Exp Brain Res (2012) 221:59–67
DOI 10.1007/s00221-012-3147-z

RESEARCH ARTICLE

Exploring the relationship between boredom and sustained attention

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Received: 7 February 2012 / Accepted: 10 June 2012 / Published online: 23 June 2012

Abstract Boredom is a common experience, prevalent in neurological and psychiatric populations, yet its cognitive characteristics remain poorly understood. We explored the relationship between boredom proneness, sustained attention and adult symptoms of attention deficit hyperactivity disorder (ADHD). The results showed that high boredom-prone individuals (HBP) performed poorly on measures of sustained attention and showed increased symptoms of ADHD and depression. The results also showed that HBP individuals can be characterised as either *apathetic*—in which the individual is unconcerned with his/her environment, or as *agitated*—in which the individual is motivated to engage in meaningful activities, although attempts to do so fail to satisfy. Apathetic boredom proneness was associated with attention lapses, whereas agitated boredom proneness was associated with decreased sensitivity to errors of sustained attention, and increased symptoms of adult ADHD. Our results suggest there is a complex relationship between attention and boredom proneness.

Keywords Boredom · Sustained attention · ADHD · TBI

Introduction

Boredom as a topic of scientific inquiry emerged from industrial psychological examinations of work place efficiency (Munsterberg 1913). Since then, boredom research has covered a range of disparate fields, and the definition of boredom varies according to the context and cognitive factors associated with the experience. Boredom proneness is related to decreased attention and reduced performance at work and school (Kass et al. 2001; O'Hanlon 1981; Pekrun et al. 2010). Boredom is a frequently reported depressive symptom following traumatic brain injury (Kreutzer et al. 2001), and the effects of boredom are detrimental to treatment and rehabilitation of psychological disorders (Bracke and Verhaeghe 2010; Todman 2003). Finally, boredom shares many characteristics with symptoms of attention deficit hyperactivity disorder (ADHD; Barkley 2006). Evidently, boredom is multifactorial and remains a construct that is difficult to define. Most authors agree that boredom is related to attention and negative affect, although the exact nature of this relationship is poorly understood. To develop a richer description of boredom proneness and its relationship to attention, we explored the relationship between boredom proneness, depression and a variety of measures of attention.

Boredom proneness and attention have frequently been linked in the literature (Farmer and Sundberg 1986; Carriere et al. 2008), especially with respect to achievement environments where boredom proneness and decreased attention are detrimental to performance, job satisfaction and academic adjustment (Pekrun et al. 2010; Kass et al. 2001; O'Hanlon 1981). O'Hanlon (1981) suggested that boredom results from prolonged exposure to monotonous tasks, leading to low cortical arousal. As a result, attention shifts away from the task-at-hand towards more rewarding stimuli. Circumventing such distraction requires sustained attention—the ability to maintain mindful, conscious processing under monotonous conditions (Robertson et al. 1997). Interestingly, boredom proneness has been shown to be correlated with self-reported everyday errors or 'slips'

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of attention (e.g. 'attention lapses' such as pouring orange juice on cereal; Cheyne et al. 2006).

Deficits in sustained attention represent a prominent symptom of ADHD (Kass et al. 2003). Adults with ADHD are of particular interest given that hyperactivity symptoms characteristic of the disorder in childhood subside with age while inattention persists (Barkley 2006). In addition, ADHD research is largely limited to younger samples, although the prevalence of the disorder in adults remains high (between 2 and 5 %; Kooij et al. 2010). Nevertheless, it has been suggested that boredom and ADHD share common characteristics, including inattention, impulsivity, poor academic achievement and negative affect (Barkley 2006).

Boredom is generally depicted as a dissatisfying, unpleasant, transient affective state, (Mikulas and Vodanovich 1993) and measures of depression demonstrate consistently high positive correlations with boredom proneness (Farmer and Sundberg 1986; Goldberg et al. 2011). Farmer and Sundberg (1986) found a positive association between boredom proneness and depression, but emphasised that they differed in mood quality and intensity. Likewise, boredom proneness has been shown to be related to, but distinct from, similar affective states including depression, apathy and anhedonia (Goldberg et al. 2011). Taken together, the evidence suggests that boredom and depression are related, but distinct, affective states that in turn may involve distinct cognitive factors (Goldberg et al. 2011; Carriere et al. 2008).

Individuals experiencing high levels of boredom proneness can be characterised in two broad ways (Greenson 1951). Apathetic boredom-prone individuals report feeling no interest in activities but feel no compulsion to redress their apathetic state. In contrast, agitated boredom-prone individuals are motivated to engage in meaningful activities but every attempt to do so fails to satisfy (Greenson 1951). Agitated and apathetically boredom-prone individuals are likely to respond differently on sustained attention tasks. One would expect more attention lapses to be evident in the apathetic boredom-prone individual who lacks the necessary motivation to engage fully in the task-at-hand. Similarly, the two subtypes may show distinct profiles in terms of other cognitive and personality traits such as extroversion and sensation seeking. That is, the bored state, characterised as a low arousal state, may actually *lead* to increased sensation seeking, defined as the tendency to seek novel, complex sensations and experiences (Mikulas and Vodanovich 1993; Zuckerman 1992). It may be the case that the apathetic and agitated boredom-prone individuals demonstrate distinct profiles in terms of novelty seeking, a proxy measure for sensation seeking, and sustained attention. We explored the relationship between boredom proneness and attention using a range of measures to better characterise these profiles.

Materials and methods

Forty-eight undergraduates (39 females; mean age = 18.9 years; SD = 1.13) from the University of Waterloo participated in this study. All had normal or corrected to normal vision and gave written informed consent prior to participation. The study protocol was approved by the University of Waterloo's institutional ethics committee.

Boredom proneness

The Boredom Proneness Scale (BPS) measured trait susceptibility to boredom. It is a self-report questionnaire composed of 28 items (e.g. 'Time always seems to be passing slowly') rated on a 7-point Likert scale. Scores range from 28 to 196, where higher scores indicate greater boredom proneness. Estimates of internal consistency (Cronbach's α) have ranged from .79 to .84 across numerous studies (Vodanovich et al. 2005). The BPS has demonstrated high convergent validity with other boredom measures (*r*s = .25 or higher; reviewed in Farmer and Sundberg 1986) as well as measures of personality, mood, negative affect, life satisfaction, cognitive failures, attention and time perception (Vodanovich 2003). Items on the BPS can be split into five factors (Vodanovich and Kass 1990), two of which measure the need for external (ES) and internal stimulation (IS).[1] High scores on ES are indicative of an individual seeking external stimulation—what we would characterise as the *agitated* boredom-prone state ($n = 24$ participants, 5 males; mean (±SD) age = 18.94 (1.21) years). High scores on IS are indicative of an individual disengaged from their environment—what we are calling the *apathetic* boredom-prone state ($n = 24$ participants, 4 males; mean (±SD) age = 18.85 (1.09) years).

Measures of attention

Attentional lapses

The Mindful Attention and Awareness Scale (MAAS; Brown and Ryan 2003) measured attention lapses characterised as the inability to sustain mindful, conscious awareness in everyday activities. The MAAS is a 15-item self-report questionnaire (e.g. 'It seems I am "running on automatic" without much awareness of what I am doing')

[1] We could have chosen the 2-factor structure suggested by Ahmed (1990) or the short-form 2-factor structure used by Vodanovich et al. (2005). We chose the 5-factor structure for two reasons: first, a previous data set (Goldberg et al. 2011) had confirmed the existence of a 5-factor structure in a larger sample ($n = 823$). Second, when we split the group based on Ahmed's (1990) structure, no participant changed group (i.e., the individuals identified as experiencing apathetic or agitated boredom proneness by the 5-factor structure were the same individuals identified by the 2-factor structure).

rated on a 6-point Likert scale. The MAAS has been shown to have high internal consistency (Cheyne et al. 2006). Higher scores indicate a greater frequency of attention lapses—in a sense, this reflects a high degree of mindlessness or mind wandering (Cheyne et al. 2006).

Everyday failures of attention

The Attention-Related Cognitive Errors Scale (ARCES; Cheyne et al. 2006) measured everyday cognitive failures. The ARCES consists of 12 self-rated items (e.g. 'I have absent-mindedly placed things in unintended locations' (e.g. putting milk in the pantry or sugar in the fridge)) on a 5-point Likert scale with high scores indicating a high frequency of everyday cognitive failures. The ARCES has been shown to have high internal consistency (Cheyne et al. 2006).

Adult symptoms of ADHD

The Conners' Adult ADHD Rating Scale-Short Version (CAARS-S; Conners et al. 2003) measured symptoms of attention deficits indicative of adult ADHD. The CAARS-S is a 26-item self-rated questionnaire on a 4-point Likert scale (e.g. 'I have trouble getting started on a task'). Items on the CAARS can be grouped into subscales measuring inattentive and hyperactive symptoms. Higher scores indicate a greater degree of ADHD symptoms.

Sustained attention

The sustained attention to response task (SART; Robertson et al. 1997; Fig. 1a) measured sustained attention and required participants to respond to single digits presented on a computer screen, but to withhold a response to one particular digit (i.e. the digit 3). Numbers from 1 to 9 were presented for 250 ms in quasi-random sequence followed by a 900 ms mask. Each digit was presented 25 times for a total of 225 trials. Participants responded by pressing the space bar on 'go' trials and withholding that response for the digit '3' (i.e. 'no-go' trials). Erroneous responses on no-go trials are coded as commission errors, with a high frequency of such errors indicative of poor sustained attention. In addition, sensitivity to having made an error was measured by looking at reaction times (RTs) following an error. Healthy individuals demonstrate a slowing of RTs following commission errors (Robertson et al. 1997).

Depression

The 7-item depression subscale of the Depression Anxiety Stress Scale (DASS-21; Antony et al. 1998) measured the degree of depressive symptoms experienced in the preceding 2 weeks. The DASS is a self-report questionnaire rated on a 4-point Likert scale. Higher scores indicate higher levels of depression.

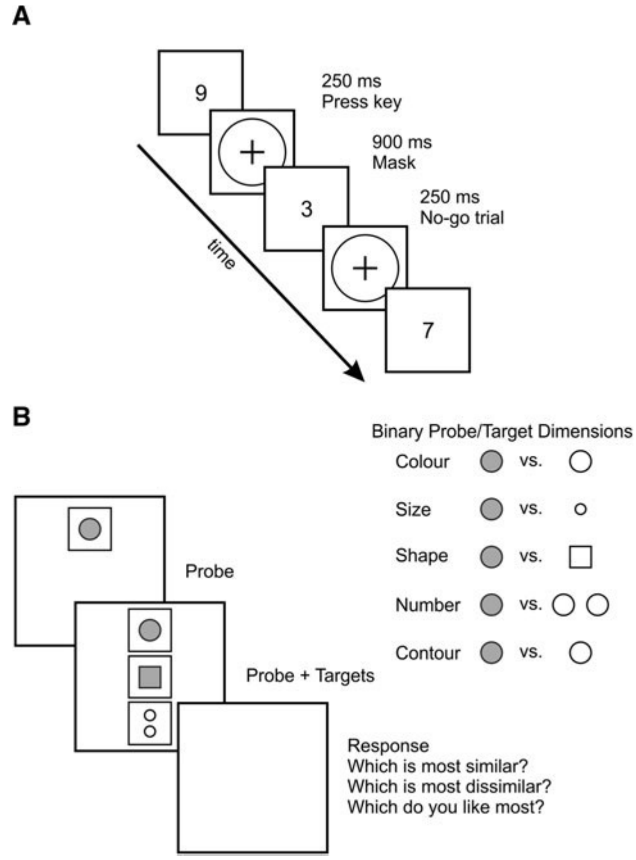

Fig. 1 **a** Schematic diagram of the SART. **b** Schematic diagram of the cognitive bias task (CBT)

Measuring preferences for novelty or familiarity

Given that the hyperactive subtype of ADHD and the agitated boredom-prone subtype may be expected to demonstrate a similar propensity for novelty seeking, we employed the cognitive bias task (CBT; Goldberg and Podell 2000; Fig. 1b) as a measure of an individual's preference for novel versus familiar stimuli. This task is participant driven and aims to determine the extent to which an individual *prefers* familiar versus novel stimuli (Goldberg and Podell 2000). On each trial, a probe appeared followed by two targets. The probe and target stimuli vary along 5 binary dimensions (*colour*, red/blue; *size*, small/large; *shape*, circle/square; *contour*, outlined/filled; *number*, one/two; Fig. 1b). Targets are assigned similarity scores relative to the probe (e.g. a target that is similar to the probe on all five binary dimensions is given a similarity index of 5). The CBT is composed of three parts; the first two blocks require participants to determine which target is most like (i.e. similar condition) or unlike (i.e.

dissimilar condition) the probe. These first two blocks, which are counterbalanced, establish a baseline for a participant's ability to *perceptually* discriminate target properties. Scores range from 220 (most similar) to 80 (most dissimilar). Participants then complete a block in which they identify which target they 'like' most. This block is always completed last and provides a measure of an individual's preference for novelty or familiarity (Goldberg and Podell 2000). High similarity scores from the 'like' trials indicate a familiarity bias such that the participant is preferentially selecting targets most *similar* to the probe, whereas low similarity scores indicate a bias for novelty (i.e. preferentially selecting targets that *differ* from the probe; Goldberg and Podell 2000). We examined the potential influence on the final 'like' or preference block of trials from having just completed either the 'dissimilar' or 'similar' block. That is, would individuals be more likely to continue choosing targets that were similar to the probe in the final 'like' block if they had just completed the 'similar' versus the 'dissimilar' block of trials? We found that there was no influence of the preceding block of trials on the performance in the 'like' or preference block.

Results

Boredom proneness was correlated with attention lapses ($r = 0.53$, $p < 0.01$), and attention-related cognitive errors ($r = 0.49$, $p < 0.01$; measured by the MAAS and ARCES respectively; Table 1). Surprisingly, the SART was not correlated with boredom proneness ($r = 0.16$, $p = 0.28$). RTs on the SART were negatively correlated with commission errors ($r = -0.69$, $p < 0.01$). Sensitivity to errors on the SART (i.e. slowing of RTs following commission errors) was also negatively correlated with commission errors ($r = -0.35$, $p < 0.05$) and boredom proneness ($r = -0.43$, $p < 0.01$; Fig. 2).

Next, we divided the group into high (HBP; $M = 108.17$, $SD = 7.64$) and low (LBP; $M = 85.33$, $SD = 8.49$) boredom-prone individuals using a median split (Table 2).

LBP individuals slowed down significantly following commission errors (mean RT pre-error = 276.21 ms; post-error = 338.34 ms, $t = -4.41$, $p < 0.001$), whereas HBP individuals were insensitive to errors of commission (mean RT pre-error = 300.01 ms, post-error = 300.45 ms, $t = -0.39$, $p = 0.97$; Fig. 3).

The results demonstrated positive correlations between boredom proneness and symptoms of adult ADHD ($r = 0.64$, $p < 0.01$) and boredom proneness and symptoms depression ($r = 0.58$, $p < 0.01$). In addition, boredom proneness was correlated with both inattentive and hyperactive symptoms of ADHD (inattention, $r = 0.48$, $p < 0.01$; hyperactivity, $r = 0.52$, $p < 0.01$). The results also indicated that the HBP individuals had a higher frequency of symptoms of adult ADHD (HBP ADHD symptoms = 33.5, $\pm SD = 8.64$; LBP ADHD symptoms = 22.25, $\pm$ SD = 8.49; $t = -4.55$, $p < 0.001$) and higher levels of depressive symptoms (HBP depressive symptoms = 5.58, $\pm$ SD = 4.11; LBP depression symptoms = 2.38 $\pm$ SD = 1.89; $t = -3.48$, $p < 0.001$). Finally, there was a negative correlation between boredom proneness and a preference for similarity ($r = -0.37$, $p < 0.05$; Fig. 4).

Table 1 Pearson product–moment correlation coefficients

$n = 48$	2	3	4	5	6	7	8	9	10	11	12	13
1. BPS	.770**	.545**	.490**	.525**	.158	.021	−.432**	.640**	.484**	.520**	.576**	−.367*
2. BPS_ Ext. Stim.		.123	−.215	−.18	.277	−.067	−.473**	.519**	.314*	.551**	.436**	−.309*
3. BPS_Int. Stim			.377**	.342*	−.04	.219	.07	.314*	.238	.081	.346*	−.287
4. ARCES				.702**	−.116	.121	−.093	.628**	.470**	.315*	.553**	−.291
5. MAAS					−127	.148	−.12	.588**	.449**	.477**	.579**	−.250
6. SART_comission errors						−.690**	−.353*	.106	.081	.25	−.032	−.017
7. SART_AvgRT							.358*	−.057	−.123	−.119	.111	−.193
8. SART PES								−.259	−.368**	−.19	−.232	−.017
9. CAARS									.758**	.620**	.687**	−.444**
10. CAARS_ inattention										.313*	.555**	−.155
11. CAARS_ hyperactivity											.274	−.220
12. DASS_depression												−.356*
13. CBT ($n = 43$)												

** $p < .01$ (two tailed); * $p < .05$ (two tailed); *BPS* Boredom Proneness Scale, *ARCES* Attention-Related Cognitive Errors Scale, *MAAS* Mindful Attention and Awareness Scale, *SART* sustained attention to response task, *AvgRT* average reaction time, *PES* post-error slowing of RT, *CAARS* Conners' Adult ADHD Rating Scale, *DASS* Depression Anxiety Stress Scale, *CBT* cognitive bias task

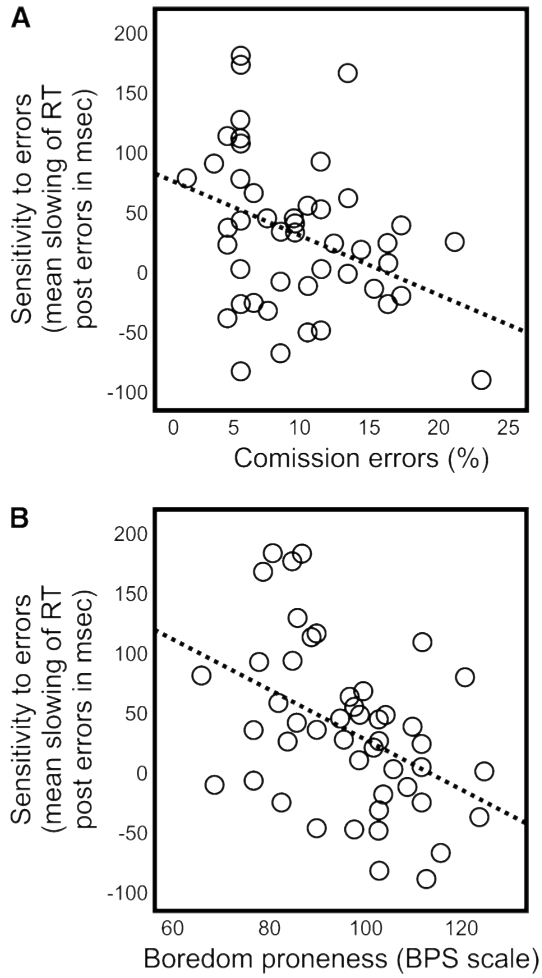

Fig. 2 **a** *Scatter plot* showing the negative correlation between commission errors on the SART and sensitivity to errors of sustained attention (i.e. mean slowing of RTs post a commission error). **b** *Scatter plot* showing the negative correlation between boredom proneness and sensitivity to errors of sustained attention

The BPS internal stimulation (IS) factor, which we used here to characterise the apathetic boredom-prone state, was correlated with attention lapses ($r = 0.34$, $p < 0.05$) and attention-related cognitive errors ($r = 0.38$, $p < 0.01$; measured by the MAAS and ARCES, respectively; see Table 3 for means). In contrast, the BPS external stimulation (ES) factor, which we used to characterise the agitated boredom-prone state, was not correlated with attention lapses or cognitive errors (for the MAAS, $r = -0.18$; while for the ARCES, $r = -0.22$). Directly comparing the correlations across the two groups using z scores (DeCoster 2007) showed that for attention-related cognitive errors, the relationship was significantly stronger for the apathetic group ($Z = 2.02$, $p < 0.05$). There was a trend in the same direction (i.e. a stronger relationship in the apathetic group) for lapses in attention ($Z = 1.74$, $p = 0.08$).

Table 2 Mean scores for high and low boredom-prone groups

Measures	BPS		t
	High ($n = 24$) M (SD)	Low ($n = 24$) M (SD)	
BPS	108.17 (7.64)	85.3 (8.49)	−9.79***
MAAS	50.46 (9.57)	42.33 (8.42)	−3.12**
ARCES	35.54 (7.38)	31.17 (5.11)	−2.39*
SART_comission errors	9.75 (5.31)	8.71 (4.65)	−0.72
SART_Avg RT	311.39 (78.02)	308.11 (80.95)	−.14
CAARS	33.5 (8.64)	22.25 (8.49)	−4.55***
CAARS_inattention	6.67 (2.22)	4.83 (2.60)	−2.63**
CAARS_hyperactivity	7.91 (2.28)	5.29 (2.18)	−4.08***
DASS_depression	5.58 (4.11)	2.38 (1.89)	−3.48***
CBT	181.0 (30.44)	193.5 (21.70)	1.56

All abbreviations as for Table 1. *M* mean, *SD* standard deviation; *** $p < .001$ (two tailed); ** $p < .01$ (two tailed); * $p < .05$ (two tailed)

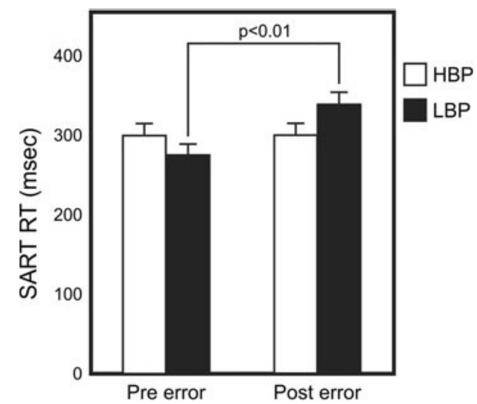

Fig. 3 Mean (+SD) reaction time (RT in msec) prior to a commission error and post a commission error for the low boredom-prone (LBP; *black bars*) and high boredom-prone (HBP; *white bars*) individuals. Only the LBP individuals slowed their RTs post a commission error ($p < 0.001$)

There was a negative correlation with sensitivity to errors of sustained attention (i.e. slowing of RTs following commission errors on the SART; $r = -0.47$, $p < 0.01$). There was no such relationship evident in the apathetic boredom-prone group ($r = 0.07$) and when the two correlations were compared directly, there was a trend towards a stronger relationship between boredom proneness and post-error slowing in the agitated boredom-prone group ($Z = -1.88$, $p = 0.06$). The ES factor was also correlated with inattentive ($r = 0.31$, $p < 0.05$) and hyperactive symptoms of adult ADHD ($r = 0.55$, $p < 0.01$). The same correlations were non-significant in the apathetic boredom-prone group (Table 1). Direct comparison of the relationships, however, showed no difference between the groups for

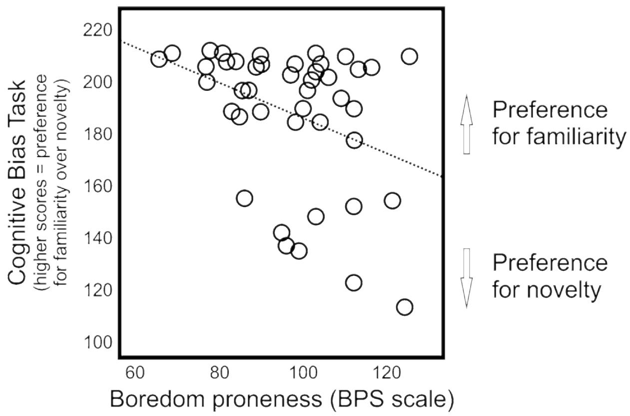

Fig. 4 *Scatter plot* showing the negative correlation between boredom proneness and a preference for novelty or familiarity (note: higher scores on the *y*-axis indicate a stronger preference for familiarity, while higher scores on the *x*-axis indicate higher levels of boredom proneness)

inattentive symptoms of ADHD ($Z = 0.12$, $p = 0.9$) and a trend towards a stronger relationship between boredom proneness and hyperactive ADHD symptoms in the agitated boredom-prone group ($Z = 1.74$, $p = 0.08$).

When judgements of similarity and dissimilarity on the CBT were compared across the two boredom-prone groups (i.e. apathetic vs. agitated), we found no significant differences. When *preference* judgements were compared (i.e. 'Which stimulus do you like most?'), there was a significant difference such that the apathetic boredom-prone group showed a higher preference for familiarity ($t = 2.45$, $p < 0.05$; Table 4).

It should be noted here that all participants were easily able to make judgements of similarity (mean similarity index score for the group = 202.95 (±6.49); max score possible = 220) and dissimilarity (mean index = 85.93 (±6.49); min score possible = 80; see Table 4 for means for each group separately). Finally, symptoms of depression were significantly correlated with boredom proneness in both the apathetic bored state ($r = 0.35$, $p < 0.05$) and the agitated boredom-prone state ($r = 0.44$, $p < 0.01$). The strength of this relationship was not different in the two groups ($Z = -0.34$, $p = 0.73$).

Discussion

The current results demonstrate two distinct types of boredom proneness; an apathetic boredom-prone state in which the individual is not motivated to engage in the environment and an agitated boredom-prone state characterised by a failure to be satisfied by the environment despite being motivated to engage. Boredom proneness was correlated with inattention, as characterised by lapses in attention, errors in everyday tasks and symptoms of ADHD. Importantly, the relationship between boredom and lapses in attention was entirely driven by the *apathetic* boredom-prone subtype, with no significant relationship evident between agitated boredom proneness and attention lapses. This suggests that previous work showing a relationship between boredom proneness and lapses in everyday attention (Cheyne et al. 2006; Carriere et al. 2008) taps into only one subtype of boredom proneness—apathetic boredom.

The only index from the SART which showed any relationship to boredom proneness was the sensitivity to having made an error (i.e. slowing of RTs post-errors) which was only evident after performing a median split on the BPS (Fig. 3). The failure to show stronger relationships between sustained attention and boredom may reflect the fact that laboratory tasks of this kind fail to capture the normal engagement with our surroundings in tasks of everyday life (i.e. low ecological validity;

Table 3 Data from the two boredom-prone groups on the BPS, CAARS-S, ARCES and MAAS

	BPS (total)	BPS (external stimulation)	BPS (internal stimulation)	CAARS-S	ARCES	MAAS
Agitated boredom prone	103.89 (11.72)	31.41 (6.6)	30.15 (4.54)	31.89 (10.12)	31.56 (4.97)	43.44 (8.75)
Apathetic boredom prone	87.52 (10.24)	21.93 (3.12)	31.63 (4.23)	22.26 (7.98)	34.67 (7.65)	47.96 (10.07)

Table 4 Group mean (±SD) similarity indices for the three blocks of the cognitive bias task (CBT)

	CBT		
	Similarity judgements	Dissimilarity judgements	Preference judgements
Apathetic boredom prone	204.58 (5.53)	85.58 (3.74)	194.88 (21.03)
Agitated boredom prone	200.89 (7.15)	86.37 (5.59)	177.95 (30.63)*

* Significant group difference at $p < 0.05$

Kingstone et al. 2008). Nevertheless, results showed that only LBP individuals were sensitive to having made commission errors (Fig. 3). The fact that HBP individuals were insensitive to errors mirrors the same finding in individuals suffering from traumatic brain injury (TBI; Kreutzer et al. 2001; Robertson et al. 1997). In other words, not only do TBI patients demonstrate higher levels of boredom proneness (Kreutzer et al. 2001), they are also insensitive to having made errors on the SART (Molenberghs et al. 2009; Robertson et al. 1997). It is worth noting here that the increased prevalence of attention lapses in the apathetic boredom-prone group (coupled with the failure to see any difference between the groups in SART error rates) may reflect a self-report bias. That is, the apathetic boredom-prone individuals may be more likely to *notice* errors in everyday attention (and certainly were more aware of having made errors on the SART as evidenced by post-error slowing of RT) and may therefore be more likely to *report* those errors. Further research would be needed to determine the influence of self-report biases of this kind, but what this hypothesis also suggests is that, like TBI patients, individuals prone to experiencing an agitated bored state may have less insight into their own behaviour (Goldberg et al. 1994; Kreutzer et al. 2001).

We found a strong relationship between boredom proneness and ADHD with HBP individuals reporting higher levels of adult symptoms of the disorder. Importantly, only those individuals demonstrating proneness to experiencing the *agitated* bored state showed significant correlations with both inattentive and hyperactive ADHD symptoms. It is important to note that these relationships cannot speak to directionality. That is, it is not possible to determine from the correlations we observed whether boredom proneness represents a core symptom of ADHD or is merely a consequence of other key symptoms of the disorder. It is also important to point out here that the current sample represents a group of healthy individuals (i.e. no participants had symptoms that would have led to a diagnosis of ADHD). One might hypothesise that the relationships observed here would be even stronger in a group of individuals diagnosed with adult ADHD. Further research will be needed to test this hypothesis. In addition, the relationships observed here may be driven to some extent by overlapping content in the items included on the BPS and the CAARS-S (notably, one of the CAARS-S items is 'I'm bored easily'!). With such a small sample, it is not possible to determine here the extent to which both scales essentially measure the same thing. Nevertheless, the high correlation between adult ADHD symptoms and agitated boredom-prone traits suggests an avenue for further research to determine the role played by this type of boredom in ADHD.

Although those individuals characterised as being prone to experiencing an agitated bored state showed a strong relationship with both hyperactive and inattentive ADHD symptoms, there was no relationship within this group for lapses in attention and everyday errors of attention. This may reflect the fact that the inattentive scale of the CAARS-S measures something very different from lapses in attention. What we are suggesting here is that the agitated boredom-prone state is characterised by high levels of motivation to engage in meaningful activities. Mindlessness (or the related state of mind wandering) as measured by both the ARCES and MAAS reflects almost the polar opposite of this state—while not genuinely apathetic, the mindless state is not connected to or motivated by a desire to engage in the external environment or task-relevant processing (Smallwood and Schooler 2006). This disconnection from the external environment (measured by such instruments as the MAAS) is distinct from a susceptibility to distraction that the inattentive subscale of the CAARS-S may tap into more directly. Similarly, while only the agitated boredom-prone group showed no sensitivity to having made errors of commission on the SART, there was no difference between the groups (i.e. agitated vs. apathetic boredom proneness) in terms of the mean amount of commission errors. One would expect that the apathetic boredom-prone individual would have higher commission error rates and perhaps slower RTs (in fact we have recently observed the latter pattern in another data set; Borman and Danckert, under consideration). The absence of these differences here may relate to the ecological validity (or lack thereof) of the SART (Kingstone et al. 2008). Alternatively, the SART and the various questionnaires used here may tap into different cognitive functions. One primary candidate may be impulsivity and/or susceptibility to distraction. In other words, the inattentive subscale of the CAARS-S may tap into increased levels of distractibility and not purely lapses in everyday attention, which may arise from mind wandering as opposed to distraction (Cheyne et al. 2006; Smallwood and Schooler 2006). The failure to slow RTs in response to an error of commission in the agitated boredom-prone group may represent an increased level of impulsivity. Certainly, a similar insensitivity to errors is seen following frontal lesions in which impulsivity is also a cardinal feature (Robertson et al. 1997). Of course, these are necessarily speculative hypotheses at this stage that would require direct experimental testing. In addition, the fact that there was no difference between the agitated and apathetic boredom-prone groups in the percentage of commission errors suggests that the SART may not have been the most sensitive attention test to discriminate between the two groups. We are in the process of contrasting sustained and transient measures of attention in high and low boredom-prone individuals using the Starry Night and Posner cuing tasks, respectively (Posner 1980; Rizzo and Robin 1990, 1996). One potential hypothesis is that the agitated boredom-prone individual may outperform the apathetic individual on *transient* measures of attention. That is, the agitated boredom-prone individual may be more easily able to *disengage* attention from transient stimuli and redirect attention to other events in the visual field. This is somewhat akin to the improved performance on transient measures of attention in experienced action video gamers (Chisholm and Kingstone 2012). This hypothesis will be borne out by further research.

Finally, HBP individuals showed a weaker preference for familiarity than did LBP individuals (Fig. 4 and Table 4). As a whole, the entire participant group showed a general propensity towards selecting familiar stimuli (i.e. target stimuli that had a high similarity index with respect to the probe; Fig. 1). This propensity was weaker in HBP individuals with a significantly lower similarity index observed in the agitated boredom-prone group (Table 4). In other words, the relationship shown here between cognitive bias and boredom proneness was entirely driven by individuals characterised as prone to experiencing the agitated bored state. These individuals are motivated to engage in meaningful activities and are more likely to seek novel stimuli in pursuit of that goal despite the fact that their attempts fail to produce an appropriate level of stimulation to stave off boredom.

Future research examining the relationship between boredom and attention should attempt to directly manipulate the bored state through mood induction techniques, as this will avoid the pitfalls of the self-report measures used here. That is, self-report measures of the kind used here are subjective to an individual's own biases in perception and recollection of events. We recently made use of a video mood induction technique to reliably induce a state of boredom (i.e. individuals watched a movie of two men hanging laundry for $\sim$3 min; the movie had been validated in an on-line study and shown to reliably induce a state of boredom; Merrifield et al., under consideration). Of course, such an approach will also need to determine the relationship between state boredom and trait boredom proneness.

In summary, we demonstrated that individuals who experience high levels of boredom proneness can best be characterised by one of two states—an apathetic versus an agitated boredom-prone state. These states display unique profiles with regard to attention, affect and novelty seeking. Apathetic boredom-prone individuals report a lack of interest in activities but feel no compulsion to redress that situation. They show a strong tendency towards lapses in attention and everyday failures of cognition. In contrast, agitated boredom-prone individuals are motivated to engage in their environment and are therefore more attentive (i.e. showing no relationship with lapses in attention or failures of everyday attention). These individuals are more likely to seek out novel stimuli and report high levels of symptoms of adult ADHD (particularly hyperactive symptoms). These results have important implications for our understanding of the subjective experience of boredom especially in populations that experience higher than normal levels of the emotion (e.g. ADHD and TBI).

References

Ahmed SMS (1990) Psychometric properties of the Boredom Proneness Scale. Percept Mot Skills 71:963–966

Antony MM, Bieling PJ, Cox BJ, Murray WE, Swinson RP (1998) Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and community sample. Psych Assess 2:176–181

Barkley RA (2006) The nature of ADHD: attention-deficit hyperactivity disorder. A handbook for diagnosis and treatment, 3rd edn. Guilford Publications, NY

Bracke P, Verhaeghe M (2010) Structural determinants of boredom among the clients of psychosocial and vocational rehabilitation centers. J Appl Soc Psych 40:1969–1998

Brown KW, Ryan RM (2003) The benefits of being present: mindfulness and its role in psychological well-being. J Pers Soc Psych 84:822–848

Carriere JSA, Cheyne JA, Smilek D (2008) Everyday attention lapses and memory failures: the affective consequences of mindlessness. Conscious Cogn 17:835–847

Cheyne JA, Carriere JS, Smilek D (2006) Absent-mindedness: lapses of conscious awareness and everyday cognitive failures. Conscious Cogn 15:578–592

Chisholm JD, Kingstone A (2012) Improved top-down control reduces oculomotor capture: the case of action video game players. Atten Percept Psychophys 74:257–262

Conners CK, Erhardt D, Sparrow MA (2003) Conners' adult ADHD Rating Scales (CAARS). Arch Clin Neuropsych 18:431–437

DeCoster J (2007) Applied Linear Regression Notes set 1. Retrieved May, 1st, 2012 from http://www.stat-help.com/notes.html

Farmer R, Sundberg ND (1986) Boredom proneness: the development and correlates of a new scale. J Pers Assess 50:4–17

Goldberg E, Podell K (2000) Adaptive decision making, ecological validity, and the frontal lobes. J Clin Exp Neuropsych 22:56–68

Goldberg E, Harner R, Lovell M, Podell K, Riggio S (1994) Cognitive bias, functional cortical geometry, and the frontal lobes: laterality, sex, and handedness. J Cogn Neurosci 6:276–296

Goldberg Y, Eastwood J, LaGuardia J, Danckert J (2011) Boredom: an emotional experience distinct from apathy, anhedonia or depression. J Soc Clin Psych 30:646–665

Greenson RR (1951) Apathetic and agitated boredom. Psychoanalytic Quart 20:346–347

Kass SJ, Vodanovich SJ, Callander A (2001) State-trait boredom: the relationship to absenteeism, tenure and job satisfaction. J Bus Psych 16:317–327

Kass SJ, Wallace C, Vodanovich SJ (2003) Boredom proneness and sleep disorders as predictors of adult attention deficit scores. J Att Dis 7:83–90

Kingstone A, Smilek D, Eastwood JD (2008) Cognitive ethology: a new approach for studying human cognition. Br J Psychol 99:317–340

Kooij SJ, Bejerot S, Blackwell A, Caci H, Casas-Brugue M, Carpentier DE et al (2010) European consensus statement on diagnosis and treatment of adult ADHD: the European network adult ADHD. BMC Psychiatry 10(67):1–24

Kreutzer JS, Seel RT, Gourley E (2001) The prevalence and symptom rates of depression after traumatic brain injury: a comprehensive examination. Brain Inj 15:563–576

Mikulas W, Vodanovich S (1993) The essence of boredom. Psych Record 43:3–12

Molenberghs P, Gillebert CR, Schoofs H, Dupont P, Peeters R, Vandenberghe R (2009) Lesion neuroanatomy of the sustained attention to response task. Neuropsychologia 47:2866–2875

Munsterberg H (1913) Psychology and industrial efficiency. Houghton-Mifflin, Boston, Massachusetts

O'Hanlon JF (1981) Boredom: practical consequences of a theory. Acta Psychol 49:53–82

Pekrun R, Daniels LM, Goetz T, Stupnisky RH, Perry RP (2010) Boredom in achievement settings: exploring control-value antecedents and performance outcomes of a neglected emotion. J Educ Psych 102:531–549

Posner MI (1980) Orienting of attention. Quart J Exp Psych 32:3–25

Rizzo M, Robin DA (1990) Simultagnosia: a defect of sustained attention yields insight on visual information processing. Neurology 40:447–455

Rizzo M, Robin DA (1996) Bilateral effects of unilateral visual cortex lesions in humans. Brain 19:951–963

Robertson IH, Manly T, Andrade J, Baddeley BT, Yiend J (1997) Oops!: performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. Neuropsychologia 35:747–758

Smallwood J, Schooler JW (2006) The restless mind. Psychol Bull 132:946–958

Todman M (2003) Boredom and psychotic disorders: cognitive and motivational issues. Psychiatry 66:146–167

Vodanovich SJ (2003) Psychometric measures of boredom: a review of the literature. J Psychol 137:569–595

Vodanovich SJ, Kass SJ (1990) A factor analytic study of the boredom proneness scale. J Pers Assess 55:115–123

Vodanovich SJ, Wallace JC, Kass SJ (2005) A confirmatory approach to the factor structure of the Boredom Proneness Scale: evidence for a two-factor short form. J Pers Assess 85:295–303

Zuckerman M (1992) Dimensions of sensation seeking. J Consult Clin Psych 36:45–52