. Values in ***bold*** *indicate changes in hypothesised direction.*

		Positive Affect (PA)[a]				Negative Affect (NA)[b]				Depression (items 'sad' and 'depressed') [c]			
Participant	Sessions	Phase A $M(SD)$	Phase B $M(SD)$	p^d	PND	Phase A $M(SD)$	Phase B $M(SD)$	p^d	PND	Phase A $M(SD)$	Phase B $M(SD)$	p^d	PND
5	35	11.35(4.01)	**11.67(2.96)**	.750	0.00	9.92(2.58)	**8.78(3.35)**	.850	0.00	5.23(2.41)	5.44(2.65)	.950	0.00
6	25	9.50(2.34)	**13.67(3.32)**	.200	22.22	8.25(2.35)	**7.11(1.96)**	.400	0.00	3.19(1.38)	**2.67(1.32)**	.400	0.00
7	34	14.90(1.89)	**15.23(2.92)**	.895	0.00	13.29(1.87)	14.77(1.64)	.632	0.00	5.57(0.75)	5.92(0.28)	.474	0.00
8	35	10.86(3.80)	9.29(2.20)	.050	0.00	9.43(2.80)	10.14(4.04)	.500	7.14	4.00(1.64)	4.50(2.65)	.400	0.00
9	25	8.75(3.92)	**11.06(3.38)**	.100	23.53	9.12(2.95)	**8.35(2.74)**	.500	0.00	3.00(1.41)	**2.24(0.56)**	.100	0.00
10	35	10.85(2.11)	**13.93(3.77)**	.400	60.00	10.50(2.16)	**8.07(1.53)**	.250	6.67	2.70(0.80)	3.33(1.18)	.250	0.00
11	35	8.09(1.64)	**10.54(3.04)**	.300	33.33	12.55(1.81)	**9.75(3.29)**	.750	29.17	5.36(0.92)	**4.33(1.13)**	.700	20.83
12	35	12.94(3.80)	**13.05(4.03)**	1.000	5.26	11.88(4.87)	**10.11(4.99)**	.650	0.00	4.31(1.92)	4.53(2.29)	.900	0.00
15	27	7.23(0.93)	**7.86(2.18)**	.167	28.57	6.92(1.93)	**6.14(1.10)**	.333	0.00	3.92(1.50)	**3.21(1.12)**	.167	0.00
16	35	10.07(2.55)	6.53(1.81)	.263	0.00	10.40(1.18)	**9.21(2.51)**	.737	36.84	2.60(0.83)	3.32(1.34)	.211	0.00
18	35	15.67(1.78)	**17.04(2.51)**	.800	21.74	11.42(5.42)	**8.39(3.97)**	.550	0.00	4.17(2.86)	**2.78(1.68)**	.350	0.00
19	35	8.29(1.65)	6.86(1.23)	.100	0.00	9.10(2.36)	9.29(1.14)	.700	0.00	3.38(0.80)	3.93(1.14)	.200	0.00
			p_{meta}[e]	.167				.801				.187	

[a]Cronbach's α: median = .83, range = .46–.91

[b]Cronbach's α: median = .75, range = .25–.95

[c]Cronbach's α: median = .83, range = 0.00–.98

[d]p value from randomisation test (Bulté & Onghena, 2008)

[e]Meta-analytic p value (Onghena & Edgington, 2005).

Discussion

This study predicted that ABMT would reduce attentional bias, which would be accompanied by reductions in worry, trait rumination, symptoms of anxiety and depression, and improvements to mood variables. Contrary to our hypotheses, we found no reduction in attentional bias towards towards negative words, no significant differences between pre and post worry, rumination, symptoms of anxiety and depression. We also found no overall changes to mood variables in the hypothesised directions. Also unsupported were our hypotheses that ABMT would reduce rumination towards, and attentional bias towards words associated with, an ideographic current concern. These findings do not support the hypothesis that rumination occurs as a result of an impaired ability to disengage from negative self-referent information (Koster et al., 2011).

We failed to replicate previous findings (Yang et al., 2015) that ABMT can reduce attentional bias towards sad words, and that this change is associated with concurrent reductions in trait rumination and depressive symptoms. One explanation for these null findings is that the study was underpowered to detect post-ABMT outcomes. Yang et al. (2015) found effect sizes of d=.49 for RRS, d=1.50 for BDI-II and d=.88 STAI-T. In the current study, with 12 participants and α set at .05, two-tailed calculations of power (1-β) gave .34 for RRS, 1.00 for BDI-II and .79 for STAI-T. Yang et al. (2015) did not measure worry, but in a similar paradigm, Enock, Hofmann and McNally (2014) reported d=.51 for PSWQ which would give the current study power (1-β) of .36. Although the study used different instruments to measure symptoms of depression (PHQ-9 vs. BDI-II) and anxiety (GAD-7 vs. STAI-T), it was not underpowered in this regard, yet failed to detect effects. In contrast with Yang et al. (2015)), participants in this study had low initial symptoms of depression and anxiety (table 3). These calculations suggest additional power may have been required to detect changes in rumination (RRS) and worry (PSWQ), both of which showed moderate but non-significant effects (table 3).

As a relatively new psychological task, questions remain regarding how dot-probe

stimulus properties and population characteristics interact, its reliability as a measure of attentional bias, and how well ABMT translates into a psychotherapy. Previous research (B. Bradley et al., 1997; Donaldson et al., 2007) strongly indicates that shorter stimulus presentations are appropriate for assessing attentional biases associated with anxiety, whereas longer durations ($\geq$ 1000 ms) are required when studying depressive symptoms and rumination. Shorter word presentations in the current study may have more effectively measured and modified bias, given that the current sample scored higher on worry than rumination. Stimulus type (words vs pictures) and sample characteristics (healthy vs. high symptomatology) are also known to modulate the effects of ABM on attentional bias, but their interactions remain unclear (Beard, Sawyer & Hofmann, 2012). Important interactions between stimulus semantics and symptoms have been shown using the Stroop task. Mogg, Bradley, Williams and Mathews (1993) found that anxious participants were slower than depressed and normal participants at naming negative, but not generally emotional words, and depression-congruent bias has been shown to depend on self-referent elaborative processing (Nunn, Mathews & Trower, 1997). The reductions in rumination and depressive symptoms found by Yang et al. (2015) were in participants with mild to severe depressive symptoms, in response to ABMT using sad and neutral words. In the current study, the I-words were highly self-relevant, but the ABMT only included N-word pairs, so it is possible that words with normative, negative valence were not sufficiently self-relevant for ABMT to modify bias in this particular sample.

Mixed findings across studies which use the dot-probe could be also be explained by its poor internal consistency and test-retest reliability. This has been demonstrated in clinical and non-clinical samples using both response times (Schmukle, 2005) and event-related potentials (Kappenman, Farrens, Luck & Proudfit, 2014). The dot-probe may also be unsuitable for studying attentional biases and comorbidity. Musa, Lépine, Clark, Mansell and Ehlers (2003) found that attentional bias in patients with social phobia and a concurrent depressive disorder equivalent to non-patients. Short dot-probe stimulus exposures are needed to detect biases in anxiety (and possibly worry), whereas

longer exposures are required to detect biases associated with depression and rumination. The longer exposure used in current study was more likely to identify identifying ruminative mechanisms rather than those common to worry and rumination, and this limitation of the dot-probe complicates the study mixed of anxiety and depression. Finally, although longer stimulus exposures are likely to result in prolonged processing of self-referent material, the dot-probe does not necessarily demonstrate attentional engagement, and as such may be a weak test of the disengagement hypothesis of depressive rumination (Koster et al., 2011).

Directly comparing the current study with previous research on attentional bias and current concerns is difficult, as this is dominated by studies which use the Stroop task. However, (Williams et al., 1997) review many studies which suggest that words semantically related with an individuals schemata surrounding their concerns may be more influential that the valence of such stimuli. For example, (A. Mathews & Klug, 1993) found more Stroop interference in words judged as highly related to likely concerns or relevant threats, irrespective of their positive or negative valence. Although dot-probe studies with anxious patients have failed to find similar evidence (Musa et al., 2003), content specificity is consistent with the mixture of valences in participants I-word ratings (appendix E) in the current study. It is also suggestive of later, more elaborative information processing common in depressive rumination. Mogg et al. (1993, p. 309) have suggested that in the Stroop task, content-specific, elaborative semantic processing may be more likely with blocked presentation of stimuli. To test these ideas, the current paradigm could be modified to use a dot-probe/ABMT with two (or more) words thematically related to a current concern, paired with thematically neutral words.

Outside of studying current concerns, the goal progress theory of rumination is very broad and lacking in testable hypotheses. For example, it is unclear what counts as a "higher order" goal, and therefore likely to trigger rumination (Martin & Tesser, 1996). Furthermore, Martin and Tesser (1996) don't claim that goal discrepancies are the exclusive cause of rumination. For example, they say the "rebound effect" of thought suppression (Wegner, Schneider, Carter & White, 1987) can occur in the

absence of goal discrepancies, notably in the case of worry. A related framework with more directly testable hypotheses (Watkins & Nolen-Hoeksema, 2014), suggests that while goal discrepancies may cause rumination, this can become a habitual thinking style. Within this framework, rumination with no overt goal discrepancy may instead be cued by contingent contexts such as mood, or the physical location in which it tends to occur. Rumination is especially likely when contingent responses involve passive focus on abstractly construed, negative content (Watkins & Nolen-Hoeksema, 2014). The disengagement hypothesis (Koster et al., 2011) is especially suited to, and as yet untested, within this framework. If rumination is a habitual thinking style, the repetitive nature of ABMT seems promising as a counter-conditioning technique. The current study used ABMT in a specific context (at home), but it was not established whether this context was likely to trigger rumination in each participant. Using a mobile phone app, it would be relatively easy to test the effects of ABMT on rumination in contingent contexts. Training attentional disengagement from negative information is also a central feature of MBCT (Donaldson et al., 2007), suggesting that positive outcomes may result from encouraging practices such as the "breathing space" (Segal et al., 2012) in rumination-contingent contexts. These suggestions raise additional questions regarding where, when and how much ABMT is effective. See et al. (2009) found signs of reduced attentional avoidance of negative information bias up to 48 hours post-ABMT, but more research on the longevity of effects is needed. In the current study, ABMT was relatively ineffective, and phase B session completion patterns (table 2) suggest that people would be unlikely to maintain such intencsive ABMT.

The non-significant effects of ABMT on reducing rumination in this study support meta-analytic findings that CBM is relatively ineffective as a treatment for anxiety and depression. Hallion and Ruscio (2011) found that CBM significantly modified anxiety but not depression, with non-significant trend toward a larger effects for studies including multiple training sessions. Mogoase, David and Koster (2014) also only found small therapeutic benefits of ABM for anxiety, although there was less data for other symptom categories, reflecting a lack of research in this area. Interpretation biases are

likely to be involved in later information processing stages associated with depressive rumination, and CBM targeting interpretation (CBM-I) does indeed show larger effects than ABM (Hallion & Ruscio, 2011). However, research in this area is limited and equivocal as to whether interpretive bias does (Mogg, Bradbury & Bradley, 2006) or does not (Bisson & Sears, 2007) play a role in depression. Furthermore, recent studies which demonstrate bias reductions using CBM-I do not demonstrate symptom change (Micco, Henin & Hirshfeld-Becker, 2014). Evidence is also mixed as to whether ABMT could translate into a self-administered treatment. See et al. (2009) found that Internet delivered ABMT was effective at inducing avoidance of negative information and reducing anxiety scores to a subsequent naturalistic stressor. In the current study, only one participant showed a change in bias (table 4) and reduced rumination (table 5), after 24 ABMT sessions (table 1). This result is more consistent with findings that ABMT is effective when delivered in the clinic, but not when delivered at home (Linetzky, Pergamin-Hight, Pine & Bar-Haim, 2015).

The inability to demonstrate attentional bias change in this study is consistent with a general critique of CBM treatments as having effect sizes too small to be clinically relevant (Cristea et al., 2015). MacLeod and Clarke (2015) question this finding, arguing that a selection criterion for meta-analysis should be that studies demonstrate that ABM reduces both attention bias and symptoms. However, a meta-analysis meeting this criterion still found effect sizes small for anxiety and non-significant for depression Mogoase et al. (2014). Cuijpers (2015) conclusion is that research seeking new psychotherapies for depression is misguided, given the many existing therapies and the difficulty demonstrating relative efficacy with sufficient statistical power. Thus, the imminent emergence of cheap, computer-based therapies for treating anxiety and depression seems unlikely. One way to address the gap between demand and supply for treating emotional disorders is to focus research on cheaper ways, such as I-CBT, of delivering existing psychological therapies known to be effective. However, cognitive biases clearly play a role in emotional disorders. Future research in this area may explain why bias modification is relatively ineffective and may

also contribute to explaining why existing treatments are only partially effective.

This study had a number of limitations. First, it lacked a control condition. Multiple baseline case-series designs provide some controls against alternative explanations of effects including regression to the mean, baseline assessment effects, extraneous events correlated with phase transition (Watkins et al., 2007; P. J. Watson & Workman, 1981). However, as an exploratory study, limiting Type I error rates was not a priority and a control condition could be added to a subsequent study there been significant findings. The study would have benefited from a more reliable state measure of depressive symptoms than the ad-hoc two item scale used. Similarly, the validity of the GRS could be questioned, especially as the the scale valence was modified to refer to a "problem" rather than a "goal". For consistency with previous research (See et al., 2009), outcome variables should be measured post ABMT in response to a naturalistic stressor.

To conclude, the null findings in this study are in line with other mixed findings in the attentional bias measurement and modification literature. However, the field has no shortage of theory or hypotheses, but existing tasks have a limited ability to validate them. Future work should look for approaches which improve on the Stroop and dot-probe tasks as measures and modifiers of attentional bias. In the short term, I-CBT may be the best means of reducing treatment costs. Future work should test the disengagement hypothesis and possibly MBCT within the habit-goal framework. Randomisation tests were shown to be complementary to visual analyses of case-series data.

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Appendices

Appendix A

Survey Measures

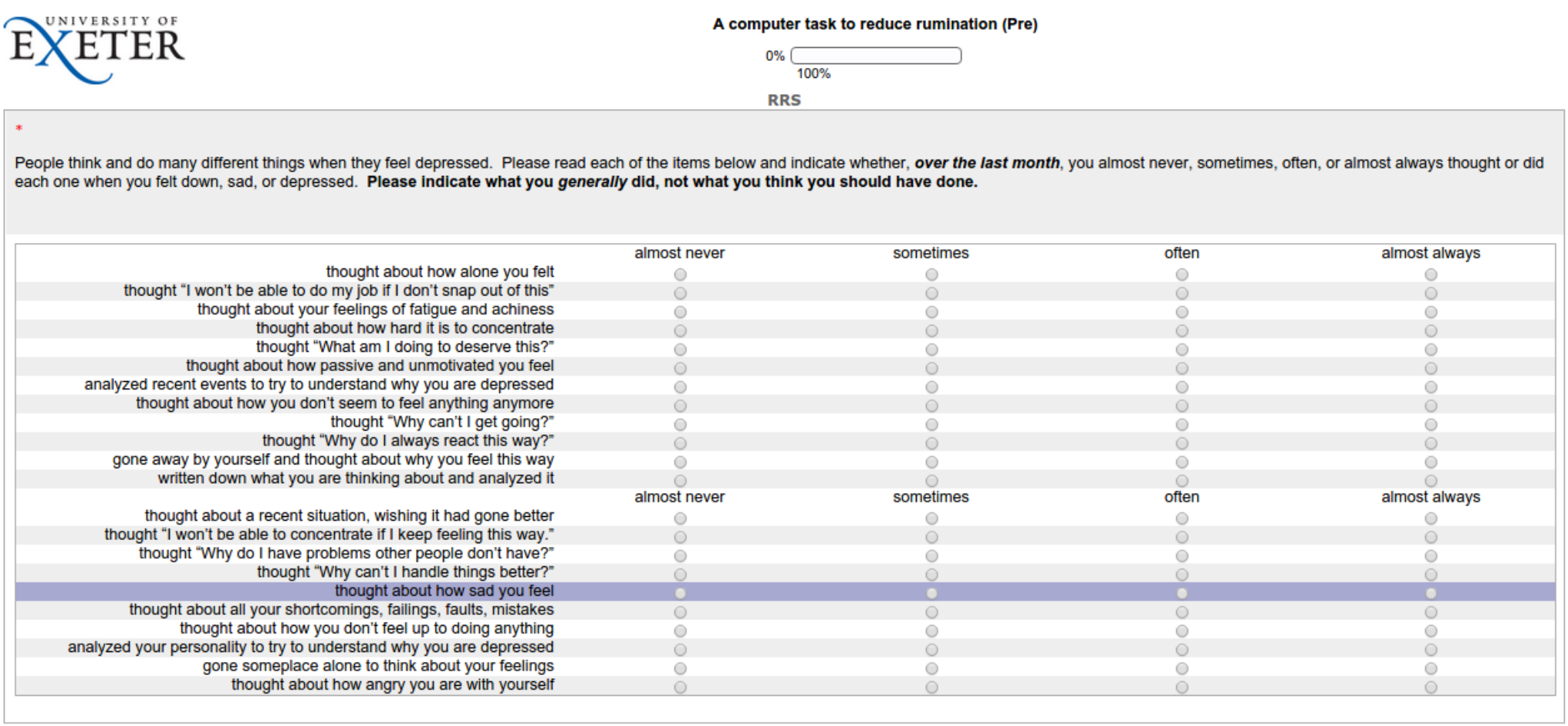


Figure A1. Ruminative Responses Scale (RRS) administered using Lime Survey

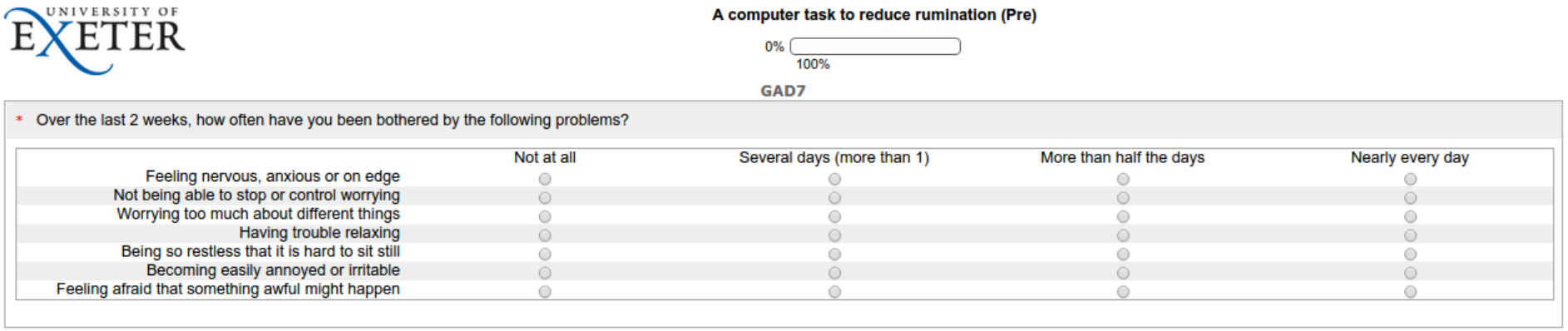


Figure A2. GAD-7 administered using Lime Survey

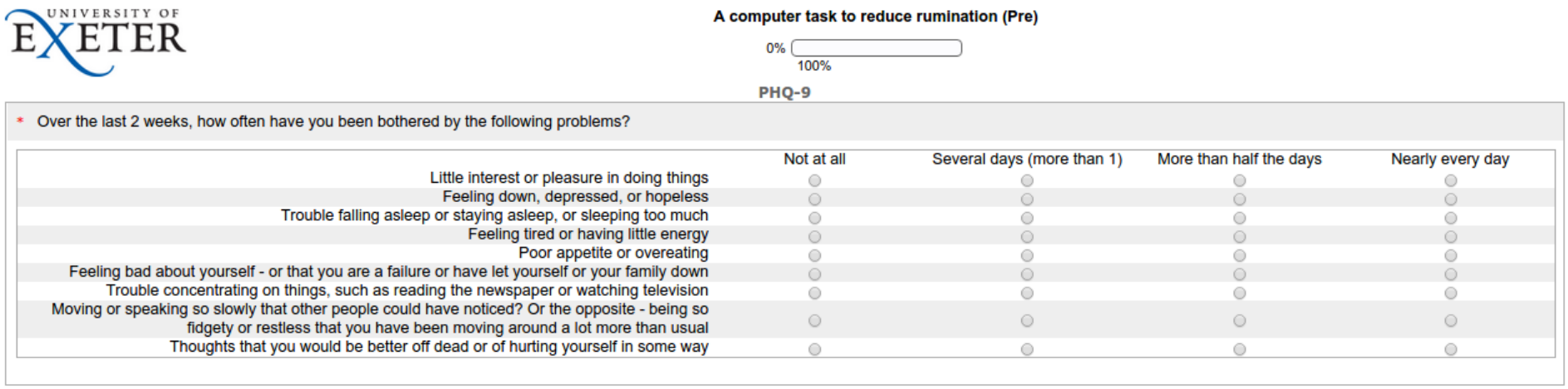


Figure A3. PHQ-9 administered using Lime Survey

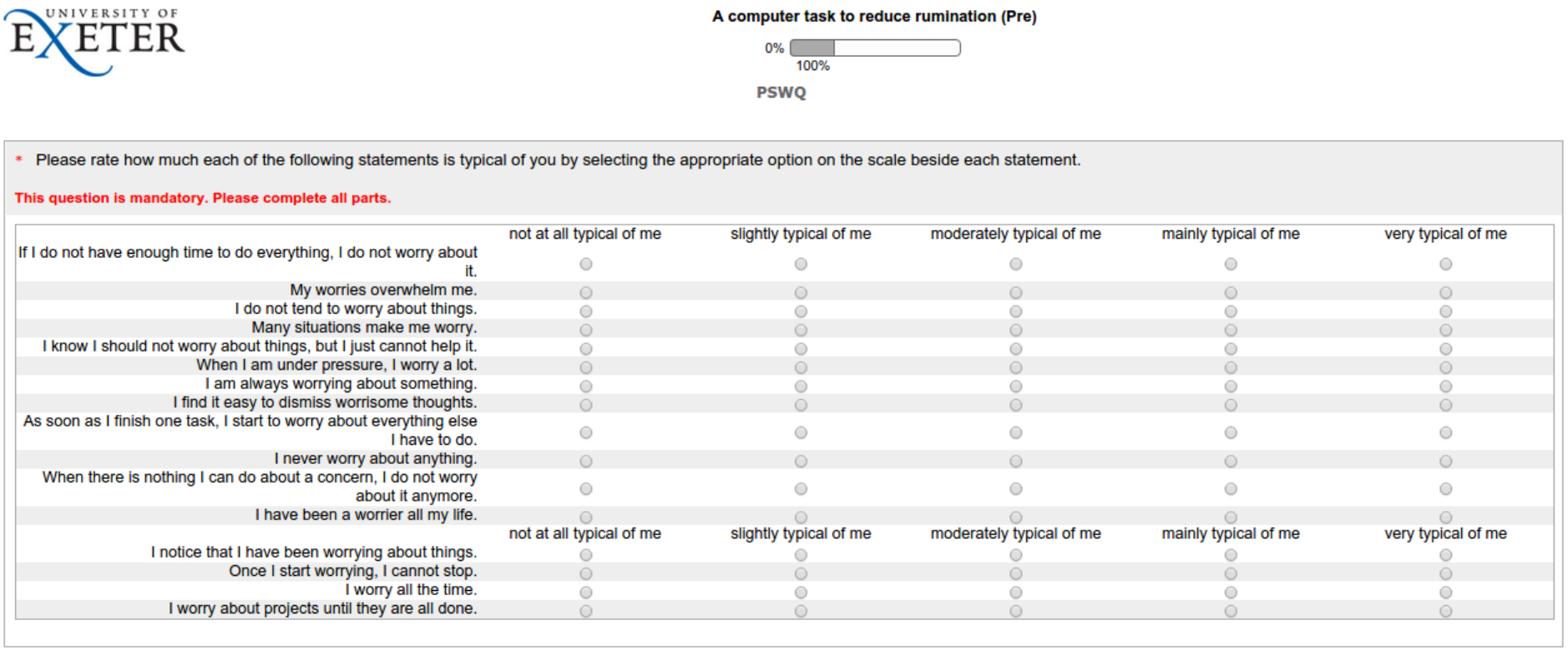
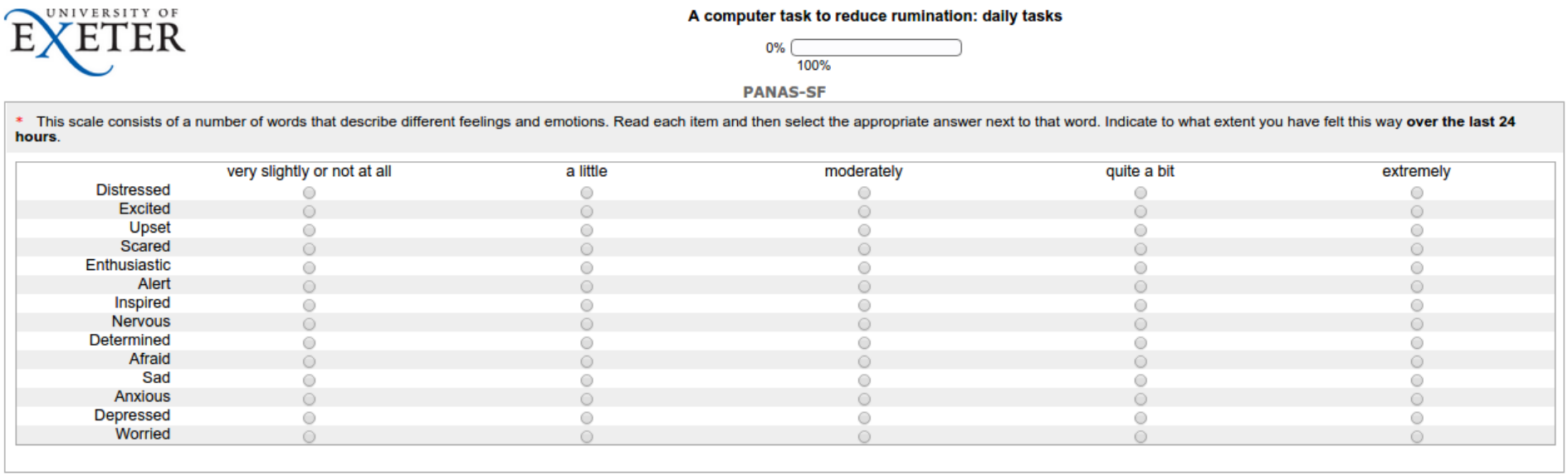


Figure A4. Penn State Worry Questionnaire (PSWQ) administered using Lime Survey



UNIVERSITY OF EXETER

A computer task to reduce rumination: daily tasks

0%

100%

PANAS-SF

* This scale consists of a number of words that describe different feelings and emotions. Read each item and then select the appropriate answer next to that word. Indicate to what extent you have felt this way **over the last 24 hours**.

	very slightly or not at all	a little	moderately	quite a bit	extremely
Distressed	○	○	○	○	○
Excited	○	○	○	○	○
Upset	○	○	○	○	○
Scared	○	○	○	○	○
Enthusiastic	○	○	○	○	○
Alert	○	○	○	○	○
Inspired	○	○	○	○	○
Nervous	○	○	○	○	○
Determined	○	○	○	○	○
Afraid	○	○	○	○	○
Sad	○	○	○	○	○
Anxious	○	○	○	○	○
Depressed	○	○	○	○	○
Worried	○	○	○	○	○

Figure A5. Positive and Negative Affect Schedule (PANAS-SF) administered using Lime Survey

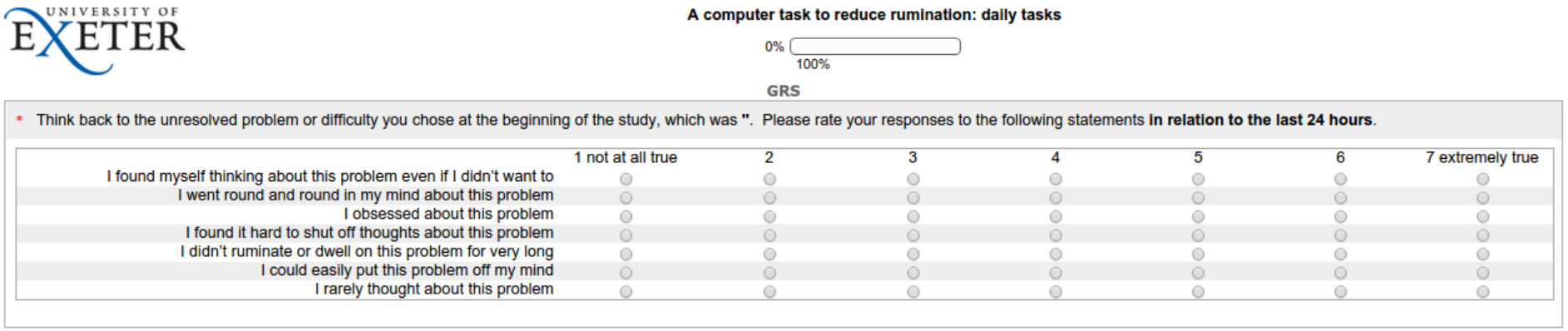
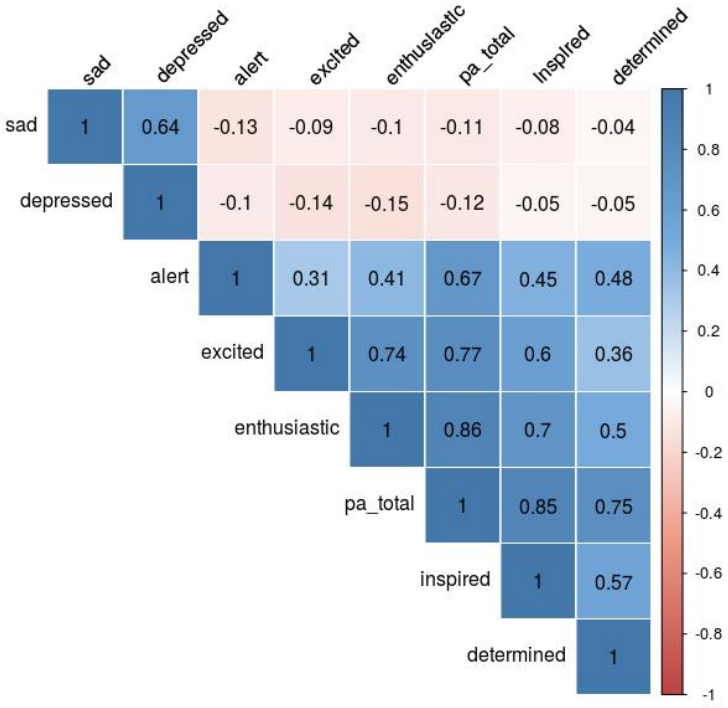


Figure A6. Goal Rumination Scale (GRS) administered using Lime Survey

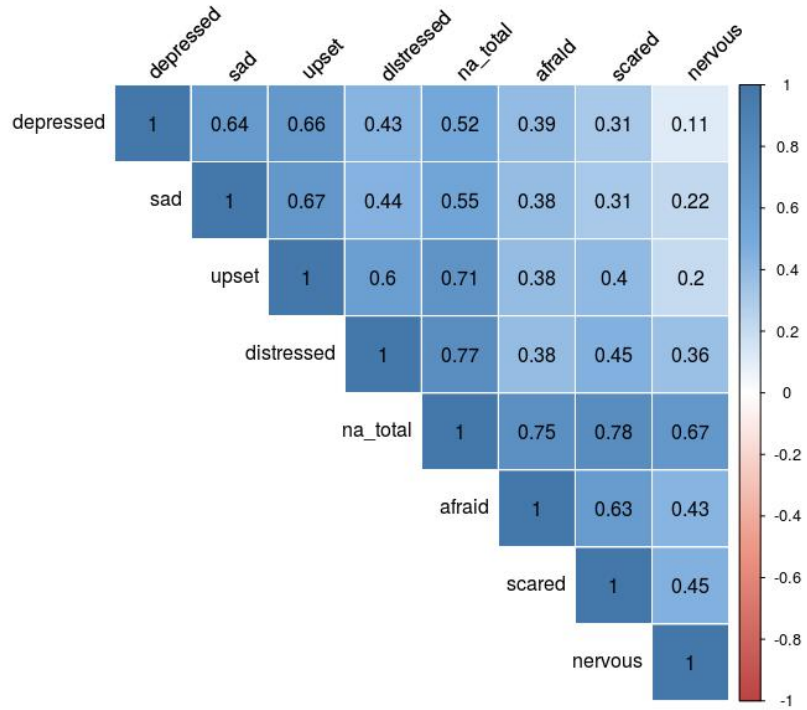
Appendix B

Correlations for PANAS-SF and additional mood items

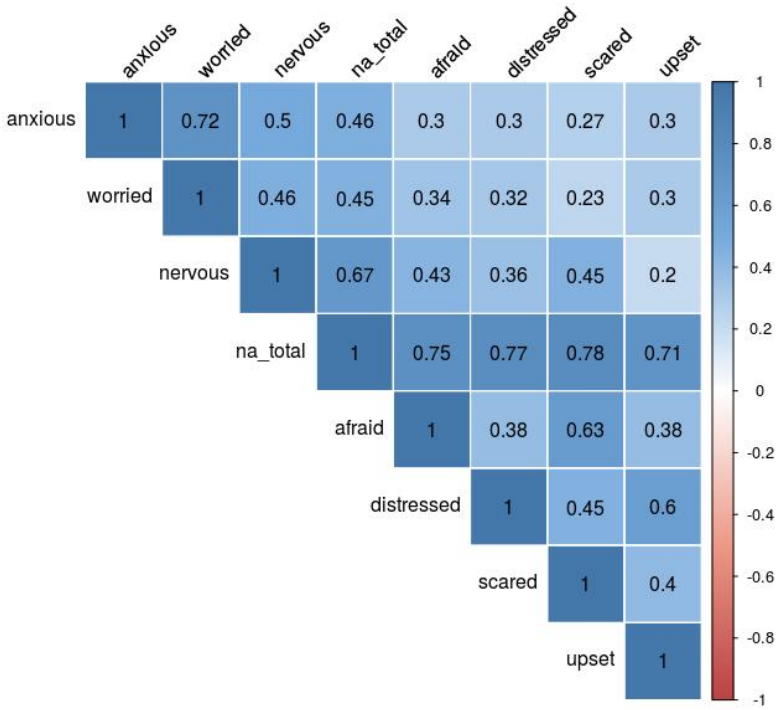
Figure B1. Correlations PANAS-SF and additional items 'sad','depressed','anxious','worried'.



(a) Correlations between PA items, 'sad' and 'depressed'



(b) Correlations between NA items, 'sad' and 'depressed'



(c) Correlations between NA items, 'anxious' and 'worried'

Appendix C

N-word stimulus pairs

The Sussex Affective Word List (SAWL) (Citron, Weekes & Ferstl, 2014) was used to create 66 N-word stimulus pairs. Starting with 66 words rated most negative and most neutral, pairs were created by matching words of equivalent character length, drawing additional words from the SAWL as necessary to ensure that all pairs were matched on length. A small number of pairs which appeared to be semantically related were adjusted by replacing the neutral word in the pair with an alternative from the SAWL. Independent samples t-tests showed significant differences (Ps $< .001$) for mean ratings of valence and arousal (table C2). Pairs were matched for frequency, imageability, familiarity, number of characters and number of syllables (all Ps $> .16$) (table C2). In addition, the mean valence between members of any pair was at least 1.44 (Mean: 2.15, $SD = 0.37$). To form the stimulus blocks, pairs were ranked by descending mean valence difference. The 6 pairs with the lowest difference were assigned to the "spare" block, used where I-words were present in the N-word set. The remaining 60 pairs were divided at every 10 word boundary, forming 6 groups. Each experimental block of 6 words was created by taking the top pair from each group, until all groups were exhausted, thereby creating 10 blocks with a mixture of valence differences. The complete N-word list can be seen in table C1.

Table C1

N-word stimulus pairs used in dot-probe and ABMT

Block	Pair 1	Pair 2	Pair 3	Pair 4	Pair 5	Pair 6
0	CONFLICT-OPPOSITE	FAILURE-STRANGE	EVIL-DROP	WEAPON-VALLEY	ASHAMED-OPINION	PRISON-MEMBER
1	DEFEATED-SCISSORS	MISTAKE-JOINING	COWARDLY-SYMPATHY	HARM-MILK	ACCUSED-CURIOUS	CRISIS-FOREST
2	SUSPICIOUS-DISCUSSION	ILLNESS-HERRING	DISTRESSED-ASTONISHED	THREAT-SOURCE	NIGHTMARE-HOUSEWIFE	SAD-LIP
3	EXCLUDED-ORDINARY	FRIGHTENED-INTONATION	LIE-VOW	USELESS-WHISPER	STRESSED-LANGUAGE	BETRAYED-MATCHING
4	PUNISHED-FOLLOWER	STINKING-RECEIVER	DESTROY-CEILING	COLLAPSE-ACTIVITY	AFRAID-LEADER	AGONY-ABBEY
5	LOSER-REACH	MISFORTUNE-COLLECTIVE	ENEMY-ORGAN	MURDER-TRICKY	ARGUMENT-REMEMBER	DIVORCE-TEACHER
6	FIRE-RISE	DEVIL-WEAVE	CRY-BOY	LONELY-CELLAR	LOSS-BOLD	DEPRESSED-ABUNDANCE
7	BAD-JOB	DISAPPOINTED-CONCENTRATED	VICTIM-DESERT	ANXIOUS-RELEASE	NAZI-TELL	HELL-POET
8	DOUBT-FAITH	TERRIFIED-APATHETIC	WORTHLESS-SITUATION	CRIME-GUEST	HURT-BOOK	BOMB-LAKE
9	ABANDON-WITNESS	BRAG-TREE	DAMAGE-MEMORY	ATTACK-RETURN	ANGRY-BUILD	CORPSE-SALARY
10 (“spare”)	DESPAIR-PARTING	WOUND-ATTIC	BATTLE-CHOOSE	ARREST-COMPEL	CHAOS-PUPIL	BURDEN-ACCENT

Table C2

Dimensional characteristics of Negative-Neutral word pairs

	Negative words ($N = 66$)		Neutral words ($N = 66$)				
Dimension	Mean	*SD*	Mean	*SD*	*t*	*p*	$CI_{95\%}$
valence	-1.78	0.38	0.29	0.36	-32.26	< .001	[-2.20, -1.94]
arousal	4.60	0.67	2.44	0.56	20.10	< .001	[1.94, 2.37]
imageability	4.05	1.13	3.99	1.50	0.27	.785	[-0.39, 0.52]
familiarity	4.50	0.71	4.49	1.01	0.08	.933	[-0.29, 0.31]
frequency	36.77	39.11	48.91	56.69	-1.43	.155	[-28.91, 4.63]
syllables	1.92	0.66	2.05	0.90	-0.88	.381	[-0.39, 0.15]
characters	6.39	1.99	6.39	1.99	0.00	1.000	[-0.69, 0.69]

Appendix D

I-word stimulus pairs

Due to the unpredictability of I-words, and the limited number of words in the SAWL (Citron et al., 2014), a larger data set was required to matched pairs to I-words. A database of neutrally valenced words was created including frequency, imageability, familiarity, word length and number of syllables attributes from the MRC psycholinguistic database (Wilson, 1988). A separate table was added to the database containing 1030 word valence means from the Affective Norms for English Words (ANEW) dataset (M. Bradley & Lang, 1999).

Two different matching approaches were used, depending on whether each I-word word was present in, or absent from, the MRC database. If present, a neutral pair was selected from a pool of words having a frequency ±15% that of the I-word, an ANEW valence mean (range 1-9) between 4.00 and 6.00 and an equal number of characters. After selecting a pool of matched words on the preceding criteria, a best match was found by inspection of candidate words based on number of syllables, imageability and familiarity. Some I-words, such as long words or high frequency words, could not be matched using these criteria due to lack of available data. In these cases, a word with the most neutral valence was chosen that also minimised differences in length and frequency between the word pair. I-words absent from the MRC database (including proper nouns) were paired with words selected from a pool of 56 words having a frequency of 1 (on the assumption that words missing from the database would most likely be of low frequency), and for which an ANEW valence rating was available. A word was selected from this pool having an ANEW valence mean between 4.00 and 6.00 and an equal number of characters to the I-word. If an I-word or its pair was a member of the N-word set, that N-word pair was substituted with the next available pair from the spare N-words block with the largest difference in valence. Resulting I-word pairs were validated by the experimenter's supervisor. The final sets of I-word pairs for each participant are shown in table D1 and their characteristics in table D2.

Table D1

Words chosen by each participant as likely to initiate rumination over their current concern (I-words) and matched pairs selected by the experimenter (WORD—PAIR).

Participant	Concern duration[1]	Pair 1	Pair 2	Pair 3	Pair 4	Pair 5	Pair 6
5	1 month 3 days	SETTLE—BARREL	MARRIAGE—HOSPITAL	AUSTRALIA[a]—EMBATTLED	JOB—AIR	LONELY—BUTTER	FAMILY—HISTORY
6	2 years	DANCE—GLASS	TECHNIQUE—ORCHESTRA	DEPENDENT—INNOCENT	INFERIOR—UMBRELLA	FRUSTRATE—APPLIANCE	UNABLE—AVENUE
7	1 year	TRAINING—BUILDING	STRUCTURE—ORCHESTRA	FRUSTRATE—APPLIANCE	SUCCESS—MACHINE	TALK—FALL	SLICK—TRUNK
8	8 years	FAMILY—OFFICE	MATURE—PENCIL	VISIT—GLASS	CAR—AIR	TIME—PART	BUSY—ITEM
9	6 months	THESIS—LOCKER	COMPLETE—BUILDING	OVERWHELM—AVALANCHE	STRESS—CORNER	TIME—PART	PROGRESS—HOSPITAL
10	3 months	STRESS—CORNER	FAILING—CABINET	FFFFFFF[a]—GLACIER	TELEPHONE—ORCHESTRA	MMMMMM[a]—TAMPER	TIME—PART
11	2 months	STUPID—BARREL	SCIENCE—SERIOUS	TARGET—ENGINE	FFFFFFF[a]—KETCHUP	FAILURE—PATIENT	LOSING—CELLAR
12	1 year 1 month	STUDENT—SERIOUS	SOCIAL—OFFICE	AGE—AIR	KENT[a]—FROG	DUTY—ITEM	FRIENDSHIP—RESTAURANT
15	1 year 6 months	FRUSTRATE—APPLIANCE	ANGER—WAGON	FAILURE—PATIENT	TIRING—KETTLE	CONFLICT—RESERVED	GUILT—PAINT
16	21 years	FEAR—FARM	PANIC—HABIT	DREAD—TRUNK	PRESSURE—BUILDING	POINTLESS—REPENTANT	FRAUD—SALAD
18	8 months 19 days	THESIS—LOCKER	CAREER—DETAIL	FINISHING—LIGHTNING	WRITING—MACHINE	FAILURE—PATIENT	DEPRESSION—RESTAURANT
19	2 months 25 days	INDECISIVE—SKYSCRAPER	TEIGNMOUTH[a]—NONCHALANT	FARM—ARMY	SMOKE—BENCH	SURF—FROG	REJECTION—APPLIANCE

[1]Answer to the question "How long has this been a difficulty for you?" at the start of the study. [2]Female and male names redacted with equivalent number of F or M characters respectively. [a]I-word not in database.

Table D2

Characteristics of each participant's I-words and matched pairs.

	I-words $M(SD)$				Pairs $M(SD)$			
Participant	Frequency[1]	Imageability[2]	Familiarity[2]	Valence[3]	Frequency[1]	Imageability[2]	Familiarity[2]	Valence[4]
5	120.50(135.10)[a]	387.50(300.55)[b]	341.00(268.90)[b]	-0.50(2.17)	117.50(125.23)	470.33(235.02)[c]	443.67(234.05)[c]	5.23(0.64)
6	42.50(33.00)	271.00(296.95)[c]	211.67(236.68)[c]	-1.17(1.72)	40.17(35.93)	524.67(48.19)	546.50(91.78)	5.42(0.51)
7	84.17(67.15)	285.00(313.33)[c]	212.83(234.45)[c]	-1.00(0.89)	80.50(67.27)	539.83(46.64)	567.00(31.31)	5.11(0.62)
8	400.33(599.34)	486.67(244.86)[c]	410.00(222.89)[c]	-1.83(0.75)	199.83(176.27)	584.50(25.96)	478.17(110.81)	5.32(0.53)
9	336.33(622.38)	201.50(312.16)[c]	125.67(196.01)[c]	-1.67(2.07)	149.17(183.03)	537.83(72.37)	540.17(99.52)	4.71(0.77)
10	300.17(637.76)[a]	286.67(315.88)[b]	247.83(285.18)[b]	-2.67(0.82)	115.67(193.31)	424.83(217.09)[c]	436.50(234.81)[c]	5.02(0.71)
11	53.00(48.20)[a]	278.17(304.94)[b]	206.83(227.32)[b]	-0.83(2.14)	50.50(43.14)	358.50(237.43)[c]	481.33(237.42)	5.09(0.43)
12	137.83(143.91)[a]	470.17(234.59)[b]	389.67(212.85)[b]	-0.33(2.66)	120.67(111.14)	568.67(37.69)	490.17(110.26)	5.73(0.68)
15	38.33(32.35)	444.17(218.68)[c]	353.17(177.59)[c]	-3.00(0.00)	35.50(31.60)	429.33(214.47)[c]	373.50(290.14)[c]	5.25(0.25)
16	58.67(77.89)	427.67(215.33)[c]	350.00(177.88)[c]	-2.83(0.41)	54.33(69.55)	465.50(231.70)[c]	451.33(231.59)[c]	5.21(0.59)
18	52.67(45.20)	383.67(299.02)[c]	308.00(242.21)[c]	-1.67(1.51)	54.17(38.84)	447.17(222.90)[c]	480.00(236.97)[c]	4.89(0.63)
19	30.17(48.93)[a]	351.00(276.64)[b]	347.17(288.03)[b]	-0.67(2.58)	29.33(51.99)	482.00(64.88)	541.17(88.80)	5.13(0.55)

[1]Frequency norms from Kučera and Francis (1967). [2]Merged from three sets of norms (Wilson, 1988). [3]Participant's subjective valence rating using procedure from Citron, Weekes and Ferstl (2014). [4]Valence norms from M. Bradley and Lang (1999)

[a]Frequency of 1 assumed for I-words not in database.[b]Missing values were set to 0 for I-words not in database. [c]Includes one or more 0 values likely to be missing data rather than normative values.

Appendix E

I-word generation procedure

Participants were instructed to generate up to 10 English words, excluding phrases, associated with their concern. When choosing these words, they were asked to consider "causes, meanings and implications" (Watkins, Baeyens & Read, 2009, p.55) relating to their concern, thereby encouraging abstract construal, which has been associated with rumination (Watkins et al., 2009). From their list, they then chose the 6 words most likely to cause them to ruminate about their concern.

Whilst participants completed the dot-probe practise block, the experimenter validated their I-words, noting any which known to be difficult to match with a pair from the neutral word database. These including plurals, acronyms, hyphenated words, words with stems related to an N-word or words longer than 10 characters. After completing the practice block, participants were instructed to replace any invalid words with synonyms or with alternatives from their list, where these were available. Care was taken to ensure that the semantics of any adjusted words were chosen by the participant without influence from the experimenter. All participants successfully generated 6 I-words. They rated the valence of each word in relation to their concern on a 7-point scale, using instructions based on Citron et al. (2014). Approximately 79% were rated negative (mean valence = -2.37), 14% positive (mean valence = +1.9) and 7% neutral (mean valence = 0). Participants then completed a distraction task to attenuate the effects of rumination (Nolen-Hoeksema et al., 2008) for 5 minutes.

Appendix F

Task instructions

Overview

The computer task will initially take about 5 minutes to complete. Later in the study, this will increase to about 15 minutes. You will need to follow the instructions in an email you receive for each daily 'session'. These will remind you to complete the computer task and answer a short set of questions using a web browser. Following the instructions in the email will ensure that the data from the computer task is matched to your answers for that session. Remember to delete the email at the end of the session to avoid accidentally repeating an earlier session. You will only receive a reminder for the next session once you have completed the current session.

Ideally you will complete all sessions on consecutive days. However, don't worry too much if your schedule means you have to miss a session. The researcher will contact you if this happens to see whether you want to complete that session on the next day (extending your participation by a day) or to skip that particular session. The emails you received will repeat the information you need for the session you are about to complete.

Hardware and software requirements

- Computer running Windows, Macintosh (OS X 10.9 or later), or Linux operating system software

Installing and running the computer task

The researcher will provide you with specific instructions to install and run the computer task on the operating system (Windows, Macintosh, Linux) installed on your own computer. The software you will install is a standard package for running psychological experiments. This has been tested, and should not otherwise affect the running your computer and can be removed at the end of the study. Whilst the researcher will be available to provide technical help, installation and removal of

software is ultimately your responsibility. The researcher will analyse your response accuracy daily, to ensure that the experiment is running smoothly.

How to complete the task

Please try to observe the following when running the computer task

- Choose at a time when you are unlikely to be interrupted or are trying to do other things (turn off mobile phones, televisions etc.)
- Before running the task, close all other programs on your computer
- Sit upright, approximately 60cm from the screen
- Use the same computer to complete each session.

Data Files

Each day you will upload a data file generated by the computer task. These are stored in the folder `experiment/data` in the location where you originally extracted the computer task. The form which asks you to upload your data file will include the name of the file to upload. Each data file has the name `p<participant>s<session>`, where `<participant>` is your participant number and `<session>` is the session number (1-35) you have just completed. For example, after completing the task for session 25, participant 2 would upload the file `experiment/data/p2s25`.

Dealing with problems during the study

I appreciate that there may be some early technical issues to overcome, so if you have any problems with the instructions, do email or call me as I should be able to help. Please use the same contact details if you are concerned about any major worsening of your mood during the study.

Finally...

Once you have the computer task running at home, you've completed most of the more difficult set-up tasks. After completing the first few sessions you will become

familiar with the tasks and should find a way of fitting them into your daily routine without too much disruption. I hope you enjoy completing the daily sessions, and want to thank you for your commitment to the study.

Appendix G

Example session reminder email

Dear <participant>,

This is a reminder to complete "A computer task to reduce rumination: daily tasks". Follow the instructions below in order, making sure you enter the correct session number (and subject number if necessary).

1. Computer task (takes about 5 minutes early in the study, and about 15 minutes later in the study).

    - Your session number for today is **34**. Make a note of this before running the task as you will need to enter it on the first screen.
    - Before running the task, close all other programs on your computer.
    - Please avoid interruptions (e.g. turn off mobile phones, TV etc.) so you can focus exclusively on the computer task.
    - Your subject number is **12**

2. Click on this link (<url>) and follow the instructions. (Remember to upload your task file on the first screen. Only click "Return to survey" after the "Uploading..." message disappears.)

3. Delete this email (you will receive new reminders for subsequent sessions in the study).

    A copy of the task instructions is attached should you need to refer to them.
    Sincerely,

Appendix H

Debrief sheet

Thank you for taking part in this study which was designed to examine whether daily attention training can reduce levels of rumination and/or improve mood. Rumination is associated with both depression and anxiety and is known to predict the length and severity of depressive episodes, as well as the risk of relapse in the future. Researchers and clinicians are investigating this type of task as a way to reduce the negative affects of rumination to supplement existing treatments.

There is evidence to suggest that rumination is linked with a difficulty disengaging from negative thoughts and that this tendency can be reduced using computer-based training programmes. There is also evidence that people tend to ruminate over self-relevant, unresolved goals. This is why you were asked to take part in a 35-day study looking at the effects of attention training on the day-to-day tendency to ruminate in response to negative words in general, and negative words relating to an unresolved goal of your own. We were also interested to see whether the training led to improvements in daily mood and changes to levels of depression before and after the training. Scores on each measure will be compared before and after participants began the attention training, to see whether it had the desired effect. One of the computer tasks you carried out each day measured your attentional orientation towards negative and neutral words. In the second phase of the study, this was preceded by a task designed to reduce your attentional focus on negative words.

Over the course of the study, you have accrued a payment of £X. Please contact the researcher to indicate which of the following methods you would prefer

1. Receive cash from researcher or supervisor at the University of Exeter
2. Electronic payment into your bank account

Now that you have completed/withdrawn from the study, the researcher will delete the link between your participant number and personal details so that all information provided by you will be stored anonymously. This means it will not be

possible to trace your scores on any measure back to you personally. A consequence of this is that the researcher will no longer be able to identify which scores belong to which participant, so you will not be able to withdraw your data once this happens. Please let the researcher know by <date> if you wish to withdraw your data from the study. After this date, your scores will be anonymised and it will no longer be possible to withdraw.

You can remove the software and data associated with the computer task by deleting the experiment folder which you created on your computer at the start of the study. If you were using a Macintosh computer, you can also uninstall the OpenSesame software.

The results of this study may be published within academic journals and shared at conferences. All information will be anonymised so that it will not be possible to identify any participants personally. If you are interested in finding out the results of the study, please contact the researcher via email after 31st October 2015 to request a summary.

If you have any questions about this study, please contact the researcher via email (see below). Questions or concerns about this study can also be addressed to the Chair of the Ethics Committee, School of Psychology, University of Exeter. He can be contacted at the following email address: <email>. You can also contact the research supervisor, <XXX>, by emailing: <email>.

I hope you found the study interesting. I'm really grateful for your participation and the significant contribution it has made to my research.

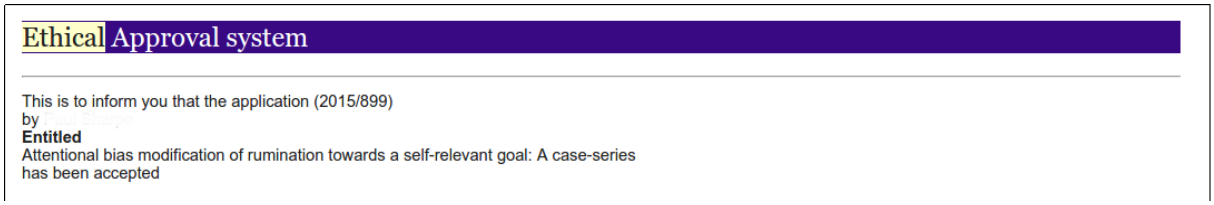
Appendix I

Ethical considerations and approval

Because screening measures were submitted remotely, depression was measured using the PHQ-8 which omits one item measuring suicidal ideation. Anyone scoring ≥ 10 on the PHQ-8 (Kroenke et al., 2009) received practical, supportive information about resources available to people who may be suffering from depression. The researcher completed training in implementing the latest risk protocol employed by the University of Exeter, Mood Disorders Centre. Risk cover by a clinically trained member of staff was arranged in advance of each PHQ-9 (which includes a suicidal ideation question) that was administered to participants. No participants triggered the risk protocol.

A potential risk of harm was identified arising from increasing rumination in high trait ruminators, along with the burden of a long testing period. The experimenter mitigated this risk by keeping in regular contact with participants, notably when more than two testing sessions were skipped. Any concerns were raised with the researcher's supervisor. On leaving the study, all participants were emailed a copy of the support information for people who may suffer from depression.

Participants were not identifiable from their electronic data. Online measures were stored on a secure digital filing system and all other data on a memory stick. Any sensitive written information was stored in a locked filing cabinet.


Ethical Approval system

This is to inform you that the application (2015/899)
by
Entitled
Attentional bias modification of rumination towards a self-relevant goal: A case-series
has been accepted

Figure I1. Notification of ethical approval

Appendix J

Sources of support information sheet

Your GP

If you have been experiencing low mood most of the day for more than a few days, you should consider consulting your GP, who can provide professional guidance and help. You can contact your GP to arrange an appointment, or in an emergency. Most GP surgeries will connect you to an out-of-hours service if you call outside office hours needing help. If you are a student you can contact the Exeter University Student Health Centre, whether or not you are currently registered there.

- Streatham Campus: Student Health Centre, Reed Mews: (01392) 676606 or x 4414
- St Luke's Campus: Heavitree Health Practice, Heavitree Health Centre: (01392) 211511
- At other times during vacation contact the St Thomas Health Centre: (01392) 676676

University of Exeter Wellbeing Service

The Wellbeing Service is available free of charge to all students, full-time, part-time, undergraduate and postgraduate. Because student life can be stressful, the Wellbeing Service is there to provide confidential help and support. We aim to help students cope more effectively with any personal problems or emotional difficulties that may arise during their time at University.

Telephone: (01392) 724381

Or book an appointment via the website:

http://www.exeter.ac.uk/wellbeing/appointments/

Student Wellbeing Service

Reed Mews Wellbeing Centre

Streatham Drive

Exeter EX4 4QP

Voice (University of Exeter)

Voice is a student-run listening and information service, run by students for fellow students at the University of Exeter and is available from 8pm to 8am every night during term time. It is completely confidential, anonymous and prejudice-free, which means you can call with the confidence of knowing you can discuss anything you want without being judged.

Telephone (8pm – 8am): 4000 (internal, free of charge)

External: (01392) 72400

Email: exetervoice@googlemail.com

Website: http://www.exeterguild.org/voice/

Exeter Samaritans

Samaritans provides confidential emotional support, 24 hours a day for people who are experiencing feelings of distress or despair. Samaritans are there if you're worried about something, feel upset or confused, or you just want to talk to someone.

10 Richmond Road

Exeter

Devon

EX4 4JA (open daily 10.30am – 9.30pm)

24 hour telephone helpline: 01392 411711 (Exeter branch) / 08457 909090 (national)

Email: jo@samaritans.org

Website: http://www.samaritans.org/branches/samaritans-exeter-mid-east-devon

Depression Alliance

Depression Alliance are a charity working to relieve and to prevent depression by providing information, support and understanding. Depression Alliance offer a range of publications and self-help groups.

Depression Alliance

20 Great Dover Street

London

SE1 4LX

Telephone: 0845 123 23 20 (for an information pack only)

Email: information@depressionalliance.org

Website: http://www.depressionalliance.org/