Abstract

Background and objectives

People who experience auditory hallucinations tend to show weak reality discrimination skills, so that they misattribute internal, self-generated events to an external, non-self source. We examined whether inducing negative affect in healthy young adults would increase their tendency to make external misattributions on a reality discrimination task.

Methods

Participants (*N*=54) received one of three mood inductions (one positive, two negative) and then performed an auditory signal detection task to assess reality discrimination.

Results

Participants who received either of the two negative inductions made more false alarms, but not more hits, than participants who received the neutral induction, indicating that negative affect makes participants more likely to misattribute internal, self-generated events to an external, non-self source.

Limitations

These findings are drawn from an analogue sample, and research that examines whether negative affect also impairs reality discrimination in patients who experience auditory hallucinations is required.

Conclusions

These findings show that negative affect disrupts reality discrimination and suggest one way in which negative affect may lead to hallucinatory experiences.

Keywords: reality discrimination; signal detection; self-monitoring; hallucinations; negative affect

1. Introduction

The process of differentiating between internal, self-generated events and external, non-self-generated events is sometimes referred to as reality monitoring (Bentall, 1990) or reality discrimination (Varese, Barkus, & Bentall, 2011; here we will use the latter term, as the term reality monitoring is more often used in source memory research, e.g., Johnson & Raye, 1981). Cognitive models of auditory hallucinations (AH) suggest that AH occur when internal events (e.g., intrusive thoughts, inner speech) are misattributed to an external agent (e.g., Bentall, 1990; Frith, 1992; Hoffman, 1986). Thus, patients who experience AH should show weak reality discrimination abilities. One way in which reality discrimination abilities are commonly measured in patients with AH is through an auditory signal detection task (SDT; e.g., Barkus, Stirling, Hopkins, McKie, & Lewis, 2007). In the SDT, participants must try to detect a signal (typically one second of neutral, non-emotional speech) in an ambiguous auditory stimulus (typically five seconds of white noise). On some trials the speech is present, on other trials the speech is absent. Reality discrimination errors occur when a participant makes a false alarm—that is, when they perceive speech to be present in the white noise when it is absent. Presumably, when a false alarm occurs, participants have mistaken their internal, self-generated representation of the speech for the external, 'real' speech. Consistent with current models, when performing a SDT, patients who experience AH show an externalizing bias, whereby they are more likely than controls to report that speech is present in the noise, even when it is absent (e.g., Bentall & Slade, 1985; Varese et al., 2012; Vercammen, de Haan, & Aleman, 2008; Brookwell, Bentall, & Varese, 2012).

At present, it is unclear why people who experience AH show this externalizing bias. Studies that have examined the antecedents or triggers of AH may suggest some variables that elicit this bias, as presumably problems in reality discrimination peak at times when a person experiences an AH. In Nayani and David's (1996) study of the phenomenology of

AH, the majority of voice-hearers reported that some form of negative affect preceded the onset of hallucinations. These findings have been supported by studies that have employed experience sampling methods (ESM), which can assess the antecedents and correlates of psychotic experiences in “the flow of daily life” (Myin-Germeys & van Os, 2007, p. 411). In one ESM study, participants reported that AH tended to occur in the context of negative affect (Delespaul, de Vries, & van Os, 2002). Importantly, as these cross-sectional associations might reflect the influence of AH upon mood, Delespaul et al. (2002) also reported that negative affect increased before the onset of AH. This suggests that negative affect may play a causal role in the development of AH. As noted by Freeman and Garety (2003), while a number of authors have proposed that negative affect may play a role in the development of AH, these accounts tend to focus on how affect influences the content or appraisal of AH (e.g., Morrison, 1998), rather than on how affect might modulate the cognitive processes that can trigger AH. There is, therefore, no theoretical account of how emotion might influence reality discrimination, nor any account of how emotion might influence apparently related processes such as self-monitoring.

Feelings of loneliness may also modulate reality discrimination. Loneliness is the perception that one’s interpersonal relationships are unsatisfying (Peplau & Perlman, 1982), and it has been shown to be related to, but distinct from, depression and other forms of negative affect (Cacioppo et al., 2006). For example, Cacioppo et al. (2006) reported that factor analysis of questionnaire items that assess depression and loneliness load onto two separate, but correlated factors. Psychotic patients have reported that feelings of loneliness (Delespaul et al., 2002) or being alone (Nayani & David, 1996; Tarrier, 1987) precede the onset of AH. Feelings of loneliness tend to elicit high levels of negative affect (Cacioppo, Hawkley, & Thisted, 2010) and this may be one way in which loneliness affects reality discrimination. However, it is possible that loneliness also influences reality discrimination through an additional mechanism. Hoffman (2007) has proposed that social isolation (a concept related, but not identical, to loneliness; see de Jong Gierveld, 1998) can lead to a bias where a person begins to attribute social meaning to non-social events and that, in this way, social isolation might play a causal role in the development of AH. For example, high levels of isolation, or intense feelings of loneliness, might encourage an internal, self-generated event, such as inner speech, to be misinterpreted as an external, social event (i.e., as speech directed at you by another person) and this erroneous attribution could form the basis of an AH. Through this bias, as well as by eliciting negative affect, loneliness may make a person struggle to differentiate internal, self-generated from external, other-generated events.

Therefore, in this study we examined whether experimentally-induced feelings of loneliness, or negative affect more generally, could impair participants' reality discrimination abilities. A mood induction procedure that has been widely used to examine the impact of loneliness on social cognition (e.g., by Pickett, Gardner, & Knowles, 2004) was employed to do this. In this procedure, three inductions are used. All involve participants recalling and writing about an autobiographical memory. One induction requires participants to write about their journey from home to the laboratory and aims to elicit a neutral mood. One induction involves participants recalling a time when they failed at an academic task; this has been shown to elicit negative affect (Pickett et al., 2004). The third induction involves participants recalling a time when they felt intensely lonely; this manipulation has been shown to elicit negative affect and feelings of loneliness (Chen, Williams, Fitness, & Newton, 2008; Pickett et al., 2004). In previous studies, the loneliness induction has influenced a variety of behaviors related to social cognition (such as prosody processing and a desire to listen to the disclosure of emotional information by friends), but the failure induction has not influenced these behaviors (Hackenbracht & Gasper, 2013; Pickett et al., 2004). These findings have been used to support arguments that feelings of loneliness elicit a set of cognitive biases independent of negative affect. Employing this design in the present study allowed us to examine whether there was any effect of negative affect on reality discrimination, and to explore the possibility of an effect of feelings of loneliness on reality discrimination that could be either (a) independent of negative affect, if the failure induction did not influence reality discrimination, or (b) in addition to negative affect, if the failure induction influenced reality discrimination, but to a smaller extent than did the loneliness induction.

In the SDT, several different parameters can be calculated. These include hits (trials where participants correctly report that speech was present in the white noise), false alarms (trials where participants incorrectly report that speech was present in the white noise), sensitivity (which indicates participants' ability to discriminate between trials when speech is present and trials when speech is absent), and response bias (which indicates participants' tendency, across all trials, towards responding that speech is present in the noise). We predicted that participants who received the two negative inductions would make more false alarms, but not more hits, than participants who received the neutral induction. This pattern of results should correspond to lower levels of sensitivity and a more liberal response bias in participants who received the two negative inductions in comparison to participants who received the neutral induction. We also predicted that participants who received the loneliness induction would make more false alarms, demonstrate lower sensitivity, and show a more liberal response bias on the SDT than participants who received the failure induction, as the loneliness induction could elicit an increase in external misattributions via both negative affect and the bias described by Hoffman (2007).

2. Method

2.1 Participants

Participants were 54 university students (45 women; mean age = 22.08 years, *SD* = 5.9), who received course credit in return for their time. Participants were native English speakers, had normal (or corrected-to-normal) vision, and had no history of hearing problems.

2.2 Mood induction

The mood induction described in study two of Pickett et al. (2004) was employed here. Participants were randomly assigned to one of three induction groups: a loneliness induction, a failure induction, and a neutral induction. In the loneliness induction, participants were asked to recall and write down an account of a time when they felt intensely lonely. In the failure induction, participants were asked to recall and write down an account of a time when they experienced an academic failure. In the neutral induction, participants were asked to recall and write down an account of their journey to the department that day. Participants were asked to spend a minimum of five minutes and a maximum of eight minutes on this task. Participants who completed the task in less than five minutes were asked to try to recall more details about their recalled event, and to write about these details. Previous studies have reported that the failure induction effectively elicits negative affect and that the lonely induction effectively elicits both negative affect and feelings of loneliness (Bernstein, Young, Brown, Sacco, & Claypool, 2008; Chen et al., 2008; Maner, DeWall, Baumeister & Schaller, 2007; Pickett et al., 2004; Wilkowski, Robinson, & Friesen, 2009).

2.3 Reality discrimination task

A signal detection task (SDT) similar to that described by Barkus et al. (2007) was employed to assess reality discrimination. This task consisted of 60 trials, with each trial consisting of five seconds of white noise. In 36 trials, one second of speech was presented in the white noise. In the remaining 24 trials, no speech was presented. In 12 of the trials when speech was presented, the speech was clearly audible. In the remaining 24 trials, the speech was presented at an auditory threshold. This threshold was determined prior to the start of testing by establishing the volume of speech that was perceived by 50% of a small sample (*n*

= 11) of participants who were in the same age range as the experimental participants. The stimuli for the speech were prepared from a recording of an adult reading a piece of non-fictional prose in an emotionally neutral tone. Twelve, one second segments of speech were taken from this recording. Each segment of speech was presented once at the clearly audible volume and twice at the auditory threshold volume. The task was presented to participants on a laptop computer via the experiment software E-Prime 2.0. Participants listened to the task stimuli using standard Sony headphones and responded via a button press at the end of each trial.

The number of hits (trials where participants correctly reported that speech had been present in the white noise) and false alarms (trials where participants incorrectly reported that speech had been present in the white noise) made by participants were recorded. A greater number of false alarms indicated weaker reality discrimination skills. Sensitivity was assessed by calculating *d*', which is found by subtracting the *z*-score of the false alarm rate from the *z*-score of the hit rate. Higher *d*' values indicate greater ability to discriminate between trials where speech was present and speech was absent. Response bias was assessed by calculating nonparametric β, as described in Barkus et al. (2007). Nonparametric β can vary from 1 to -1. Values near to 1 indicate a more conservative response bias (i.e., a bias towards responding that the speech is absent), and values further from 1 indicate a more liberal response bias (i.e., a bias towards responding that the speech is present).

2.4 Additional measures and rating of recalled memories

Participants were also asked to complete the UCLA loneliness scale (Russell, 1996) and the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). Inclusion of these measures allowed us to examine whether there were pre-existing group differences in loneliness, depression, or anxiety, and if so, to control for these differences.

Following Pickett et al. (2004), to assess the effectiveness of the mood inductions, participants rated how positive or negative the recalled event was (1 = *very negative*; 7 = *very positive*), the valence of the mood that was generated by recalling the event (1 = *very negative*; 7 = *very positive*), and how the event made them feel about themselves (1 = *very bad about myself*; 7 = *very good about myself*). Given that the failure and the loneliness inductions were meant to elicit similar levels of negative affect, it was predicted that there would be no significant differences in participants' ratings of how negative the failure and the loneliness memories were, of the valence of the mood generated by recalling the failure and the loneliness memories, and of how bad they felt about themselves after recalling the failure and the loneliness memories. However, we expected that the ratings provided by participants who completed the neutral induction would differ from the ratings provided by participants who completed the failure and the loneliness inductions.

In addition, two independent raters, who were blind to the study's hypotheses, provided ratings of the emotions described in the memories. Each rater was asked to read the memory and rate to what extent the person who wrote the memory had felt distressed, upset, isolated, disappointed, embarrassed, and lonely in the situation they described. For each descriptor, the rater responded on a 5-point Likert scale (1 = *very slightly or not at all*; 5 = *extremely*). The raters' responses for 'distressed' and 'upset' were summed, as were the responses for 'disappointed' and 'embarrassed', and the responses for 'isolated' and 'lonely'. Inter-rater reliability was established by calculating correlation coefficients for these three variables. Correlations between their ratings of how distressed and upset ($r = .80$, $p < .001$), of how disappointed and embarrassed ($r = .75$, $p < .001$), and of how isolated and lonely ($r = .88$, $p < .001$) participants felt in the memories indicated that there were acceptable levels of inter-rater reliability. The responses of the two raters were summed, so that for these three variables, total ratings could range from 4 to 20. It was predicted that (a) the two negative memories would be rated as describing events that made the participant feel more distressed and upset than the neutral memories, (b) that the failure memories would be rated as describing events that made the participant feel more disappointed and embarrassed than in the neutral and loneliness memories, and (c) that the loneliness memories would be rated as describing events that made the participant feel more isolated and lonely than the neutral and failure memories.

2.5 Procedure

The study was approved by a departmental ethics committee and was conducted in accordance with the principles of the Declaration of Helsinki. To avoid the demand characteristics associated with some mood inductions (see Buchwald, Strack, & Coyne, 1981), participants were deceived about the true purpose of this study. The study was advertised as research examining links between memory specificity and auditory processing. On arrival at the laboratory, this was reiterated, and participants were told that they would perform the 'memory specificity task' first, that this task would involve recalling a memory and writing about it in as much detail as possible, and that an auditory processing task would then be completed. Participants then completed a set of six practice trials for the SDT, to ensure that they understood the task and that they could tolerate the white noise. They were presented with two trials where the speech was clearly audible in the white noise, followed by two trials where the speech was presented at an auditory threshold, and then two trials where the speech was absent. After completing the practice trials, participants confirmed that they could tolerate the white noise and were informed about what type of trials had been presented.

After providing consent, participants were read a set of instructions about the type of memory they were to recall. Participants who were assigned to the failure or loneliness induction, but could not recall a time when they felt intensely lonely, or a time when they felt they had failed at an academic task, were re-assigned to the neutral induction. Four participants were re-assigned from the failure induction and five participants were re-assigned from the loneliness induction. Following completion of the SDT, participants were presented with the self-report measures. Following completion of these measures, participants were informed that they had been deceived about the true purpose of the study, were asked whether they suspected that they had been deceived, and were fully debriefed. None of the participants guessed the true nature of the study. They were then invited to 'repair' their mood by watching a short clip of their choice from a variety of comedy television series.

2.6 Statistical analysis

Data were analysed using SPSS version 20. Gender differences were assessed using *t*-tests. A series of one-way ANOVAs were used to analyse the features of the recalled memories and to investigate the effect of the mood inductions. Where appropriate, ANOVA was followed by planned contrasts. In all instances, the first contrast was between mean scores in the neutral group versus the combined means of the two negative induction groups, with the second contrast between the means of the failure and loneliness groups.

3. Results

3.1 Loneliness, depression, and anxiety

Mean scores for loneliness, depression, and anxiety are presented in Table 1. Group differences in levels of depression, anxiety, and loneliness were not significant (all F-values < 1.5, all p-values $> .24$) and so these variables are not considered in any of the subsequent analysis.

3.2 Gender differences

Given the unbalanced nature of the sample, we investigated the influence of gender on number of false alarms, number of hits, *d'*, and β values. When looking at the whole sample, gender differences were not significant (all p-values $> .14$), except for a trend level difference in *d'*, *t*(52) = 1.74, *p* = .09, *d* = 0.62. Men (*M* = 1.80, *SD* = 0.54) had marginally higher *d'* values than did women (*M* = 1.45, *SD* = 0.56). However, this difference appears to be a function of the large proportion of men (five of nine) who were assigned to the neutral group. When gender differences were examined within each mood induction group, there were no differences between men and women (all *p*-values > .28). Gender is not, therefore, considered in the subsequent analyses.

3.3 Analysis of recalled memories and manipulation check

The amount of time spent on recalling and writing about a memory did not differ between the three induction groups, *F*(2, 53) = 1.70, *p* = .19. However, the number of words written by participants in the three induction groups did differ, *F*(2, 53) = 3.79, *p* = .03. Participants in the neutral group wrote the most words (*M* = 231.11, *SD* = 40.89), followed by participants in the lonely group (*M* = 196.50, *SD* = 57.25), with participants in the failure group writing the fewest words (*M* = 191.61, *SD* = 40.76). Planned contrasts revealed that the neutral group wrote fewer words than participants in the two negative inductions, *t*(51) = 2.73, *p* = .01, *d* = 0.75. The difference in number of words written between the failure and loneliness groups was not significant, *t*(51) = 0.31, *p* = .76, *d* = 0.01. Given that there was no reason to believe that the number of words participants wrote would influence their reality discrimination abilities, this variable was not considered in subsequent analyses.

Mean scores for the self-report manipulation check scales are presented in Table 1. One-way ANOVA revealed significant group differences for memory valence, *F*(2, 51), = 12.43, *p* < .001, for mood after recall, *F*(2, 51), = 15.26, *p* < .001, and at the trend level, for how participants felt about themselves after recall, *F*(2, 51), = 3.12, *p* = .06. Planned contrasts showed that participants in the two negative induction groups rated the memory they recalled as more negative than did the participants in the neutral induction group, *t*(51) = 4.90, *p* < .001, *d* = 1.20, but that differences between the ratings made by participants in the failure and loneliness inductions did not reach statistical significance, $t(51) = 0.82$, $p = .42$, $d = 0.32$. Planned contrasts showed that participants in the two negative induction groups rated their mood as more negative after having recalled the memory than did the participants in the neutral induction group, $t(51) = 5.51$, $p < .001$, $d = 1.29$, but that differences between the ratings made by participants in the failure and loneliness inductions did not reach statistical significance, $t(51) = 0.34$, $p = .73$, $d = 0.09$. Planned contrasts showed that participants in the two negative induction groups reported feeling worse about themselves after having recalled the memory than did the participants in the neutral induction group, $t(51) = 2.45$, $p = .02$, $d = 0.68$, but that differences between the ratings made by participants in the failure and loneliness inductions did not reach statistical significance, $t(51) = 0.16$, $p = .88$, $d = 0.05$.

Mean scores for the blind ratings of participants' memories are also presented in Table 1. One-way ANOVA revealed significant group differences for how distressed and upset participants appeared to have felt, $F(2, 51), = 60.14$, $p < .001$, for how disappointed and embarrassed participants appeared to have felt $F(2, 51), = 75.46$, $p < .001$, and for how isolated and lonely participants appeared to have felt, $F(2, 51), = 30.23$, $p < .001$. Planned contrasts revealed that participants were rated as appearing more distressed and upset in the two negative memories than they did in the neutral memory, $t(51) = 10.85$, $p < .001$, $d = 1.74$, but that differences between participants in the loneliness and failure condition did not reach statistical significance for this variable, $t(51) = 1.63$, $p = .11$, $d = 0.47$. Planned contrasts revealed that participants were rated as appearing more disappointed and embarrassed in the two negative memories than they did in the neutral memory, $t(51) = 7.15$, $p < .001$, $d = 1.42$, and that participants appeared more disappointed and embarrassed in the failure memory than they did in the loneliness memory, $t(51) = 3.07$, $p =.003$, $d = 0.78$. Finally, planned contrasts revealed that participants were rated as appearing more isolated and lonely in the two negative memories than they did in the neutral memory, $t(51) = 8.10$, $p < .001$, $d = 1.20$, and that participants appeared more isolated and lonely in the loneliness memory than they did in the failure memory, $t(51) = 9.24$, $p < .001$, $d = 1.56$.

3.4 SDT performance

Descriptive statistics for the measures of SDT performance are shown in Table 1. There was a main effect of induction on the number of false alarms participants made, $F(2, 51) = 3.83$, $p = .03$. Participants in the failure group made the most false alarms, followed by participants in the loneliness group, with participants in the neutral group making the fewest false alarms. Planned contrasts revealed that the neutral group made fewer false alarms than participants in the two negative inductions, $t(51) = 2.45$, $p = .02$, $d = 0.75$. The difference in number of false alarms between the failure and loneliness groups was not significant, $t(51) = 1.29$, $p = .20$, $d = 0.39$, and was in the direction opposite to that predicted. In contrast, with respect to number of hits, there was no effect of induction, $F(2, 51) = 0.49$, $p = .62$.

There was a main effect of induction on *d'*, $F(2, 51) = 4.88$, $p = .01$. *d'* values were lowest in the failure group, followed by the loneliness group, with *d'* values highest in the neutral group. Planned contrasts revealed that *d'* was higher in the neutral group than the two negative inductions, $t(51) = 2.72$, $p = .01$, $d = 0.73$. The difference in *d'* between the failure and loneliness groups was not significant $t(51) = 1.54$, $p = .13$, $d = 0.51$. Again, this difference was in the direction opposite to that predicted (*d'* values were predicted to be lower in the loneliness group).

Finally, at the trend level, there was a main effect of induction on β, $F(2, 51) = 3.02$, $p = .06$. β values were lowest in the failure group, followed by the loneliness group, with β values highest in the neutral group. Planned contrasts revealed that β was higher in the neutral group than the two negative inductions, $t(51) = 2.32$, $p = .02$, $d = 0.65$. The difference between the failure and loneliness groups was not significant $t(51) = 0.80$, $p = .42$, $d = 0.27$.

Again, this difference was in the direction opposite to that predicted (β values were predicted to be lower in the loneliness group).

4. Discussion

The present study set out to examine whether experimentally-induced negative affect and feelings of loneliness could elicit an externalizing bias when participants performed a reality discrimination task. Participants who received either of the negative inductions made more external misattributions than did participants who received a neutral mood induction. Importantly, the negative inductions did not appear to impair participants' performance in all aspects of the task. That is, participants who received the two negative inductions made the same number of hits as did participants who received the neutral induction. This indicates that the negative inductions did not impair participants' ability to detect a signal when it was present, but that they specifically made participants were more likely to misattribute internal, self-generated events to an external, non-self source.

If it is assumed that a person's reality discrimination skills are weakest, and that they are most likely to make an external misattribution, at times when they experience AH, these findings can be considered consistent with a number of studies. Nayani and David (1996), Tarrier (1987), and Delespaul et al. (2002) have all reported that some form of negative affect tends to occur around the onset of AH. While Nayani and David's and Tarrier's studies relied on retrospective reporting, Delespaul et al.'s ESM data provided evidence that anxiety precedes the onset of AH, suggesting that negative affect plays a causal role in the day-to-day onset of AH in voice-hearers. The present findings are consistent with this suggestion, and indicate one mechanism by which negative affect can cause AH. It is possible that negative affect might lead to AH through other mechanisms (e.g., by increasing the likelihood that a person will experience intrusive, unpleasant thoughts that are difficult to identify as internal, self-generated events), and future research should examine whether this is the case.

More broadly, by demonstrating that negative affect elicits a bias considered to be important in the development of AH, these findings are consistent with approaches that have emphasized the importance of affective problems in the development of psychotic experiences (Freeman & Garety, 2003). These approaches (e.g., Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001) typically focus on the way in which emotion may influence the content of AH (e.g., depression may cause a person to hear a voice telling them that they are worthless) or on the way in which a person responds to a hallucinatory experience (e.g., anxiety may cause a person to respond to a threatening voice in a fearful, subordinate manner). The present study, however, suggests that these accounts should also consider the possibility that emotional problems may elicit the biases that help to trigger AH.

Given that reality discrimination problems are thought to underlie AH, our results might be interpreted as suggesting that whenever a person experiences negative affect, they are likely to experience AH. This, however, seems unlikely. It seems more plausible that AH occur in the presence of a number of predisposing factors. That is, AH may only occur when a person who has a trait-like weakness in reality discrimination, experiences both high levels of negative affect, which act to exacerbate their difficulties with reality discrimination, and intrusive cognitions, which tend to be difficult to identify as self-generated (Bentall, 2003). This account is consistent with the findings of the present study, with experience sampling data (e.g., Delespaul et al., 2002), and with current cognitive models of AH (Waters, Badock, Michie, & Mayberry, 2006).

The lack of any specific effect of the loneliness induction on reality discrimination performance could be considered to be inconsistent with Hoffman's (2007) suggestion that social isolation might play a role in the development of AH. Hoffman has argued that social isolation creates a bias so that a person will begin to attribute social meaning to non-social events. Given the associations between loneliness and social isolation (e.g., Golden, Conroy, Bruce, Denihan, Greene, Kirby, & Lawlor, 2009), it seems likely that loneliness will encourage a person to attribute social meaning to non-social events. And, given that internal, self-generated events tend to be non-social while external, non-self-generated events may often be social (e.g., they may be instances of another person talking to you), we predicted that loneliness would elicit an externalizing bias. While participants who received the loneliness induction did make more external misattributions than participants who received the neutral induction, they did not make more external misattributions than participants who received the failure induction, suggesting that feelings of loneliness do not elicit an externalizing bias independent of negative affect. It could be argued that this is simply a result of employing an ineffective loneliness induction. However, this induction has been used successfully in a range of studies to elicit feelings of loneliness and a set of biases associated with high levels of loneliness (e.g., Chen et al., 2008; Wilkowski et al., 2009). In addition, in the present study, using two independent raters who were blind to the study's hypotheses, we showed that participants in the loneliness condition recalled situations that featured higher levels of loneliness and isolation than did participants in either of the two other conditions. Thus, it seems unlikely that the loneliness induction was ineffective. Rather, given that Hoffman's hypothesis focuses on objective social isolation, rather than feelings of isolation or loneliness, it is possible that only a procedure that involves isolating participants from human contact, rather than simply asking them to recall a time when they felt isolated from others, would elicit the kind of bias Hoffman described. Future research should thus examine the effects of social isolation on reality discrimination and other aspects of self-monitoring.

Negative affect may have elicited an externalizing bias in this study through a number of different mechanisms. One possibility is that good reality discrimination abilities rely upon intact working memory, that negative affect interferes with working memory capacity, and in this way impairs reality discrimination. This interpretation is suggested by research showing that (a) participants are less likely to identify themselves as the agent of an action (and so will presumably be more likely to display an externalizing bias) when working memory load is increased (Hon, Poh, & Soon, 2013), and (b) negative affect reduces working memory capacity (Elzinga & Roelofs, 2005; Schoofs, Preuss, & Wolf, 2008). Research that examines whether impairments in working memory mediate the effect of negative affect on reality discrimination is required.

One limitation of the present study was the way in which participants were allocated to a mood induction condition, as this was non-random for a sub-group of participants. Nine participants who were randomly assigned to one of the two negative inductions were unable to recall a time when they had experienced an academic failure or when they had experienced intense feelings of loneliness, and so were re-allocated to the neutral condition. While it seems unlikely that the reality discrimination abilities of these participants will have differed from the reality discrimination abilities of the participants who were able to complete the negative inductions, it remains a possibility. Research that examines the question investigated here, but that employs an induction that is not vulnerable to this kind of problem (e.g., Robinson & Sahakian, 2009), would be helpful.

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Table 1

Descriptive statistics for all study variables

	Neutral	Failure	Loneliness
Reality discrimination performance			
Mean number of false alarms (SD)	3.22 (3.51)	7.17 (4.64)	5.33 (4.50)
Mean number of hits (SD)	24.44 (3.17)	25.67 (3.01)	25.11 (4.75)
Mean *d’* (SD)	1.79 (0.56)	1.23 (0.55)	1.50 (0.49)
Mean β (SD)	0.46 (0.44)	0.12 (0.37)	0.23 (0.48)
Ancillary measures			
Mean loneliness (SD)	39.50 (7.57)	37.28 (8.13)	38.50 (7.36)
Mean depression (SD)	5.17 (4.05)	4.17 (2.83)	3.33 (2.66)
Mean anxiety (SD)	9.33 (4.64)	8.61 (3.45)	8.33 (4.43)
Manipulation checks — Self-reports			
Mean memory valence (SD)	4.70 (1.05)	2.17 (0.87)	1.83 (0.75)
Mean mood after recall (SD)	5.03 (1.13)	3.43 (1.01)	3.23 (0.82)
Mean felt about self after recall (SD)	4.53 (0.82)	3.43 (0.90)	3.73 (0.98)
Manipulation checks — Blind ratings			
Distressed and upset mean (SD)	5.06 (1.83)	12.94 (3.59)	14.44 (2.57)
Embarrassed and disappointed mean (SD)	4.06 (0.24)	11.61 (3.94)	8.61 (3.20)
Lonely and isolated mean (SD)	4.06 (0.24)	6.44 (4.34)	15.67 (2.82)

Fig. 1. Mean (a) number of false alarms, (b), number of hits, (c), *d'* and (d) β in the three mood induction groups.