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THE PERSEVERATION OF CHECKING THOUGHTS AND MOOD-AS INPUT HYPOTHESIS

By

Graham C.L. Davey, Helen M. Startup, Ayten Zara, C. Benie MacDonald

& Andy P. Field

The University of Sussex, Brighton, UK.

Correspondence to:

Graham Davey, Ph.D.,
Professor of Psychology,
School of Cognitive & Computing Sciences,
The University of Sussex,
Brighton,
East Sussex,
Bn1 9QH
UK

Email: grahamda@cogs.susx.ac.uk

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ABSTRACT

This paper describes two experiments designed to investigate how a current model of task perseveration, the mood-as-input hypothesis, might be applied to activities relevant to compulsive checking. The mood-as-input hypothesis predicts that perseveration at an open-ended task will be determined by a combination of the 'stop rules' adopted for the task, and the valency of the mood state in which the task is conducted. Experiment 1 required participants to generate items that should be checked for safety/security if they were leaving their home unattended. Experiment 2 used an analogue recall task, in which participants were asked to recall items from a comprehensive list of items that should be checked if they were to leave their home safe/secure. Both experiments found that perseveration at the tasks was determined by particular configurations of mood and stop rules for the task. Of most relevance to compulsive checking was the fact that facilitated perseveration occurred when participants were asked to undertake the tasks in a negative mood using 'as many as can' stop rules. Implications for the factors that develop and maintain compulsive checking are discussed.

A number of prominent psychopathologies are characterized by the dysfunctional perseveration of certain thoughts, behaviours or activities. Examples include pathological worrying, which is the current cardinal diagnostic feature of Generalized Anxiety Disorder (GAD) (DSM, 4th ed.; DSM-IV; American Psychiatric Association, 1994); obsessive compulsive disorder (OCD) in which individuals indulge in perseverative bouts of activities such as checking, washing or obsessive thoughts; and rumination, which has been recognised as an important maintaining factor in depression. In almost all examples of these psychopathologies the perseveration is viewed as excessive, out of proportion to the functional purpose that it serves, and a source of emotional discomfort for the individual concerned.

Cognitive explanations of these perseverative psychopathologies have tended to be focussed within individual disorders rather than addressing the possible common factors that might facilitate perseveration *per se*. Even though there is some evidence for co-morbidity across at least some of these perseverative disorders (e.g. Andrews, Stewart, Morris-Yates, Holt & Henderson, 1990; Schut, Castonguay & Borkovec, 2001), suggesting the possibility of some common mechanisms operating across them, there have been few attempts to identify what these common mechanisms might be.

However, there has been one recent attempt to address the processes underlying pathological perseveration, and this model has already been applied to a number of perseverative psychopathologies. This model is known a the mood-as-input hypothesis (Martin & Davies, 1998; Martin, Ward, Achee & Wyer, 1993), and it is centrally concerned with explaining how perseveration at a task is generated by the way in which mood is used as information in determining whether the goals of the task have been achieved, and the task should therefore be terminated. However, rather than being intrinsically linked to certain default processing strategies (such as mood-congruent processing), the mood-as-input hypothesis proposes that it is an individual's

interpretation of their mood rather than the mood *per se* that has particular performance implications. The mood-as-input hypothesis can best be explained by describing a study conducted by Martin et al. (1993). They induced either positive or negative moods in their participants and asked them to generate a list of birds' names. Half of the participants were told to stop generating the names of birds when they no longer felt like it (a "feel like continuing" stop rule), whereas the other half were asked to stop when they thought they had generated as many as they could (an "as many as can" stop rule). They found that the effect of mood on the generation task was dependent on the stop rule that the participant was asked to use. For the "feel like continuing" stop rule group, participants in the positive mood persisted at the task for significantly longer than those in the negative mood. However, for the "as many as can" stop rule group, participants in the negative mood persisted for significantly longer than those in the positive mood. Martin et al. (1993) interpreted these results in mood-as-input terms. For example, participants in a negative mood interpret their mood in relation to the stop rule. In the "feel like continuing" condition, their negative mood tells them to stop. In the "as many as can" condition, their negative mood tells them they are not satisfied with the number of items they have generated on the task, and so they persist at the task for longer.

Startup & Davey (2001, 2003) have attempted to apply the mood-as-input hypothesis to the explanation of why pathological worriers generate longer worry bouts (Craske, Rapee, Jackel & Barlow, 1989; Borkovec, Shadick & Hopkins, 1991) and persist for longer when catastrophising their worries (Vasey & Borkovec, 1992; Davey & Levy, 1998) than nonworriers. When applied to catastrophic worrying, the mood-as-input model assumes that (a) worriers are in a negative mood, and (b) they use "as many as can" stop rules for terminating the worry or catastrophising bout. The conjunction of negative mood and "as many as can" stop rules is hypothesised to generate perseveration at the worry task. Startup & Davey (2001) tested some predictions from the mood-as-

input explanation of perseverative catastrophic worrying. Using a catastrophising interview procedure, they demonstrated that (a) participants in a negative mood persisted for longer at a catastrophising task than participants in either positive or neutral moods, and (b) explicitly manipulating the stop rules for catastrophising has differential effects on worriers and nonworriers: asking participants to use an "as many as can" stop rule resulted in worriers producing significantly more catastrophising steps than nonworriers, but when asked to use a "feel like continuing" stop rule, worriers emitted fewer catastrophising steps than nonworriers. These results indicated that the degree to which worriers would persist at any iterative task (such as a catastrophising task) was dependent on the configuration of their current mood state and the stop rules specified for the task. Consistent with this approach, other studies have demonstrated that, compared with nonworriers, pathological worriers do enter worry bouts in a negative mood (Startup & Davey, 2001, Studies 2 & 3; cf. Davey et al., 1992; Meyer et al., 1990) and do use stricter 'as many as can' stop rules for the worry task (Davey, Startup, MacDonald, Jenkins & Patterson, 2002) – conditions under which the mood-as-input hypothesis would predict perseveration of the task.

Apart from pathological worrying, the mood-as-input hypothesis has also been applied to perseverative rumination in depression. Deriving their predictions from mood-as-input theory, Watkins & Mason (2002) hypothesised that high ruminators would use a default "as many as can" stop rule for determining when to stop analysing the causes and consequences of any problem. These predictions were upheld, and they found that high ruminators asked to use an "as many as can" stop rule produced significantly more reasons for their depressed mood than either high ruminators asked to use a "feel like continuing" stop rule or low ruminators using any stop rule.

One perseverative psychopathology that the mood-as-input model has yet to be applied to is the obsessive-compulsive (OC) range of disorders, the most prevalent of

which are compulsive checking, compulsive washing and obsessive thoughts. The known characteristics of obsessive-compulsive disorder suggest that a mood-as-input account may be relevant to explaining the dynamics of the obsessive persistence found in this disorder. Taking the example of compulsive checking, OC checkers report significantly higher levels of negative mood, both generally (Frost, Sher & Green, 1986) and while engaging in checking (Salkovskis, 1985), than noncheckers, indicating that they will enter a checking activity in a negative rather than positive mood. Secondly, many contemporary accounts of OC checking claim that inflated responsibility is a vulnerability factor which plays an important role in the development of compulsive checking behaviour (Salkovskis, 1985; Rachman, 1998). Excessive or inflated responsibility can be defined in terms of the individual's belief in their power to cause harm (Rheaume, Ladouceur, Freeston & Letarte, 1994; Wilson & Chambless, 1999), and this inflated responsibility both generates negative affect and motivates the individual to persist in checking. That OC checkers possess beliefs of inflated responsibility would indicate that they deploy inherent "as many as can" stop rules during a checking task. That is, they will be motivated to ensure that they have successfully completed the task rather than terminating the task simply when they 'feel like stopping'.

The present paper describes two experiments conducted as a preliminary investigation into the mood-as-input hypothesis as applied to tasks related to checking. Experiment 1 examines how manipulations of mood state and stop rules influence persistence at a checking item generation task. Experiment 2 describes a similar analysis of the effects of mood and stop rules on persistence in a checking-relevant recall task.

EXPERIMENT 1

Experiment 1 uses an item generation task to investigate whether persistence at an analogue cognitive check generation task is determined by a combination of stop-rule and concurrent mood. If so, then individuals in a negative mood should persist longer at an analogue checking task when asked to perform under an 'as many as can' stop rule, than under a 'feel like continuing' stop rule. In the present task, participants are asked to write down all the things they would wish to check for safety or security reasons in their home before they left for a 3-week holiday. While compulsive checking is a cognitive and behavioural activity that has many different features and dimensions, the present analogue task has a number of features in common with these compulsive checking activities. For example, the task is an open-ended one (i.e. there is no objectively defined end to the task, in the same way that compulsive checking is often viewed as having no 'natural terminus', Rachman, 2002), it requires individuals to generate items to check which, if not checked, may cause harm or negative outcomes for which the individual may perceive themselves as responsible (see Salkovskis, Rachman, Ladouceur, Freeston, Taylor, Kyrios & Sica, 1996; Rheaume, Ladouceur, Freeston & Letarte, 1994), and it represents the first cognitive stages of a process that in natural circumstances would lead to behaviours required to ensure safety/security and prevent catastrophe to either the individual or others.

METHOD

Participants

The participants were 60 undergraduate and postgraduate students from the University of Sussex. 30 were female and 30 male. Ages ranged from 18 to 47 yr. with a

mean age of 25.1 yr. All of the participants were volunteers and were paid a small fee for their participation.

Procedure

Participants were assigned randomly to one of six groups. These groups differed on the valency of the mood induction they were to receive and the nature of the stop-rules under which they would perform the check generation task (see below). There were three mood induction conditions (negative, positive and neutral), and two stop-rule conditions ('as many as can' and 'feel like stopping'). Thus, six sub-groups existed, each consisting of 10 participants. Participants were tested individually in a small sound-proofed room containing an audio-cassette player with headphones and an angle-poise lamp. They were instructed that they would be required to fill in a number of questionnaires, listen to an extract of taped music, and take part in an item-generation task. They were then asked to complete an informed consent form.

Stage 1 (mood induction): Participants were asked to rate their current levels of anxiety, sadness, happiness and arousal on separate 100-point visual-analogue scales (where 0=not at all anxious/sad/happy/aroused, and 100=extremely anxious/sad/happy/aroused). The headphones were then placed on the participant's head and they were told to listen to the short extract of music. This music lasted for 8 min. Group negative (N=20) listened to music which pilot studies had indicated induced negative mood (Gyorgy Ligeti, *Lux Aeterna*). To facilitate this negative mood, lighting in the experimental room was subdued by drawing the window blinds and using only the angle-poise lamp for illumination. Participants in the positive mood condition (N=20) listened to 8-min of music which was known from pilot studies to induce positive mood

(Vivaldi, *Four Seasons*) during which blinds in the room were raised to allow full daylight, and the central light and angle-poise were switched on. Participants in the neutral mood condition listened to a tape containing music which pilot studies had shown indicated no significant changes in mood (Chopin, *Waltz*). During the playing of this tape, the window blinds were raised and the angle-poise and central lights were turned off (see also Startup & Davey, 2001, for further details of these mood induction procedures). At the end of the mood induction period, participants were once again asked to complete the four 100-point visual-analogue mood measures.

Stage 2 (distractor task): To minimise demand effects and to distract participants from consciously attributing their subsequent mood directly to the induction procedures, participants were asked to spend 1 min. constructing a cognitive map of the University campus (see also Martin, Ward, Achee & Wyer, 1993).

Stage 3 (check generation task): An item generation task was then described to all participants in which they had to 'imagine you are leaving home to go on holiday for 3 weeks. List as many things in or around your home that you should check for safety or security reasons before you go away'. Half the participants in each mood condition were asked to perform this task under an 'as many as can' stop rule, and the remaining half under a 'feel like continuing' stop rule. In the 'as many as can' condition, participants were told to ask themselves throughout the task "have I generated as many items to check as a can?" If the answer is 'yes' - then stop, if the answer is 'no' - then continue. Participants were told there is no right or wrong time to stop. In the 'feel like continuing' condition, participants were told continually to ask themselves whether they felt like continuing with the task: if the answer was 'yes' they should continue, if the answer was 'no' they should stop. The length of time that participants persisted at the check

generation task was recorded. When they indicated that they wished to stop the task participants were then debriefed and paid.

RESULTS

All effects are reported at $p < .05$, and where appropriate effect sizes are reported using Pearson's correlation coefficient, *r*, as an effect size measure. Using Cohen's (1988) criteria this means that small, medium and large effects are reflected by *r*s of .1, .3, and .5 respectively.

Mood induction procedures

Table 1 shows the mean mood ratings on scales of anxiety, sadness, happiness and arousal for participants in all three mood conditions both before and after the mood induction procedure. Each measure was subjected to a repeated measures ANOVA comparing mood measure (before/after) and mood group (negative, positive, neutral).

In the case of the anxiety measure, there was a significant main effect of before/after, $F(1, 57) = 4.94$, $r = .27$, indicating that anxiety was rated highest before the induction regardless of the nature of the mood induction. There was no significant difference between mood groups on anxiety ratings prior to the mood inductions. The before/after × mood group interaction was also nonsignificant.

For the sadness measure, the main effect of before/after was nonsignificant, but there was a significant before/after × mood group interaction, $F(2, 57) = 15.73$. Further comparisons revealed no significant differences between mood groups on sadness ratings prior to the induction, but there was a significant difference between groups following the respective inductions, $F(2,59)=3.32$. This was manifested as the negative group giving

significantly higher sadness ratings than the positive group (Tukey's LSD, $p < .05$). There were no other significant pairwise comparisons.

There was no significant main effect of before/after with the happiness measure, but there was a significant before/after × mood group interaction, $F(2,57) = 34.37$. Subsequent comparisons revealed no significant difference between mood groups on happiness ratings prior to the induction, but there was a significant difference following the induction, $F(2, 59) = 11.17$. This was manifested as the positive group giving significantly higher happiness ratings than the negative group (Tukey's LSD, $p < .05$). There were no other significant pairwise comparisons.

For the arousal measure, there was a significant main effect of before/after, $F(1, 57) = 5.02$, $r = .28$, indicating that participants across all three groups tended to be more aroused after the induction than before. There was no significant difference in arousal ratings between mood groups prior to the mood induction. The before/after × mood group interaction was also nonsignificant.

These analyses suggest that following the different mood induction procedures, the negative group was significantly sadder and significantly less happy than the positive group.

Generation of checking items

The number of items to check that was generated by participants in all three moods and two stop-rule conditions is illustrated in Figure 1. A 3 (mood group: negative, positive, neutral) × 2 (stop rule: as many as can vs. feel like continuing) independent ANOVA was conducted on the number of checking items generated by participants. This revealed no significant main effects of mood group, $F < 1$, or stop rule, $F(1, 54) = 2.09$. However the mood group × stop rule interaction was significant, $F(2, 54) = 6.35$.

To break down this interaction term tetrad differences were examined by comparing the differences between the number of items generated using an as many as can stop rule compared to a feel like continuing one across different mood groups. The first contrast revealed that the difference in the number of checks using an 'as many as can' stop rule compared to a 'feel like continuing' stop rule was not significantly different when in a negative mood compared to a neutral mood, $t(54) = 1.45$, $r = .19$. The second contrast revealed that the difference in the number of checks using an 'as many as can' stop rule compared to a 'feel like continuing' stop rule was significantly different when in a positive mood compared to a neutral mood, $t(54) = -2.09$, $r = .27$. Figure 1 shows that this reflects the fact that when in a positive mood the number of checks was much higher when using a 'feel like' rule then when using an 'as many as can' rule, whereas in a neutral mood the number of checks was similar regardless of the stop rule used. The final contrast revealed that the difference in the number of checks using an 'as many as can' stop rule compared to a 'feel like continuing' stop rule was significantly different when in a negative mood compared to a positive mood, $t(54) = -3.54$, $r = .43$. Figure 1 shows that this reflects the fact that when in a positive mood the number of checks was much higher when using a 'feel like' rule than when using an 'as many as' rule, whereas in a negative mood the opposite was true: the number of checks was higher when an 'as many as can' stop rule was used.

Time spent on the check-generation task

The time spent checking in all three moods and two stop-rule conditions is illustrated in Figure 2. This shows a similar pattern of results to the number of checks generated (see Figure 1). A 3 (mood group: negative, positive, neutral) × 2 (stop rule: as many as can vs. feel like continuing) independent ANOVA was conducted on the number of

checking items generated by participants. This revealed no significant main effects of mood group, F (2, 54) = 2.26, or stop rule, $F < 1$. However the mood group × stop rule interaction was significant, F(2, 54) = 3.26.

This interaction term was also broken down by examining tetrad differences between the time spent checking using an 'as many as can' stop rule compared to a 'feel like continuing' one across different mood groups. The first two contrasts revealed that the difference in the time spent checking using an 'as many as can' stop rule compared to a 'feel like continuing' stop rule was not significantly different when in a negative mood compared to a neutral mood, t(54) = 1.05, r = .14, or in a positive mood compared to a neutral mood, t(54) = –1.49, r = .20. Looking at Figure 2, although the time spent checking appears to be similar for the two stop rules in participants in a neutral mood, yet different for people in a positive or negative mood, these two contrasts show that these apparent differences are not significant. However, both contrasts yield a small to medium effect size. The final contrast revealed that the difference in the time spent checking using an 'as many as can' stop rule compared to a 'feel like continuing' stop rule was significantly different when in a negative mood compared to a positive mood, t(54) = –2.54, r = .33. Figure 1 shows that this reflects the fact that when in a positive mood the number of checks was much higher when using a 'feel like' rule then when using an 'as many as' rule, whereas in a negative mood the opposite was true: the number of checks was higher when an 'as many as' stop rule was used.

DISCUSSION

These results confirm that both the number of items generated to check and the amount of time spent on the task are influenced by a combination of the valency of the mood experienced by the participant and the stop rules that they are asked to work

under. Thus, mood does not have a simple unidirectional effect on persistence at the task, but interacts with the rules governing persistence at the task. Individuals using an 'as many as can' stop rule persisted longer at the check-generation task and generated significantly more items to check when in a negative mood. However, when persistence at the task is governed by a 'feel like continuing' stop rule, then participants in a positive mood persisted at the task for longer and generated more check items than those in the negative mood.

Of particular relevance to compulsive checking activities is the condition in which participants generate items to check in a negative mood using 'as many as can' stop rules. This is the condition that is most similar to the natural circumstances under which obsessive checkers perform. First, obsessive checkers exhibit high levels of negative mood generally (compared with noncheckers) (Frost, Sher & Green, 1986) and specifically exhibit high levels of negative mood while they are engaged in checking activities (Salkovskis, 1985). Secondly, there are two sources of evidence that suggest that obsessive checkers use 'as many as can' stop rules. Richards (1995, 1997) has highlighted the importance of the use of unusual checking criteria by OC checkers that guide the decision to stop checking. These studies cite evidence that obsessional patients are more likely to use difficult to achieve internal states (e.g. being sure of something feeling certain) as criteria for ceasing repetitive activities such as checking – stopping criteria that closely resemble 'as many as can' rules. In addition, obsessive checkers possess beliefs of inflated responsibility (Rheaume et al., 1994; Wilson & Chambless, 1999; Rachman, 1998) which would clearly bias them towards deploying 'as many as can' stop rules prior to and during checking. That is, their excessive or inflated beliefs in their power to cause harm will motivate the individual to ensure that they have successfully completed the task as best they can ('as many as can' stop rules) rather than terminating the task when they simply feel like doing so. The present findings can also be seen as consistent with

the view from clinical experience that OC checkers continue to check until they feel they have checked everything "just right" (Coles, Frost, Heimberg & Rheaume, 2003). This would indicate that the OC checker would normally be using an 'as many as can' rather than 'feel like continuing' stop rule. The former would determine perseveration until rather strictly defined goal criteria are met so that everything is "just right", whereas the latter permits termination of the task without regard to whether checking has successfully achieved its purpose.

Nevertheless, equally persistent at the task were participants in a positive mood performing under a 'feel like continuing' stop rule. This raises the question of the relevance of this combination of factors to OC checking. However, while this condition is a necessary part of a balanced design for this kind of study, it has significantly less relevance to naturally-occurring combinations of mood and stop rule inherent in checking tasks. For example, the function of checking tasks is such that these tasks would most likely be carried out under 'as many as can' stop rule conditions because they function to ensure that negative consequences do not occur. Thus, naturally occurring combinations of mood and 'feel like continuing' stop rules may be rare in relation to checking behaviours. So, while the 'feel like continuing' stop rule is a useful tool for experimentally demonstrating how the same mood can have quite different effects depending on the nature of the stop rules employed (e.g. Martin et al., 1993; Startup & Davey, 2001), it is a stop rule that probably has little relevance in the context of explaining perseverative checking.

EXPERIMENT 2

One important characteristic of OC checkers is their repeated attempts to recall whether a checking activity has been executed properly, and related to these repeated

memory checks is the fact that checkers report having less confidence in the validity of their memories than do noncheckers (e.g. Watts, 1995; Christianson & Nilsson, 1984; Sheffler-Rubenstein, Peynircioglu, Chambless & Pigott, 1993; McNally & Kohlbeck, 1993). This characteristic of OC checking has led to memory-based theories of perseverative checking which variously allude to OC checkers having specific memory deficits (Sher, Mann & Frost, 1984; Sher, Frost, Kushner, Crews & Alexander, 1989), a deficit in the ability to distinguish between the memory of real and imagined actions (a reality monitoring deficit) (Brown, Kosslyn, Breiter, Baer & Jenike, 1994; McNally & Kohbeck, 1993), or simply less confidence in the validity of their memories as a result of either repeated checking (Tolin, Abramowitz, Brigidi, Amir, Street & Foa, 2001) or carrying out checking under conditions of high responsibility (Radomsky, Rachman & Hammond, 2001).

While these memory-based accounts attempt to explain persistence largely in terms of various kinds of memory 'deficit', an alternative explanation for perseverative recall can also be derived from the mood-as-input hypothesis. Configurations of mood and stop rule predict perseveration of all activities relevant to ensuring that the expected negative outcomes are prevented, and this would include (1) cognitive processes defining and generating items to be checked, (2) actual checking behaviours, and (3) recall processes required to confirm that steps 1 and 2 have been completed properly and successfully. Experiment 2 uses an analogue recall task, to determine whether recall persistence can also be modulated in a predictable way by manipulating mood and stop rule conditions.

METHOD

Participants

The participants were 40 undergraduate and postgraduate students from the University of Sussex. 20 were male and 20 were female. Ages ranged from 18 to 59 yr. with a mean age of 26.1 yr. All of the participants were volunteers and were paid a small fee for their participation.

Procedure

Participants were introduced to the experimental room, given a brief description of the tasks involved in the experiment and asked to sign an informed consent form. They were then asked to complete the four 100-point visual-analogue mood scales described in Experiment 1.

Stage 1 (learning the checking items list): Participants were presented with a list consisting of 60 items, each of which was something that they might check in or around the home before they left on a 3-week holiday. This list of checks was constructed from the items generated by participants in Experiment 1. Participants were informed that this was an important list which consisted of items that they would need to check for safety/security reasons if they were leaving their home for an extended period oftime (e.g. to go on holiday). They were given 2 min. to read through the list and were informed that at a later point in the experiment would be required to recall as many of the items as they could (order of recall was unimportant), and that recalling the items would be helpful to them in the future if they ever did want to check their homes for safety/security reasons prior to a holiday or absence.

Stage 2 (mood inductions): Participants were then divided randomly into two groups of 20, one of which was subjected to a negative mood induction and the other a positive mood induction. These inductions were identical to those described in Experiment 1 with the exception that the number of mood induction groups was reduced to two because the major effects demonstrated in Experiment 1 were found only in relation to the negative and positive conditions. After the inductions, participants were again asked to complete the four visual-analogue mood scales.

Stage 3 (distractor task): Participants spent 1 min. engaged in the distractor task described in Experiment 1.

Stage 4 (recall task): Participants were now asked to recall items from the previously presented list of check items under two different stop rule conditions. Half of the participants from each mood condition were told to ask themselves throughout the recall task "have I recalled as many items as I can", and to continue until they felt they had ('as many as can' stop-rule condition). The other half were instructed to ask themselves throughout the recall task "Do I feel like continuing with this task?" - if the answer was 'yes' they should continue, if the answer was 'no' they should stop ('feel like continuing' stop-rule condition). The length of time that participants persisted at the recall task was timed by the experimenter. When they had completed the task, participants were debriefed and paid.

RESULTS

All effects are reported at $p < .05$, and where appropriate effect sizes are reported using Pearson's correlation coefficient, *r*, as an effect size measure. Using Cohen's (1988)

criteria this means that small, medium and large effects are reflected by *r*s of .1, .3, and .5 respectively.

Mood induction procedures

Table 2 shows the mean mood ratings for participants in both mood conditions before and after the mood induction procedures. Each measure was subjected to a repeated measures ANOVA comparing mood measure (before/after) and mood group (negative, positive).

In the case of the sadness measure, the main effect of before/after was nonsignificant, but there was a significant before/after × mood group interaction, $F(1, 38) = 9.51$, $r = .45$. Further comparisons revealed no difference between mood groups on sadness ratings prior to the mood inductions, but sadness ratings were significantly higher for the negative group following the induction, $F(1, 39) = 14.07$, $r = .51$.

There was no significant main effect of before/after with the happiness measure, but there was a significant before/after × mood interaction, $F(1, 38) = 21.00$, $r = .60$. Subsequent comparisons revealed no differences between the negative and positive groups prior to the mood induction, but happiness ratings were significantly lower in the negative group following the induction, $F(1,39) = 11.25$, $r = .47$.

For both the anxiety and arousal measures both the main effects of before/after and the before/after × mood group interactions were nonsignificant.

These analyses, like those in Experiment 1, indicate that the negative group was significantly sadder and significantly less happy than the positive group following their relative mood inductions.

Time spent recalling checking items

The mean amount of time spent by each group recalling the checking items is shown in Figure 3. These data were subjected to a 2-way Mood (negative/positive) × Stop-rule (many as can/feel like) ANOVA. There was no significant main effect of mood condition nor stop-rule, both *F*s < 1. However, there was a significant mood × stop-rule interaction, $F(1, 39) = 15.47$, $r = .53$. For participants performing under the 'as many as can' stop-rule condition, those in the negative mood group spent significantly more time recalling checking items than those in the positive group, $t(18) = 2.92$, $r = .57$. For participants performing under the 'feel like continuing' stop-rule, those in the positive group spent significantly more time on the recall task than those in the negative group $t(18) = 2.63$, $r = .53$. Within individual mood conditions, participants in the negative mood condition spent significantly more time on the recall task in the 'as many as can' stop-rule condition than the 'feel like continuing' condition, $t(18) = 2.11$, $r = .45$. Participants in the positive mood condition spent significantly more time on the recall task if they were in the 'feel like continuing' condition, than in the 'as many as can' condition, $t(18) = 3.43$, $r = .63$.

Number of checking items recalled

Figure 4 shows the mean number of checking items recalled by participants in the four groups. These data were subjected to a 2-way mood (negative/positive) x stop-rule (many as can/feel like) ANOVA. There was no significant effect of either mood condition or stop-rule, both $F(1, 39)$s < 1. However, there was a significant mood × stop-rule interaction, $F(1,39) = 6.50$, $r = .38$. The only significant pair-wise comparison was that participants in the negative mood conditioned recalled more checking items

under the 'as many as can' stop-rule condition than under the 'feel like continuing' stop rule condition, $t(18) = 2.69$, $r = .57$.

DISCUSSION

When participants could determine for themselves how long to spend recalling 'items to check' from a previously learnt list, the actual time spent recalling was dependent on the configuration of both mood and stop rule. Participants in a negative mood spent significantly more time recalling 'items to check' under an 'as many as can' stop rule condition than under a 'feel like continuing' stop rule. Conversely, in the positive mood condition, participants in the 'feel like continuing' condition spent more time recalling than those in the 'as many as can' stop-rule condition.

These results complement those of Experiment 1 by demonstrating that mood x stop rule interactions will determine both the number of checking items generated in an item generation task (Experiment 1) and the amount of time an individual is willing to spend attempting to recall checking-relevant items in a free-recall task (Experiment 2).

Figure 4 shows that participants in the negative mood/'as many as can' condition also recalled more items than in other conditions (although only the negative mood/'as many as can' x negative mood/'feel like continuing' pairwise comparison reached statistical significance). This finding is consistent with other studies that have shown that, compared with controls, OC checkers show enhanced recall when in negatively-valenced mood states (Constans, Foa, Franklin & Mathews, 1995; Burke & Mathews, 1992), but do not show this effect when the task fails to generate negative mood (e.g. Sheffler-Rubenstein, Peynircioglu, Chambless & Pigott, 1993; Sher, Mann & Frost, 1984). One explanation of this effect is in mood-as-input terms. The negative mood combined with the exaggerated 'as many as can' stop rules possessed by OC checkers would facilitate

persistence at the recall task. OC checkers would therefore be more likely to persist in recall attempts longer during the recall period than would participants in less negative mood states and with less strict stop-rule criteria.

Experiment 2 also demonstrates that persistent attempts to recall checking-relevant activities or items need not involve explanations which necessarily invoke memory deficits (either in terms of specific memory deficits, reality monitoring deficits, or memory confidence deficits) – perseverative recall can be achieved simply through establishing mood and stop rule requirements that mimic those under which the OC checker would normally commence checking-related activities (i.e. negative mood and 'as many as can' stop rules). In this type of account, the poor memory confidence exhibited by OC checkers would be a *result* of perseverative checking activities rather than a *cause* of checking activities. There is some evidence to support this proposition. Tolin et al. (2001) exposed individuals diagnosed with OCD to objects that they had previously rated as 'unsafe', and they were then asked to recall as many of these objects as possible. They found that memory confidence for unsafe objects showed a progressive decline over successive exposure and recall trials, indicating that when individuals with OCD are repeatedly exposed to unsafe or threat-relevant items, their level of confidence in remembering these items decreases. This finding is consistent with the view that checking perseveration may be caused by factors other than memory deficits *per se* (e.g. mood and stop rule configurations) and that memory deficits (e.g. poor recall confidence) are an outcome of repeated exposure to threat-relevant items/information resulting from perseveration (see also van den Hout & Kindt, 2003).

GENERAL DISCUSSION

The two Experiments described in this paper were designed to investigate how a current model of task perseveration, the mood-as-input hypothesis (Martin & Davies, 1998), might apply to activities relevant to compulsive checking. Such models of general perseveration have already been applied to anxious psychopathologies such as chronic worrying (Startup & Davey, 2001, 2003; Davey, Startup, MacDonald, Jenkins & Patterson, 2002) and depressive rumination (Watkins & Mason, 2002).

Experiment 1 utilised an open-ended task that required participants to generate items that should be checked for safety/security if they were leaving their home to go on holiday. This task represents the first cognitive stages of a checking process that would lead to behaviours required to ensure safety/security and prevent catastrophe to either the individual or others. Experiment 2 used an analogue recall task, in which participants were asked to recall items from a comprehensive list of items that should be checked if they were to leave their house safe/secure. As predicted by mood-as-input hypothesis, these experiments found that perseveration at both the item generation and the recall task was determined by particular configurations of mood and stop rules for the task. Of most relevance to anxious psychopathologies such as OC checking was the condition in which participants were asked to undertake the task in a negative mood using 'as many as can' stop rules. This is the condition that is most similar to the natural circumstances under which obsessive checkers perform (see Discussion to Experiment 1), and in both experiments it generated significant perseveration in the respective tasks.

If it is convincingly shown to be relevant to perseverative psychopathologies, the mood-as-input model makes some important predictions about response or task persistence. First, it assumes that a combination of negative mood and 'as many as can' stop rules predicts perseveration better than either negative mood alone or 'as many as can' stop rules alone. Studies on analogue populations have repeatedly demonstrated this effect (Startup & Davey, 2001, 2003; Martin et al., 1993), and, if applicable to

psychopathologies such as OCD, this implies that neither negative mood (as measured by anxiety or depression) nor inflated responsibility (to the extent that OC stop rules are derived from such beliefs) on their own represent a sufficient condition for persistence to occur. It is only in combination that these two factors would be predicted to generate perseveration. The putative importance of the combined presence of negative mood and inflated responsibility beliefs in determining OC persistence is consistent with the fact that measures of inflated responsibility predict less than 10% of the unique variance in scores of OC symptom severity when negative affect has been controlled for (Wilson & Chambless, 1999). This suggests that the influence of inflated responsibility may well be reliant on the presence of other necessary factors for it to have its perseverative effects on behaviour; the present results suggest that negative mood may be one of those other necessary factors.

As a direct application of the mood-as-input hypothesis to OC checking the current studies have a number of limitations. First, the studies involve analogue tasks using a nonclinical population. However, this in itself may not necessarily be a problem, since the constructs and mechanisms that explain behaviour in nonclinical samples are also quite capable of explaining the symptomatic behaviour of clinical populations (e.g. Williams, Watts, MacLeod & Mathews, 1988). As such, the mood-as-input model is a good example of how the mechanisms underlying a particular behavioural characteristic have been established explicitly in nonclinical circumstances (e.g. Martin & Davies, 1998; Martin et al., 1993) only to be found to be applicable to psychopathology at a later time (Startup & Davey, 2001). Second, the analogue tasks used in the present studies cover only a small part of the OC checking spectrum of characteristics, and arguably to do not address the central feature of OC checking which is the repeated, ritualised checking of individual items (e.g. returning on many occasions to check that a door is locked or an oven is off). Even so, mood-as-input hypothesis predicts the persistence of activities that

are themselves involved at various stages of checking to ensure that negative outcomes do not happen, and this suggests that the configuration of negative mood and 'as many as can' stop rules is a relevant feature of persistent checking activities *per se*, and may represent (a) a vulnerability factor for the subsequent acquisition of persistent, ritualised checking, and (b) a mechanism within OC checking which modulates perseveration of checking activities. Third, the negative mood inductions used in the present experiments succeeded in generating only differential increases in sad mood and decreases in happy mood, but no significant change in anxious mood. Given that compulsive checking is an anxiety disorder associated with increased levels of anxiety, it may be surprising that perseveration at checking activities was associated with a negative mood characterised by sadness rather than anxiety. Nevertheless, there is clearly an overlap between OC symptoms and depression, with some studies indicating between 17-70% of OCD patients with depression (Miguel, Rauch & Jenike, 1997). The mood-as-input hypothesis claims only that the experienced mood should be characterised by the individual as 'negative' for it to have an interactive effect with stop rules to determine perseveration. Thus, the presence of either depressed or anxious mood, or both, is sufficient to generate mood-as-input effects. Fourth, the previous point does raise the issue of why repeated checking is not usually observed in individuals who are primarily depressed. Two putative reasons for this are (a) that individuals who suffer primarily depression may use 'feel like continuing' rather than 'as many as can' stop rules; i.e. their depressed state and lack of initiative may tend away from naturally using stop rules that tend them towards persistence at a task, and (b) depressed individuals may use 'as many as can' stop rules in conjunction with a negative mood, but these perseverative factors are channelled into activities other than checking, such as rumination; in support of this latter explanation, there is evidence that mood-as-input predictions do apply to rumination in depression (Watkins & Mason, 2002).

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FIGURE LEGENDS

Figure 1

Mean number of check items listed for all six sub-groups in Experiment 1.

Figure 2

Mean time (in seconds) spent listing check items for all six sub-groups in Experiment 1.

Figure 3

Mean time (in seconds) spent recalling check items for all four sub-groups in Experiment 2.

Figure 4

Mean number of check items correctly recalled for all four sub-groups in Experiment 2.

TABLE 1: Mean mood ratings (+ standard deviations) taken before and after the mood induction procedure for all three mood induction conditions (negative, positive neutral) in Experiment 1.

	ANXIETY		SADNESS		HAPPINESS		AROUSAL	
	Pre-Induction	Post-Induction	Pre-Induction	Post-Induction	Pre-Induction	Post-Induction	Pre-Induction	Post-Induction
NEGATIVE	34.2 (29.7)	36.3 (31.4)	18.2 (20.6)	34.6 (27.8)	57.4 (14.9)	40.6 (20.0)	35.7 (26.8)	31.9 (25.8)
POSITIVE	24.9 (20.0)	15.0 (20.2)	28.4 (20.6)	15.7 (17.9)	51.4 (20.5)	67.9 (16.2)	23.8 (21.1)	39.9 (19.4)
NEUTRAL	23.5 (21.4)	16.2 (17.2)	18.5 (21.6)	21.6 (27.9)	60.4 (20.4)	60.4 (19.9)	27.0 (20.8)	33.7 (24.3)

TABLE 2: Mean mood ratings (+ standard deviations) taken before and after the mood induction procedure for both mood induction conditions (negative, positive) in Experiment 2.

	ANXIETY		SADNESS		HAPPINESS		AROUSAL	
	Pre-Induction	Post-Induction	Pre-Induction	Post-Induction	Pre-Induction	Post-Induction	Pre-Induction	Post-Induction
NEGATIVE	20.9 (23.8)	22.1 (20.7)	26.5 (23.3)	36.3 (21.9)	59.8 (18.8)	47.8 (26.5)	30.2 (31.8)	18.3 (17.0)
POSITIVE	31.1 (26.1)	24.2 (22.6)	16.3 (17.5)	14.0 (15.0)	60.4 (14.1)	65.5 (15.1)	28.3 (24.8)	29.3 (23.2)

FIGURE 1

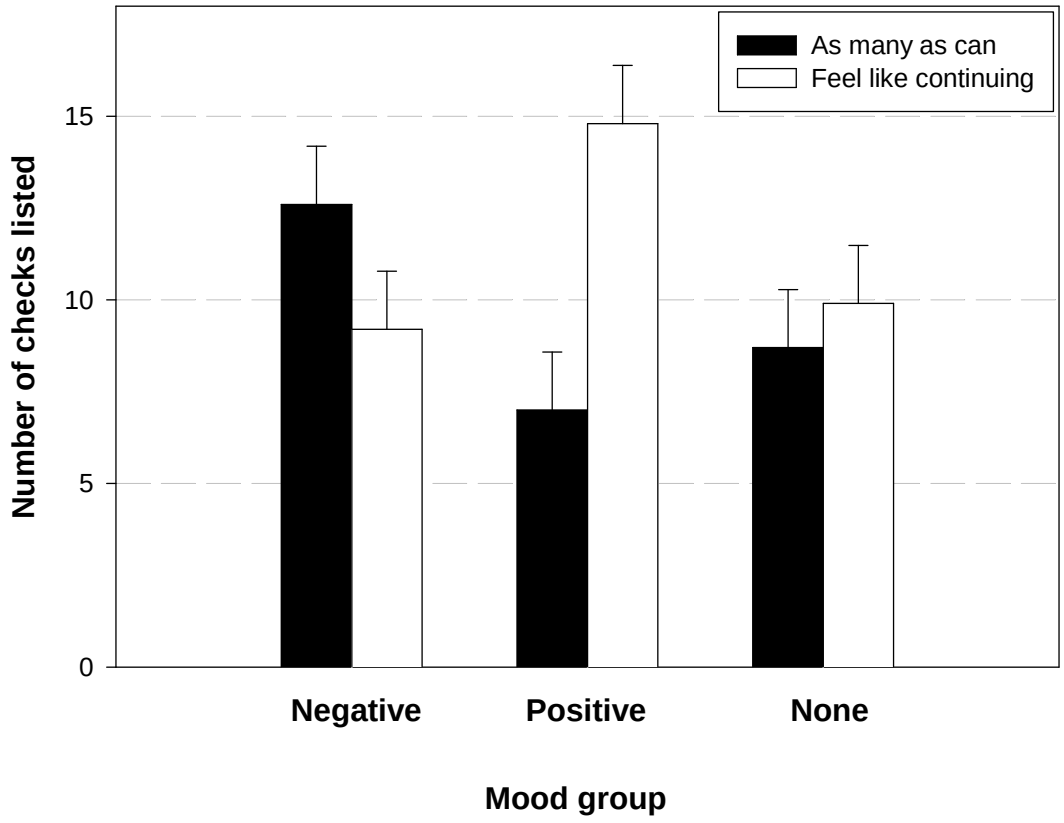

As many as can
Feel like continuing
Number of checks listed
15
10
5
0
Negative
Positive
None
Mood group

FIGURE 2

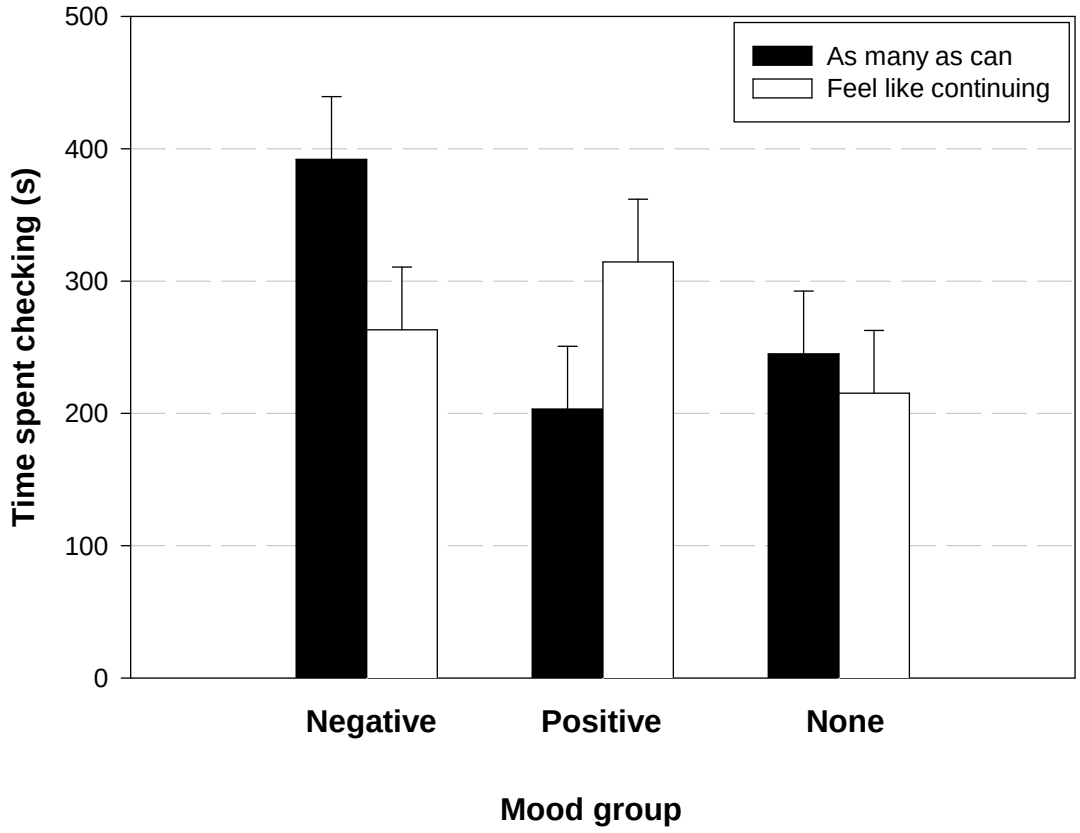

500
400
300
200
100
0
Time spent checking (s)
As many as can
Feel like continuing
Negative
Positive
None
Mood group

FIGURE 3

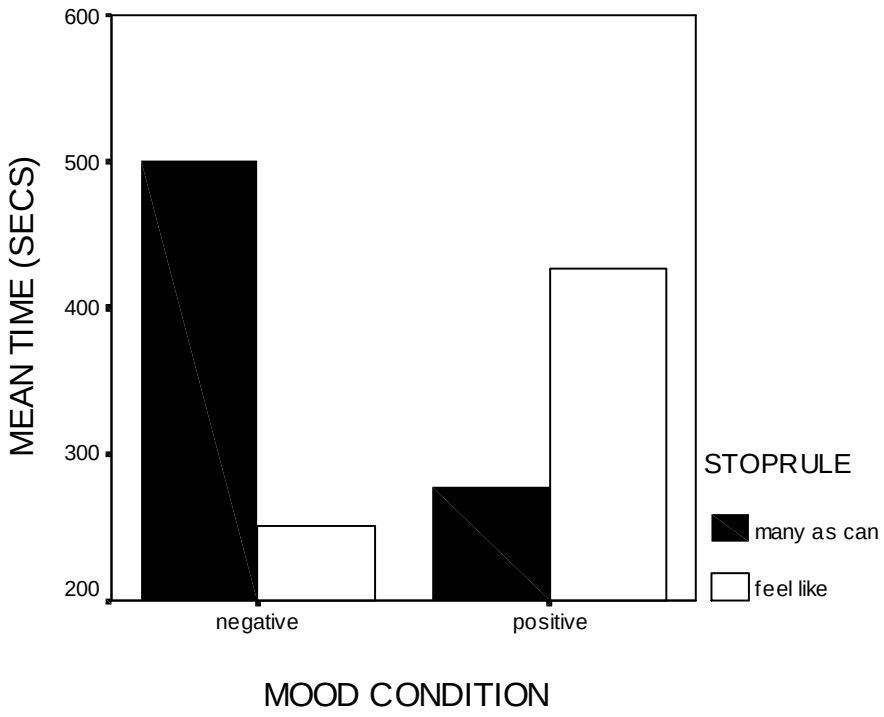
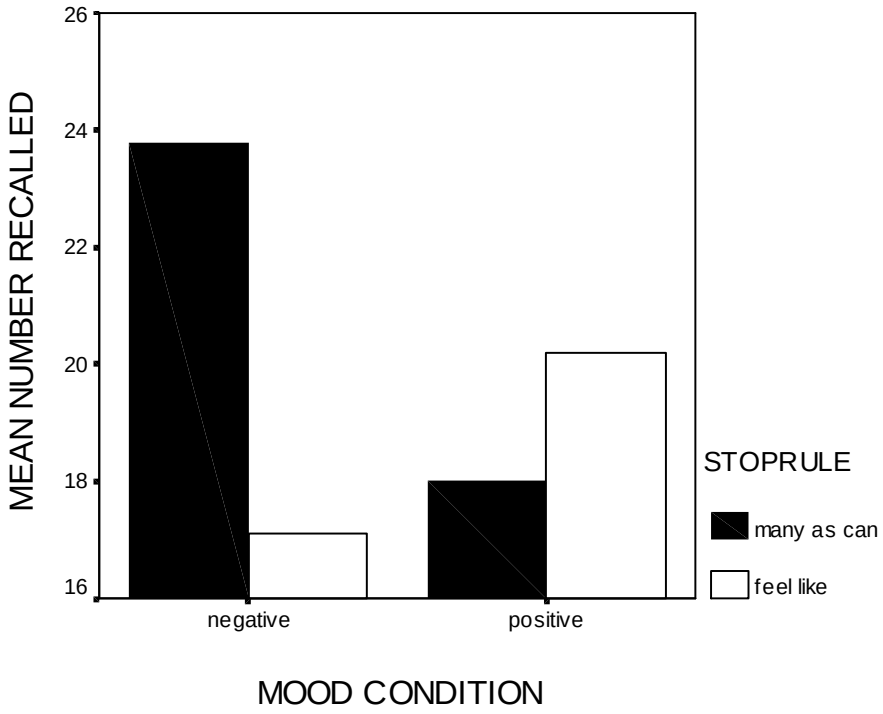

600
500
400
300
200
MEAN TIME (SECS)
negative
positive
MOOD CONDITION
STOPRULE
many as can
feel like

FIGURE 4


26
24
22
20
18
16
MEAN NUMBER RECALLED
negative
positive
MOOD CONDITION
STOPRULE
many as can
feel like