

## A load on my mind: Evidence that anhedonic depression is like multi-tasking

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### ABSTRACT

Multi-tasking can increase susceptibility to distraction, affecting whether irrelevant objects capture attention. Similarly, people with depression often struggle to concentrate when performing cognitively demanding tasks. This parallel suggests that depression is like multi-tasking. To test this idea, we examined relations between self-reported levels of anhedonic depression (a dimension that reflects the unique aspects of depression not shared with anxiety or other forms of distress) and attention capture by salient items in a visual search task. Furthermore, we compared these relations to the effects of performing a concurrent auditory task on attention capture. Strikingly, both multi-tasking and elevated levels of anhedonic depression were associated with increased capture by uniquely colored items, but decreased capture by abruptly appearing items. At least with respect to attention capture and distraction, depression seems to be functionally comparable to juggling a second, unrelated cognitive task.

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### 1. Introduction

Difficulty concentrating is a hallmark feature of clinical depression (APA, 2000). Not surprisingly then, people with depression tend to perform poorly on selective attention tasks (e.g., Gotlib & McCann, 1984; Miallet, Pope, & Yurgelun-Todd, 1996; Ottowitz, Dougherty, & Savage, 2002). One might therefore expect depressed individuals to be more easily distracted by salient stimuli that are otherwise irrelevant to the task at hand. An intriguingly similar pattern has emerged from studies of attention capture in non-depressed individuals, which have shown that multi-tasking<sup>1</sup> can increase vulnerability to distraction by irrelevant items (e.g., Boot, Brockmole, & Simons, 2005; Lavie & De Fockert, 2005). Together, these independent literatures suggest that experiencing

elevated levels of depression may be comparable, in some respects, to working on one task while distracted by another. The main goal of the present research was to test this hypothesis.

Most clinical research examining the relation between depression and attention has focused on the processing of emotional stimuli. These studies have consistently shown that depressed individuals have difficulty disengaging their attention from negative emotional stimuli and/or pay less attention to positive emotional stimuli (e.g., Gotlib & McCann, 1984; Koster, Raedt, Goeleven, Franck, & Crombez, 2005; Shane & Peterson, 2007). However, people with depression also perform relatively worse on selective attention tasks that use non-emotional stimuli (e.g., Continuous Performance tasks, the color-word Stroop task; see Miallet et al., 1996 and Ottowitz et al., 2002, for reviews). Furthermore, depression is associated with other cognitive deficits, ranging from difficulty remembering information to trouble solving problems (see Levin, Heller, Mohanty, Herrington, & Miller, 2007, for a review). The breadth of these deficits suggests that depression might involve a general depletion in cognitive resources (e.g., Hasher & Zacks, 1979; Mathews & MacLeod, 1994). However, the results of numerous studies suggest that people with depression have sufficient cognitive resources, but simply have difficulty initiating efficient cognitive strategies (e.g., Hertel & Gerstle, 2003; Marx, Claridge, & Williams, 1992; see Hertel, 1994 for a review) and/or appropriately

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<sup>1</sup> In this manuscript, we use the phrase "multi-tasking" in a fairly generic sense to refer to any case in which an individual attempts to perform more than one task at the same time. In Studies 1A and 1B, we examined the effects of multi-tasking on attention capture by salient distractors using a dual-task manipulation. Thus, we cannot be certain whether the findings from these studies would generalize to circumstances in which individuals must perform more than two tasks simultaneously.

allocating these resources (e.g., Levens, Muhtadie, & Gotlib, 2009; Yee & Miller, 1994; see Ellis & Ashbrook, 1989 for a review). As a result, depressed individuals are presumed to dedicate more cognitive resources to processing irrelevant aspects of the task they are performing (Ellis & Ashbrook, 1988; Jones, Siegle, Muelly, Haggerty, & Ghinassi, 2010), as well as to internal processes such as ruminative thoughts (Beevers, 2005; Ellis & Ashbrook, 1988; Hertel, 1998; Levens et al., 2009). In line with this view, depressed individuals often struggle to plan, make decisions, correct errors, and resist impulses (i.e., they show impaired “executive functioning”; see Austin, Mitchell, & Goodwin, 2001; Fossati, Ergis, & Allilaire, 2002, and Rogers et al., 2004, for reviews). Furthermore, people with depression have difficulty engaging in reflective, effortful processing (see Beevers, 2005 and Hartlage, Alloy, Vazquez, & Dykman, 1993), which likely requires executive resources. Finally, rumination and low levels of positive affect (both of which are associated with depression) have been linked with “mental inflexibility” (e.g., Ashby, Isen, & Turken, 1999; Davis & Nolen-Hoeksema, 2000).

Though some existing theories point to problems with attentional control as a prominent factor driving cognitive deficits in depressed individuals (e.g., Hertel, 1994), the implications of these theories for understanding basic attention deficits associated with elevated levels of depression, and in particular attention capture by salient stimuli, remain unclear. In large part, this lack of clarity results from the fact that most studies on attention problems in depressed individuals have utilized relatively coarse measures of attentional processing, such as digit span tasks and Stroop tasks (see Rokke, Arnell, Koch, & Andrews, 2002 for a more detailed discussion of this issue). One way to address this issue is to employ cutting edge methods used by cognitive scientists who study attention.

Most studies on attention capture examine the sorts of features that draw attention by virtue of their salience (see Rauschenberger, 2003, Simons, 2000, and Yantis, 1993, for reviews). Yet, the availability of processing resources can influence attention capture as well. People with reduced working memory capacity and people under cognitive load exhibit decreased attentional control, which in turn can lead to increased attention capture by salient but task-irrelevant stimuli (e.g., Conway & Kane, 2001; De Fockert & Bremner, 2011; De Fockert, Rees, Frith, & Lavie, 2001; Kane, Bleckley, Conway, & Engle, 2001). These findings support the claim that working memory provides goal-directed control over selective attention (see Lavie & De Fockert, 2005). However, in some cases, a reduction in processing resources leads to the opposite effect — that is, decreased capture by task-irrelevant distractors (e.g., Brisson, Leblanc, & Jolicoeur, 2009; Fougner & Marois, 2007; Matsukura, Brockmole, Boot, & Henderson, 2011; SanMiguel, Corral, & Escera, 2008). One possible explanation for this apparent inconsistency is that the impact of reduced resources on attention capture depends upon the nature of the stimuli which must be ignored; in other words, not all salient stimuli are the same. In line with this view, Boot et al. (2005) found that performing a concurrent auditory task leads to increased capture by uniquely colored items but decreased capture by items that appear abruptly in the display.

Although the reason for this differential effect of multi-tasking on capture by abrupt onsets and uniquely colored items is not clear (and a full discussion of the possibilities is beyond the scope of this paper, see Boot et al., 2005), one interpretation rests upon the distinction between transient and sustained events. An abrupt onset item is a transient event because after the item has appeared, it is no longer salient. In contrast, a uniquely colored item remains salient throughout. Under dual-task conditions, participants may be more likely to rely on distinctiveness to guide their search and to miss brief, transient events.

To the extent that multi-tasking taxes “executive resources” (see Logan & Gordon, 2001 and Pashler, 1994), people suffering from executive functioning deficits should show a similar pattern of increased attention capture by uniquely colored items and decreased capture by abrupt onsets. Depression is associated with impaired executive functioning and sustained attention, but no previous studies have examined patterns of attention capture by salient but non-

emotional stimuli in people with elevated levels of depression. To this end, the present research explored whether experiencing elevated levels of depression moderates attention capture in the same way that multi-tasking does<sup>2</sup>. Such findings would have important implications for our understanding of attention deficits associated with depression, and for theories and research on cognition and depression more generally. In Study 1, we attempted to replicate the differential effect of multi-tasking on attention capture by unique color items (Study 1A) and abrupt onsets (Study 1B) using a different type of visual search task than that used in the original research. We then investigated if and how levels of depression are associated with capture by unique color items (Study 2) and abrupt onsets (Study 3) using the same visual search task introduced in Study 1. In doing so, we focused on the construct of anhedonic depression, which reflects the unique aspects of depression not shared with other forms of distress (in particular, anxiety).

## 2. Studies 1A and 1B

The nature of the relation between multi-tasking and attention capture by transient and sustained salient distractors remains unclear. In the original research conducted by Boot et al. (2005), participants searched for a target letter in displays that also contained one item with a unique but irrelevant feature (onset or color). The unique feature was irrelevant because it was no more likely to be associated with the target than it was to be associated with any distracter item (Jonides & Yantis, 1988). Avoiding attention capture in this task requires participants to treat the critical feature as statistically irrelevant. However, adopting the appropriate search strategy can be cognitively demanding because treating a stimulus as statistically irrelevant requires an understanding of the likelihood that it will be a target item on any given trial. Here we used a conceptually simpler capture task in which the unique feature is never associated with the target (Theeuwes, 1992, 1994). Consequently, the strategy for participants is simple: ignore the uniquely colored item (or onset item) as it will never be the target. Attention capture is revealed if search is slower in the presence of an additional unique item (or “singleton”) than in its absence. We attempted to replicate the multi-tasking effects from earlier research (Boot et al., 2005) using this “additional singleton” task to see whether the differential effect of multi-tasking on onsets and colors depends on the complexity of the search strategy necessary to avoid capture.

### 2.1. Methods

#### 2.1.1. Participants

Forty-eight undergraduate students (24 in each study), reporting normal or corrected-to-normal vision and normal color vision, participated for monetary compensation. Demographic information was not collected in these studies. All participants provided informed consent.

#### 2.1.2. Procedure

In Study 1A, participants completed 148 trials in which they searched for a single green circle among 6 square distracters (see Fig. 1). Each shape contained a horizontal or a vertical line, and participants reported the orientation of the line within the target (i.e., the green circle) as quickly and accurately as possible (using a keyboard). On half the trials, all of the squares were green. On the other half of trials, one of the squares was red (a color singleton). Each trial started with a fixation point for 3000 ms, followed by the search display, and

<sup>2</sup> Our proposal that experiencing elevated levels of depression is like multi-tasking (which leads to a variety of predictions, such as those tested in the present research regarding attention capture) should not be confused with the proposal that individuals experiencing elevated levels of depression have trouble multi-tasking, which is a different claim altogether (and would be tested by comparing depressed and non-depressed participants in single and dual-task conditions). In fact, there is already some evidence to support the latter proposal (e.g., Levens et al., 2009; Rokke et al., 2002; Wenzlaff & Bates, 1998; Yee & Miller, 1994).

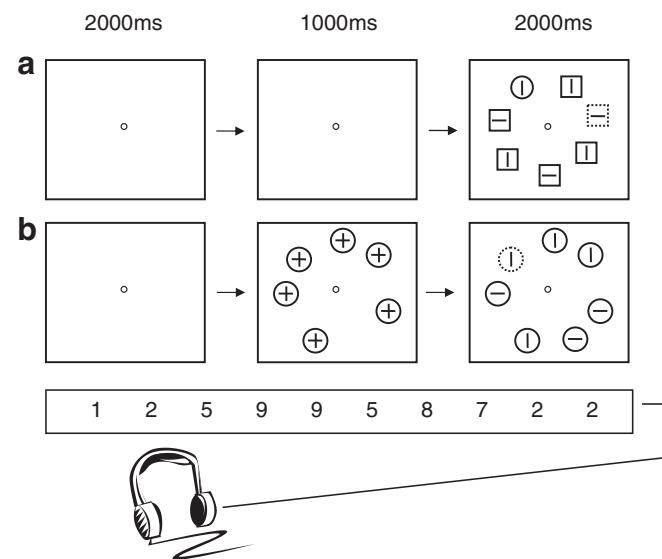
participants were given 2000 ms to respond (non-responses were considered errors). Participants were told to maintain fixation at the center of the screen and to ignore the red item.

In Study 1B, participants completed 148 trials in which they searched for a red circle among green distracter circles and reported the orientation of the line within the target (i.e., the red circle) as quickly and accurately as possible (see Fig. 1). A fixation point appeared for 2000 ms, followed by a preview display of green circles containing crosses. In the no-onset condition, the preview display contained 7 circles and in the onset condition it contained 6 circles. After 1000 ms, the search display was revealed. In the no-onset condition, the crosses turned into horizontal and vertical lines, and one of the circles turned red. The onset condition was similar except that an additional green circle was added to the display. Participants were given 2000 ms to respond to the target (non-responses were treated as errors). Participants were told to maintain fixation at the center of the screen and that the additional item should be ignored—it would never be the target item.

In both studies, participants also wore headphones and listened to a voice reading a string of ten numbers at a rate of 2 per second. The voice started as soon as the initial fixation point appeared on each trial (see Fig. 1). Half of the participants were asked to ignore this string of numbers (*single-task*) and the other half (*dual-task*) were asked to count the number of sequential repetitions in the string (a *one-back task*). Each string contained either two or three repetitions, but participants in the dual-task condition were told that up to four repetitions could occur so that they would continue to attend to the voice throughout each trial. The string ended when the search display disappeared, at which time participants in the dual-task condition were prompted to report the number of repetitions they counted.

## 2.2. Results and discussion

The first twenty trials were considered practice and were not included in analyses. For Study 1B, data from one participant in the



**Fig. 1.** a) The sequence of events for a trial from Study 1A. Participants reported the orientation of the line within the circle, and the rest of the array contained squares that either were all green (solid line) or were green except for one red square (dotted line, as depicted here). b) The sequence of events for an onset trial from Study 1B. Arrays began with six green circles containing '+' signs. After 1000 ms, segments were removed to reveal lines within the circles and participants reported the orientation of the line within a circle that turned red. On "onset" trials, an additional green circle appeared in previously unoccupied location (as shown here). As depicted at the bottom of the figure, in both studies, participants heard digits spoken through headphones for the duration of the trial. In the "single-task" condition, they ignored the digits; in the "dual-task" condition, they counted the number of times a digit appeared twice in a row.

single-task condition were lost due to computer malfunction, and data from one participant in the dual-task condition were excluded due to low accuracy on both tasks. Overall accuracy in the auditory one-back task for dual-task participants was 66% for Study 1A and 72% for Study 1B, confirming that they were attending to the string of numbers. Although objective chance performance was 50% (2 or 3 repetitions), participants were told that 1–4 repetitions could occur and data included all four responses. For the visual search task, we excluded error trials in which participants reported the wrong line orientation (Study 1A: Single-task = 2%, Dual-task = 8%; Study 1B: Single-task = 6%, Dual-task = 6%).

Performance data from Studies 1A and 1B are presented in Table 1. As in the original study using a different attention capture task (Boot et al., 2005), performing a concurrent auditory task increased attention capture by an irrelevant color singleton. Participants in the single-task condition were 25 ms slower in the presence of a color singleton ( $t(11) = 2.32$ ,  $p < .05$ ). For participants in the dual-task condition, the color singleton had an even greater effect, slowing responses by 65 ms ( $t(11) = 4.33$ ,  $p < .01$ ). The difference in the effect of the color singleton across the two task conditions was reflected in the interaction term,  $F(1, 22) = 4.22$ ,  $p < .05$ ,  $\eta_p^2 = .17$  of a 2 (singleton present vs. singleton absent)  $\times$  2 (single-task vs. dual-task) Analysis of Variance (ANOVA). Accuracy levels were comparable across singleton conditions in both the single-task condition (97.2 vs. 97.8) and the dual-task condition (92.8 vs. 91.1), suggesting that the observed effects on RT are unlikely to reflect speed–accuracy tradeoffs.

In contrast to Study 1A, in Study 1B performing a concurrent auditory task reduced attention capture by an abrupt onset. In the single-task condition, responses were 23 ms slower in the presence of an abrupt onset ( $t(10) = 3.81$ ,  $p < .01$ ). In the dual-task condition, the presence of an abrupt onset did not have a significant impact on search times ( $M = -11$  ms,  $t(10) = -.65$ ,  $p = .5$ ). The difference between these conditions was reflected in the interaction term of the  $2 \times 2$  ANOVA ( $F(1, 20) = 3.56$ ,  $p = .07$ ,  $\eta_p^2 = .15$ ). Accuracy levels were comparable across singleton conditions in both the single-task condition (93.8 vs. 93.9) and the dual-task condition (93.8 vs. 94.1), again suggesting that the observed RT effects are unlikely to reflect speed–accuracy tradeoffs.

In summary, Studies 1A and 1B replicated earlier evidence (Boot et al., 2005) that performing a concurrent secondary task increases attention capture by color singletons but decreases capture by abrupt onsets. Moreover, we found the same pattern using a capture task that has simpler demands than the task used in the initial research; participants knew to ignore the additional singleton entirely, and didn't need to try to treat it as statistically uninformative. In Studies 2 and 3, we examine whether elevated levels of anhedonic depression are associated with a comparable pattern of attention capture.

## 3. Study 2

If depression is accompanied by cognitive deficits that are akin to multi-tasking, then elevated levels of anhedonic depression should be associated with: (a) increased capture by color singletons; and (b) reduced capture by abrupt onsets in the additional singleton task. In Study 2, we tested the first of these two predictions.

**Table 1**  
Performance data from Studies 1A and 1B.

	Study 1A	Study 1B		
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
<i>Single-task condition</i>				
Mean RT for singleton absent trials (ms)	771.8	90.2	673.7	147.6
Mean RT for singleton present trials (ms)	797.1	92.4	696.7	153.3
<i>Dual-task condition</i>				
Mean RT for singleton absent trials (ms)	921.8	199.3	820.0	100.3
Mean RT for singleton present trials (ms)	986.3	206.4	809.1	78.5

Note: Study 1A = unique color singleton, Study 1B = abrupt onset singleton.

Depression is often conceptualized (and operationalized) in categorical terms; the most popular example is DSM-IV defined major depressive disorder (MDD). Although there is a clear value in studying MDD, there are also some problems, especially if one wishes to identify unique cognitive deficits associated with different forms of psychological distress. One notable problem with conceptualizing depression categorically is that existing evidence suggests depression is better conceptualized as a continuum of severity (e.g., Ruscio & Ruscio, 2002; Slade & Andrews, 2005; see Brown & Barlow, 2009 and Haslam, 2003 for reviews). In support of this view, cognitive deficits have been observed in individuals with moderate depression, though these deficits tend to be less pronounced than they are in severely depressed individuals (e.g., Sweeney, Wetzler, Stokes, & Kocsis, 1989; see McClintock, Husain, Greer, & Cullum, 2010, for a review). Further, individuals with MDD frequently have comorbid anxiety disorders (e.g., Brown, Campbell, Lehman, Grisham, & Mancill, 2001; Mineka, Watson, & Clark, 1998). This is particularly important given that anxiety is associated with attentional control deficits (see Eysenck, Derakshan, Santos, & Calvo, 2007), though most existing research examining cognitive deficits in depression has failed to address this concern (see Levin et al., 2007). In addition, individuals with MDD typically exhibit elevated levels of general distress or negative affect, which is also true of individuals with most other psychiatric disorders (see Ormel, Rosmalen, & Farmer, 2004). These latter confounds (i.e., overlap with anxiety and general distress) also apply to many popular self-report measures of depression, such as the Beck Depression Inventory (see Richter, Werner, Heerlein, Kraus, & Sauer, 1998; Sloan, Marx, Bradley, Strauss, Lang, & Cuthbert, 2002, and Watson & Clark, 1984). An alternative approach is to examine specific and distinguishable dimensions of psychological distress. Studies 2 and 3 examine three such facets of distress: anhedonic depression (a dimension that reflects the unique aspects of depression), anxious apprehension (also referred to as worry or cognitive anxiety), and anxious arousal (also referred to as somatic anxiety).

Although there are some conceptual and methodological advantages to studying specific and distinguishable dimensions of psychological distress, this strategy brings with it one disadvantage relative to the more typical strategy of comparing individuals with MDD to "healthy" (nonpsychiatric) controls. Since the latter strategy essentially compares individuals who fall at the extreme ends of a continuum, effect sizes tend to be rather large, so fewer participants are needed to achieve sufficient statistical power. In contrast, when including individuals from across the full continuum, effect sizes will generally be smaller, necessitating larger samples. To this end, we collected data from a large number of participants for Studies 2 and 3, relative to most existing research on cognitive deficits associated with depression.

### 3.1. Methods

#### 3.1.1. Participants

One hundred forty-one undergraduate students (56% female<sup>3</sup>), ranging in age from 17 to 24 years ( $M = 19.0$ ;  $SD = 1.1$ ), participated in the study for course credit. This sample was completely independent of the samples used for Studies 1A and 1B. Only individuals that reported having normal or corrected-to-normal vision, including normal color vision, were permitted to participate. All participants provided informed consent<sup>4</sup>.

<sup>3</sup> Because there are substantial gender differences in the prevalence of depressive disorders (APA, 2000), we examined whether our findings varied by gender in Studies 2 and 3. In both samples, we did not find significant gender differences in attention capture scores ( $p > .2$ ). More importantly, gender did not significantly moderate the associations between anhedonic depression and capture in either sample ( $p > .2$ ). In fact, when controlling for gender, the associations between anhedonic depression and capture were just as strong (Study 2:  $p = .18$ ,  $p = .05$ , Study 3:  $p = -.17$ ,  $p = .05$ ).

<sup>4</sup> Only one participant in this sample was 17 years of age. This participant received parental permission to take part in the study and provided informed assent.

#### 3.1.2. Materials and procedure

**3.1.2.1. Self-report measures.** We measured anhedonic depression using the relevant subscale from the Mood and Anxiety Symptoms Questionnaire (MASQ; Watson et al., 1995), which focuses on symptoms of depression that are unique to depressive disorders (i.e., it does not measure global distress, dysphoria, neuroticism, or negative affect). The anhedonic depression subscale of the MASQ is composed of 22 items such as "felt really slowed down," "felt like nothing was very enjoyable" and "thoughts of death or suicide." Participants indicate how frequently they have experienced each of these symptoms during the past week on a scale from 1 ("not at all") to 5 ("extremely"). Thus, scores range from 22 to 110, with higher scores reflecting greater levels of anhedonic depression. This subscale has good convergent and discriminant validity (Nitschke, Heller, Imig, McDonald, & Miller, 2001; Reidy & Keogh, 1997; Watson et al., 1995). In fact, though it is not designed to measure symptoms of depressive disorders per se, scores from this measure do predict whether or not an individual will qualify for a current depressive disorder (e.g., Bredemeier et al., 2010). Furthermore, this scale is better at distinguishing patients with depressive disorders from patients with anxiety disorders than some other popular depression instruments, such as the Center for Epidemiologic Study of Depression Scale (CES-D; see Buckby, Yung, Cosgrave, & Killackey, 2007). Internal consistency for this scale in our sample was .90.

In order to test for specificity and rule out potential confounds, we also administered questionnaires designed to measure two types of anxiety: cognitive and somatic (see Heller, Nitschke, Etienne, & Miller, 1997; Liebert & Morris, 1967, and Schwartz, Davidson, & Goleman, 1978). More specifically, the anxious arousal subscale of the MASQ and the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) were administered to measure somatic and cognitive anxiety, respectively. For both scales, higher scores reflect greater anxiety. These scales have good psychometric properties (Meyer et al., 1990; Watson et al., 1995). More importantly, these two scales measure facets of psychological distress that are distinguishable from one another, and from anhedonic depression (Nitschke et al., 2001). Internal consistency for the MASQ anxious arousal subscale and the PSWQ in our sample was .84 and .93, respectively.

**3.1.2.2. Visual search task.** Participants completed the same visual search task used in Study 1A, but without the auditory string of numbers and with the following minor changes to the task parameters: 1) the initial fixation appeared for 1100 ms; 2) the search display disappeared if participants responded before 2000 ms; 3) the figures were reversed, such that the target item was a green square and the distracter items were circles; and 4) participants completed 110 trials. These changes were introduced to make the task more closely resemble versions used in past research (e.g., Theeuwes, 1992). In other words, the parameters for Studies 1A were selected to make the task more appropriate for the dual-task manipulation.

**3.1.2.3. Procedure.** Participants were tested individually. All participants completed the questionnaires first, then the visual search task. To test whether attention capture by unique color singletons was moderated by participants' self-reported levels of distress, we conducted repeated measures ANOVAs, treating singleton condition (singleton present vs. absent) as a within-subjects variable and scores from the questionnaires as between-subjects (continuous) variables. For follow-up analyses, an attention capture score was computed for each participant by subtracting their mean RT on singleton absent trials from their mean RT on the singleton present trials. Higher capture scores indicate a larger capture effect. We also computed a difference

score using error rates from the two singleton conditions to test whether any associations that emerged involving the capture scores could be due to speed–accuracy tradeoffs<sup>5</sup>.

### 3.2. Results and discussion

The first ten trials were considered practice and were not included in analyses. Furthermore, trials were excluded if the line orientation judgment was incorrect. Although most participants were accurate throughout the task, some participants showed elevated error rates. Given that the critical measure in search tasks is response time, high error rates undermine the interpretability of the results. Consequently, we excluded data from participants with accuracy scores below 75% ( $n=13$ ). We also excluded data from 3 participants who had means RTs for one or both task conditions that were three or more standard deviations above the sample mean. Thus, the analyses reported below include data from 125 participants<sup>6</sup>.

Descriptive statistics for Study 2 are reported in Table 2. Overall, participants were 10 ms slower in the presence of the color singleton, showing that the uniquely colored item captured attention,  $t(127)=2.60$ ,  $p<.01$ . However, the extent of this capture was moderated by participants' self-reported levels of anhedonic depression, as reflected in the interaction term,  $F(1, 123)=3.89$ ,  $p=.05$ ,  $\eta_p^2=.03$  of a repeated measures ANOVA. In line with our predictions, follow-up analyses revealed that the amount of attention capture exhibited by each participant was positively correlated with self-reported levels of anhedonic depression ( $r=.18$ ,  $p=.05$ ; see Table 3). In contrast, anhedonic depression was not significantly correlated with the difference score for error rates ( $r=.02$ ,  $p=.82$ ), indicating that the association between depression and capture by color singletons is not due to a speed–accuracy tradeoff. Furthermore, neither cognitive nor somatic anxiety significantly moderated capture ( $p$ 's>.8). In fact, the association between anhedonic depression and capture remained unchanged when all three variables were entered into a single regression analysis ( $\beta=.18$ ,  $p=.05$ ). These results suggest that the association between anhedonic depression and capture by color singletons is not accounted for by anxiety.

In summary, people with elevated levels of anhedonic depression showed greater capture by unique color items, just as performing a concurrent auditory task led to increased capture by color singletons in Study 1A. This finding is consistent with the claim that depression is associated with difficulty concentrating. More importantly, this result is also consistent with the notion that experiencing elevated levels of depression is functionally comparable to multi-tasking, at least in terms of attention capture by color singletons.

## 4. Study 3

To further test our proposal that depression is like multi-tasking, in Study 3 we explored whether elevated levels of anhedonic depression are associated with decreased attention capture by an abrupt onset item, just as a secondary task led to decreased capture by onsets in Study 1B.

### 4.1. Methods

#### 4.1.1. Participants

One hundred forty-six undergraduate students (55% female) reporting normal or corrected-to-normal vision, ranging in age from 18 to 28 years ( $M=19.4$ ;  $SD=1.4$ ), participated in the study for course

<sup>5</sup> The difference score for error rates was computed solely to test for speed–accuracy tradeoffs because past research using this search paradigm (e.g., Theeuwes, 1992, 1994) has shown that capture effects are reflected primarily in RT interference rather than accuracy.

<sup>6</sup> Participants who were excluded due to low accuracy or as outliers in Studies 2 and 3 did not score significantly higher or lower than participants who were included in the analyses on any of the self-report measures, including the MASQ anhedonic depression subscale.

**Table 2**  
Descriptive statistics from Studies 2 and 3.

	Study 2		Study 3	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
<i>Self-report measures</i>				
MASQ-Anhedonic Depression	53.4	15.1	54.1	12.4
MASQ-Anxious Arousal	25.2	7.7	26.6	7.7
Penn State Worry Questionnaire	49.3	13.4	45.8	13.7
<i>Visual search tasks</i>				
Mean RT for singleton absent trials (ms)	725.0	92.7	626.2	50.8
Mean RT for singleton present trials (ms)	734.6	95.7	643.1	51.7
% accuracy for singleton absent trials	94.0	4.6	89.2	6.8
% accuracy for singleton present trials	94.1	4.5	88.6	6.6

Note: Study 2 = unique color singleton, Study 3 = abrupt onset singleton.

credit. This sample was completely independent of the samples used in Studies 1A, 1B, and 2. Again, all participants provided informed consent.

### 4.1.2. Materials and procedure

**4.1.2.1. Self-report measures.** Anhedonic depression, cognitive anxiety, and somatic anxiety were measured using the same instruments from Study 2; internal consistencies in this sample were .93 (MASQ-Anhedonic Depression), .85 (Penn State Worry Questionnaire), and .93 (MASQ-Anxious Arousal).

**4.1.2.2. Visual search task.** Participants completed the same visual search task used in Study 1B, but without the auditory string of numbers and with the following minor changes to the task parameters: 1) the

**Table 3**  
Zero-order correlations between the self-report questionnaire scores and performance indices from the visual search tasks from Studies 2 and 3. Results for the critical analyses are shown in bold.

Performance index	Anhedonic depression	Cognitive anxiety	Somatic anxiety
<i>Attention capture score</i>			
Study 2	<b>.18*</b>	<b>.02</b>	<b>.02</b>
Study 3	<b>-.18*</b>	<b>-.10</b>	<b>-.08</b>
<i>Mean RT across conditions</i>			
Study 2	.09	.08	-.03
Study 3	.02	.25**	.22**
<i>Mean RT – singleton absent</i>			
Study 2	.05	.08	-.04
Study 3	.06	.27**	.23*
<i>Mean RT – singleton present</i>			
Study 2	.12	.08	-.03
Study 3	-.02	.22**	.19*
<i>Difference score – error rates</i>			
Study 2	<b>.02</b>	<b>.02</b>	<b>.09</b>
Study 3	<b>.05</b>	<b>-.02</b>	<b>.05</b>
<i>% accuracy across conditions</i>			
Study 2	.07	.10	-.04
Study 3	-.09	-.09	-.13
<i>% accuracy – singleton absent</i>			
Study 2	.07	.09	.02
Study 3	-.05	-.08	-.09
<i>% accuracy – singleton present</i>			
Study 2	.05	.07	-.09
Study 3	-.10	-.07	-.14

Notes: Study 2 = unique color singleton, Study 3 = abrupt onset singleton.

\*  $p<.05$ .

\*\*  $p<.01$ .

initial fixation appeared for 700 ms and the preview display appeared for 2000 ms; 2) the search display appeared for a maximum of 1000 ms and disappeared when participants responded; and 3) participants completed 110 trials. These changes were introduced to make the task more closely resemble versions used in past research (e.g., Theeuwes, 1994). In other words, the parameters for Studies 1B were selected to make the task more appropriate for the dual-task manipulation.

**4.1.2.3. Procedure.** Participants, tested in groups of six or fewer, completed the questionnaires and the visual search task in counterbalanced order. As in Study 2, to test whether attention capture by abrupt onset singletons was moderated by participants' self-reported levels of distress, we conducted repeated measures ANOVAs treating singleton condition as a within-subjects variable and scores from the questionnaires as between-subjects (continuous) variables. Further, capture scores were computed for each participant for follow-up analyses, along with difference scores using error rates to test for speed-accuracy tradeoffs. Again, higher capture scores indicate a larger capture effect.

#### 4.2. Results and discussion

As in Study 2, the first ten trials were considered practice, and trials were excluded if the line orientation judgment was incorrect. Also, participants with accuracy levels below 75% for the search task were excluded ( $n=9$ ). Thus, the analyses include data from 137 participants.

Descriptive statistics for Study 3 are reported in Table 2. Overall, participants were 17 ms slower in the presence of an abrupt onset, showing that this item captured attention,  $t(136)=8.96$ ,  $p<.01$ . Again, the extent of this capture was moderated by participants' self-reported levels of anhedonic depression, as reflected in the interaction term,  $F(1, 135)=4.66$ ,  $p<.05$ ,  $\eta_p^2=.03$  of a repeated measures ANOVA. As expected, in contrast to Study 2, follow-up analyses revealed that the amount of attention capture exhibited by each participant was negatively correlated ( $r=-.18$ ,  $p=.03$ ) with self-reported levels of anhedonic depression (see Table 3). As in Study 2, anhedonic depression was not significantly correlated with the difference score for error rates ( $r=.05$ ,  $p=.53$ ; see Table 3), indicating that the association between depression and capture by onsets is not due to a speed-accuracy tradeoff. Again, neither cognitive nor somatic anxiety significantly moderated capture ( $p$ 's > .2). Furthermore, the association between anhedonic depression and capture remained virtually unchanged when all three variables were entered into a single regression analysis ( $\beta=-.16$ ,  $p=.07$ ). These findings suggest that the association between anhedonic depression and capture is not accounted for by anxiety.

In summary, the results of Study 3 revealed that elevated levels of anhedonic depression are associated with decreased capture by abrupt onsets, just as a concurrent auditory task led to decreased capture by onsets in Study 1B. Again, these results are consistent with the claim that depression is like multi-tasking.

#### 5. General discussion

Although depression has been linked to attention deficits, the nature of these deficits has been underspecified. We drew upon methods used to study attention capture to examine if and how anhedonic depression is related to one's ability to ignore distracting visual information. Elevated levels of anhedonic depression were associated with increased capture by uniquely colored items but with decreased capture by abrupt onsets, a pattern similar to the impact of performing a concurrent auditory task. This result suggests that experiencing elevated levels of anhedonic depression is, at least in some ways, functionally comparable to multi-tasking. Our findings also extend evidence of links between depression and attention to

nonemotional stimuli (Mialet et al., 1996; Ottowitz et al., 2002) and have important implications both for understanding the nature of these links, as well as basic mechanisms of attention capture.

First, anhedonic depression moderates the involuntary capture of attention. The nature of the relation between anhedonic depression and attention capture, however, seems to depend on the type of stimuli that people try to ignore. Specifically, our results suggest that people experiencing elevated levels of anhedonic depression are more likely to be distracted by things that stand out (e.g., brightly colored signs), but less likely to be distracted by new or changing aspects of the external environment (e.g., flashing signs). These associations do not appear to reflect differences in motivation or engagement given that anhedonic depression was not significantly correlated with accuracy or speed of responding. Instead, it may be driven by difficulty initiating efficient search strategies (see Hertel, 1994). In our task, people experiencing elevated levels of anhedonic depression may have adopted simpler or less proactive search strategies that require fewer cognitive resources (e.g., relying on unique stimuli to guide search, delaying search until the target has appeared; Boot et al., 2005). Such strategies would lead to increased distraction by sustained salient stimuli (e.g., uniquely colored items) and decreased distraction by transient events that occur at or before the time that the target appears (e.g., abrupt onsets). Perhaps in line with this proposal, elevated levels of depression have recently been linked with deficits in preparation for effortful processing (attention "alerting"; Lyche, Jonassen, Stiles, Ulleberg, & Landro, 2011). Converging evidence for this interpretation could be obtained by attempting to manipulate search strategies (e.g., by providing contextual cues or varying task instructions) and/or exploring other individual difference variables that could mediate the link between anhedonic depression and attention capture (e.g., dimensions of executive functioning – see Miyake et al., 2000; rumination – see Levens et al., 2009). Furthermore, future research should examine if and how anhedonic depression moderates attention capture by other sorts of salient nonemotional distractors to determine whether, as we have argued, the critical difference between onset and color singletons results from one being transient and the other sustained.

Second, anhedonic depression moderates attention capture in the same way as multi-tasking. Both are associated with deficient attention control, resulting in greater capture by uniquely colored items but reduced capture by onsets. This similarity suggests that elevated levels of anhedonic depression and multi-tasking are associated with comparable "executive deficits." Additional support for this proposal could be obtained by examining patterns of attention capture in other populations known to suffer from executive functioning deficits (e.g., individuals with Attention-Deficit/Hyperactivity Disorder; see Barkley, 1997). However, the patterns were not identical: multi-tasking led to slower overall response times (cf. Boot et al., 2005; Han & Kim, 2004), but participants with elevated levels of anhedonic depression were not slower in performing the search tasks. The difference might be due to the nature of the task demands. For example, participants in the dual-task conditions had to generate two responses (one for each task), leading to additional processing demands that might affect the efficiency of search (see Pashler, 1994). In contrast, participants in Studies 2 and 3 only needed to generate one response. Another possibility is that participants in the dual-task conditions had to switch back and forth between the task sets (see Duncan, 1995), a process which takes time to perform (see Monsell, 2003). Additional research is needed to determine why visual search is less efficient even in the absence of salient distractors under dual-task conditions, but not in individuals with elevated levels of anhedonic depression. Furthermore, given that Studies 1A and 1B used a laboratory dual-task manipulation, future research examining the effects of multi-tasking on attention capture should test whether comparable findings emerge when participants perform more than two tasks at once, as well as using more ecologically valid forms of dual-

tasking (e.g., talking on a cellular phone while driving; see Strayer, Drews, & Johnston, 2003).

Third, our findings have important implications for related areas of research. For example, in order to claim that people with depression show biased attention to emotional stimuli, researchers should verify that these biases result from the emotional valence of the stimuli and not just from their salience. After all, in Study 2 we found that participants reporting elevated levels of anhedonic depression exhibited increased attention capture by physically salient but emotionally neutral stimuli (color singletons). Our research also illustrates the importance and utility of examining individual differences in performance on standard tasks used to study attention capture, and highlights the potential for important individual differences in basic attention mechanisms. To date, individual differences have largely been ignored in research using these experimental paradigms. More generally, examining individual differences in this fashion in cognitive research may shed new light on the mechanisms involved in performance on cognitive tasks (see Lee & Webb, 2005).

Our findings also open several avenues for future research. If depression is indeed like multi-tasking, we would expect people with elevated levels of anhedonic depression to show deficits in other areas of performance that are compromised in dual-task situations. For example, dual-task interference affects the likelihood of noticing unexpected objects in a display (De Fockert & Bremner, 2011; Fougner & Marois, 2007) as well as driving performance (Strayer et al., 2003), and both might be similarly impaired in depressed individuals. Conversely, we would also expect multi-tasking to cause deficits comparable to those observed in people with depression. For example, performing a secondary task might influence the extent to which individuals attend to emotionally-valenced stimuli, akin to the “attentional biases” that occur in depression (e.g., Gotlib & McCann, 1984; Koster et al., 2005; Shane & Peterson, 2007).

It is worth noting that the effect sizes observed in Studies 2 and 3 would be considered small by most conventions (e.g., Cohen, 1988), and a few of these effects did not quite reach statistical significance. However, we feel that the strength of our findings ultimately lies in the consistent pattern of findings across the three studies, and as previously noted, we anticipated small effects given the methods that were utilized in these studies. Furthermore, it is important to emphasize that effect size should not be equated with practical or clinical significance per se (see Kazdin, 1999). After all, in certain cases, small effects can have very important implications (see Prentice & Miller, 1992). In fact, it is noteworthy that we were able to detect variations in attention capture associated with anhedonic depression using a design that did not involve comparing extreme groups (e.g., clinically depressed individuals vs. controls). By selecting a depression instrument that targets the unique aspects of this construct and measuring anxiety, we were able to demonstrate specific links between anhedonic depression and attention capture. Furthermore, our samples were composed of college students; thus, we expect that relatively few of these participants would have qualified for a current depressive disorder. While mean levels of anhedonic depression in our samples were comparable to those reported in previous studies involving college and community samples, they were much lower than those reported in treatment-seeking samples (Geisser, Cano, & Foran, 2006; Watson et al., 1995). Despite evidence that cognitive deficits tend to be more pronounced in individuals with severe depression (e.g., McClintock et al., 2010, for a review), attention problems have been observed in college students with moderate levels of depression (e.g., Rokke et al., 2002). These findings are consistent with accumulating evidence that suggests that depression is a dimensional phenomenon (see Brown & Barlow, 2009 and Haslam, 2003). Nevertheless, caution must be exercised in generalizing our findings to people with diagnosable depressive disorders. Furthermore, not all individuals suffering from depressive disorders experience symptoms

of anhedonia – given that the measure used in our research focused on these symptoms, our findings may be more applicable to those who do. Future work should attempt to replicate our findings in more diverse and/or more distressed samples.

In addition to limitations of the samples used in Studies 2 and 3, it is important to note that participants were not screened for some factors which can have an impact on cognitive performance and may have been positively correlated with anhedonic depression (e.g., medication/substance use). Thus, additional research is needed to explore these potential confounds. Furthermore, we used a single self-report questionnaire that is designed to measure current symptoms, and participants were not screened for past depression. Thus, we cannot tease apart whether our findings are driven by current symptoms or depression vulnerability. These issues could be addressed in future research by also administering a diagnostic interview to obtain both current and past symptom ratings. Finally, since the results are cross-sectional, we cannot determine whether the relation between anhedonic depression and attention capture is causal. Although one might assume that attention problems are merely by-products of mood disturbances in individuals with elevated levels of anhedonic depression, it is possible that these problems actually confer risk for becoming depressed (see Nuechterlein, 1990 and Yee & Miller, 1994). In line with this view, attention and executive functioning deficits often persist even after depressed mood has remitted in people with depressive disorders (e.g., Paelecke-Habermann, Pohl, & Leplow, 2005; Weiland-Fiedler et al., 2004). Additional research using longitudinal and/or experimental designs will enable researchers to determine whether the cognitive deficits responsible for variations of attention capture actually contribute to the development and/or maintenance of depression. If so, clinical interventions could be developed to remediate these deficits as a means of treating (or possibly preventing) depression.

In conclusion, our results provide support for the notion that elevated levels of anhedonic depression and multi-tasking are associated with comparable deficits in attentional control and the ability to filter irrelevant distracting information. More generally, our results illustrate the potential utility of integrating experimental and correlational methods in the investigation of basic cognitive phenomena, as well as psychopathology.

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