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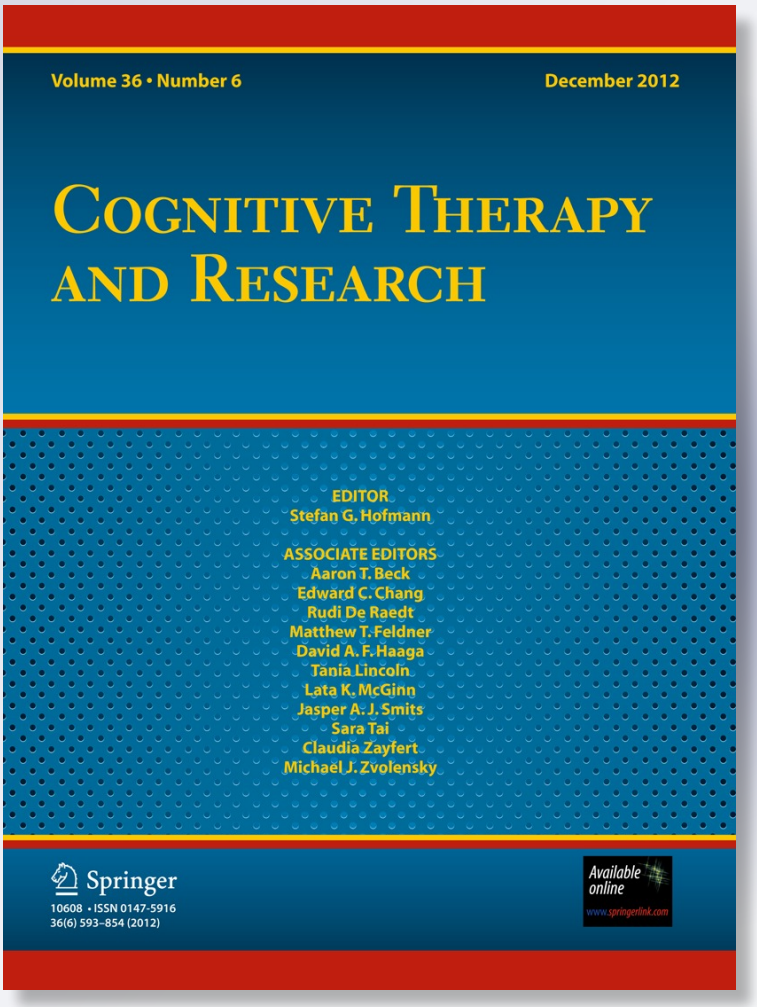

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BRIEF REPORT

Perceived Stress, Anhedonia and Illusion of Control: Evidence for Two Mediational Models

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Abstract Illusion of control (IOC) refers to the perception that one has control over an outcome that is, in actuality, uncontrollable; low IOC has been linked to depression. Prior studies in depression have mostly assessed IOC using paradigms involving positive outcomes, suggesting that IOC might be influenced by anhedonia. Recent evidence indicates that anhedonia, in turn, is linked to stress. To clarify such links, we examined putative relationships among perceived stress, anhedonia, and IOC (as assessed by a non-contingency task) in 63 participants. Perceived stress and anhedonia, but not general depressive symptoms, were associated with reduced IOC. Moreover, anhedonia fully mediated the relationship between stress perception and IOC, and perceived stress partially mediated the relationship between IOC and anhedonia. Findings suggest that (1) IOC is integrally related to hedonic capacity, (2) reward processing deficits may promote reduced IOC, and/or (3) a low IOC may promote depression via anhedonia-related mechanisms.

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Keywords Illusion of control · Reward · Stress · Depression · Anhedonia

Abbreviation
IOC Illusion of control

Introduction

People often overestimate the control they have over outcomes (Langer 1975). High illusion of control (IOC)—i.e., the belief that one has control over an outcome that is, in actuality, uncontrollable—has been associated with happiness, motivation, effective task performance, and adaptive coping to stressful events (Taylor and Brown 1988; Thompson et al. 2004). Low IOC, on the other hand, has been linked to major depressive disorder (MDD) and elevated depressive symptoms (Alloy and Abramson 1979; Alloy and Clements 1992; Thompson et al. 2004). It has been suggested that the perception that one's actions influence outcomes may prevent despair during stress and encourage motivated behavior to cope (Alloy and Abramson 1979; Alloy and Clements 1992). Consistent with this argument, low IOC has been associated with increased negative affect following failure, perceptions that negative life events are discouraging, as well as future depressive symptoms, suggesting that it may provide a cognitive diathesis that may promote the depressogenic effects of stress (Alloy and Clements 1992). However, what may contribute to differences in IOC and how IOC may be linked to depressive symptoms remain unknown.

Findings of reduced IOC in depression have led researchers to postulate that individuals with depression perceive the world in a more accurate fashion than

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nondepressed counterparts, a phenomenon known as *depressive realism* (Alloy and Abramson 1979; Soderstrom et al. 2011; but see Carson et al. 2010). Importantly, research associating reduced IOC with depression has relied almost exclusively on positive outcomes (e.g., monetary gains; Thompson et al. 2004). In fact, the only study we are aware of that used both positive (i.e., monetary gains) and negative (i.e., monetary losses) outcomes (Experiment 3; Alloy and Abramson 1979) found that, relative to controls, depressed participants had reduced IOC to positive, but not negative outcomes. Alongside this evidence, research suggests that individuals with depressive symptoms overestimate the occurrence of negative future events (Strunk et al. 2006). In light of this research, it is unclear whether reduced IOC, as typically studied in relation to positive outcomes, reflects a general accurate perception of the world (i.e., depressive realism; Alloy and Abramson 1979) or may be more specifically related to, or even an artifact of, reward processing dysfunction characteristic of the disorder (Henriques et al. 1994; Dunn et al. 2009).

Of note, a wealth of non-human animal research inspired by the learned helplessness model of depression suggests that stress, particularly when uncontrollable, induces behavioral despair (Maier and Watkins 2005). Speculatively, low IOC has face validity as a perceptual/psychological homolog to behavioral despair demonstrated in animal studies. Hence, stress may be associated with the development of reduced IOC in humans which may, in turn, promote the development of depressive symptoms. In this conceptualization, low IOC might be a consequence of stress (promoting the development of depression), rather than, or in addition to, a diathesis (see Monroe et al. 2007 for similar arguments with respect to other depressotypic cognitive biases).

Of particular relevance to the present study, research suggests that stress reduces hedonic capacity and reward responsiveness (Berenbaum and Connelly 1993; Bogdan and Pizzagalli 2006). Moreover, elevated perception of real-world life stress has been associated with blunted reward responsiveness (Pizzagalli et al. 2007). As such, stress may be associated with reduced IOC via mediating effects of stress-induced anhedonia (Fig. 1a). Additionally, and consistent with theoretical arguments, reduced IOC may constitute a cognitive diathesis for the depressogenic effects of stress (Alloy and Clements 1992). In this framework, low IOC may increase stress perception by reducing perceptions of one's ability to influence the situation, which may, in turn, foster the development of anhedonia (Fig. 1b).

The Present Study

The present study had three primary goals: (1) to clarify associations between self-reported stress perception, anhedonic symptoms, and IOC; (2) to test whether stress-related reductions in IOC in relation to positive outcomes may be mediated by anhedonic symptoms (Fig. 1a); and/or (3) to test whether the relationship between IOC and positive outcomes and anhedonia may be mediated by stress (Fig. 1b). To this end, participants completed a widely used non-contingency task to elicit a measure of IOC to positive outcomes (Alloy and Abramson 1979) and completed self-report measures.[1] We had three primary hypotheses. First, we predicted that increased stress perception would be associated with reduced IOC. Second, in light of evidence that depression is associated with reduced IOC in response to positive but not negative outcomes (Study 3; Alloy and Abramson 1979) and that stress is associated with reward processing deficits (Bogdan and Pizzagalli 2006; Pizzagalli et al. 2007), we hypothesized that anhedonic symptoms would be associated with reduced IOC and more importantly, would mediate the relationship between stress and IOC. Third, consistent with theoretical arguments that low IOC may be a diathesis for

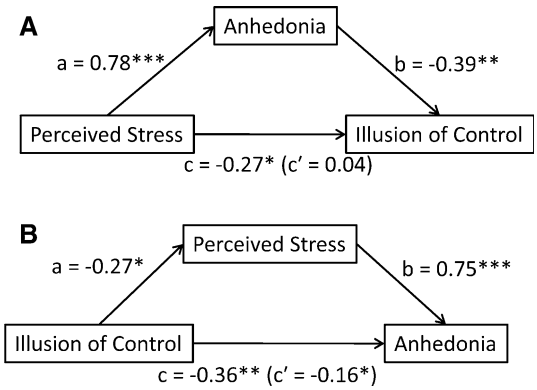

Fig. 1 Hypothesized meditational models between stress, IOC, and anhedonia. **a** Anhedonia (as measured via the MASQ) fully mediates the relationship between perceived stress (as measured by the PSS) and IOC. **b** Perceived stress (as measured by the PSS) partially mediates the relationship between IOC and anhedonia. Path values represent standardized regression coefficients (unstandardized coefficients are presented in text). Bootstrapping and causal path analyses suggest mediation in both models. $^{*}P < .05$; $^{**}P < .01$; $^{***}P < .001$

[1] One additional goal of the present study was to investigate whether an acute laboratory stressor (threat-of-shock manipulation) affected IOC, and further modulated relationships among perceived stress, IOC, and anhedonia. To this end, participants completed the non-contingency task under a stress, i.e., threat-of-shock (no actual shock was delivered), and no-stress condition (counterbalanced across participants). Unexpectedly, and contrary to prior studies using similar threat-of-shock manipulations (e.g., Bogdan and Pizzagalli 2006; Grillon et al. 1993), self-report measures of anxiety and mood as well as skin conductance measurements revealed that the acute stress manipulation was unsuccessful. Based on these null findings, the acute stress manipulation was not further considered, and IOC scores were averaged across conditions for further analyses. IOC scores in the no-stress and stress condition were strongly correlated ($r = .68$, $P < .01$).

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depression and evidence that stressor controllability plays an important role in the depressogenic effects of stress and in particular the development of anhedonia (Anisman and Matheson 2005; Maier and Watkins 2005), we hypothesized stress perception would mediate relationships between IOC and anhedonic depressive symptoms.

Methods

Participants

Participants ($n = 75$) were recruited through the Harvard University Psychology Department study pool and community advertisements, and had not participated in any prior study from our laboratory. Twelve participants were excluded due to endorsement of exclusionary factors known to influence reward processing including: tobacco use ($n = 5$), psychotropic medication ($n = 2$), and ADHD ($n = 1$). In addition, four additional participants were excluded due to left handedness ($n = 2$) and task non-compliance ($n = 2$). Hence, the final sample included 63 participants (age: M = 20.86, SD = 2.24; 57.14% female, 66.67% Caucasian). All participants were 18–28 years of age, and reported to be right-handed, non-smokers, with normal or corrected-to-normal vision, and free of any past or present neurological or psychiatric illness. Participants were paid $17 in total ($5 for participation + $12 in "earnings" from the non-contingency tasks). The study was approved by the Committee on the Use of Human Subjects in Research at Harvard University.

Procedure

After providing written informed consent, participants completed a non-contingency task under a stress, i.e., threat-of-shock, and no-stress condition. Condition order was counterbalanced across participants (see footnote 1). Between conditions, participants completed a variety of questionnaires assessing depressive and anxious symptomatology and stress, including the Beck Depression Inventory-II (BDI-II; Beck et al. 1996), Mood and Anxiety Symptom Questionnaire (MASQ; Watson et al. 1995), the trait version of the Positive and Negative Affect Schedule (PANAS; Watson et al. 1988), and the Perceived Stress Scale (PSS; Cohen et al. 1983).

Non-Contingency Task

Non-contingency tasks assess the degree of control individuals believe to possess over outcomes that are actually uncontrollable. The non-contingency task was modeled after Alloy and Abramson (1979). After reading instructions (participants were told that after task completion they would be asked to report how much control they had over outcomes), participants were given 10 practice trials before completing 40 experimental trials. Each trial began with a fixation cross presented for 1 s. Next, "Begin" appeared for 1 s, followed by a blank screen for 2 s. Participants were instructed to either press or not press the space bar with their right hand immediately after "Begin" appeared and were provided with a 3 s window to respond. Following the blank screen, an outcome screen (either three yellow "O"s or three blue "X"s) appeared for 1.5 s. Consistent with previous studies (e.g., Alloy and Abramson 1979, Experiment 3 and 4; Alloy and Clements 1992; Thompson et al. 2004), participants were instructed that one outcome (either OOO or XXX; letter and color counterbalanced across participants) was a success and that they would receive $.20 each time it appeared. Following the presentation of a successful outcome, "You won 20 cents!" was displayed for 1.5 s. If the outcome was unsuccessful, the next trial began immediately after the presentation of the three letters.

Critically, there was no contingency between outcomes and participants' behavior. To maximize IOC ratings: (1) a 75% (success)–25% (failure) reinforcement rate was implemented for both button press and no-button press trials (Thompson et al. 2004; Alloy and Abramson 1979, Experiment 2), and (2) successes were rewarded monetarily (Alloy and Abramson 1979, Experiment 3). After completing the non-contingency task, participants reported the degree of control their actions had on the appearance of the success outcome on a scale from 0 (i.e., *no control*) to 100 (i.e., *complete control*), which was the primary variable of interest.

Self-Report Questionnaires

The Perceived Stress Scale (PSS; Cohen et al. 1983) instructs participants to appraise how unpredictable, uncontrollable and stressful their daily life was in the preceding week. It was selected because it is a widely used and well-validated measure of stress perception; it is heritable and has been linked to stress hormones, illness and physiological response (Cohen et al. 1983; Ebrecht et al. 2004; Federenko et al. 2006). The Beck Depression Inventory-II (Beck et al. 1996) is a reliable and validated measure of depressive symptomatology. The Mood and Anxiety Symptom Questionnaire (MASQ; Watson et al. 1995) is a well-validated measure of anxiety and depressive symptoms; it yields four subscales assessing symptoms specific to anxiety (Anxious Arousal, AA), or depression (Anhedonic Depression, AD) as well as non-specific depression and anxiety related symptoms (General Distress Anxiety, GDA and General Distress Depression, GDD). The trait version of the Positive and Negative Affect Schedule (PANAS; Watson et al. 1988) was

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administered to assess dispositional positive (PA) and negative (NA) affect. In the present sample, all scales showed excellent reliability (Cronbach's α for: PSS = .89; BDI-II = .94; MASQ AA = .86; MASQ AD = .94; MASQ GDA = .83; MASQ GDD = .94; PANAS PA = .93; PANAS NA = .86).

Statistical Analyses

Pearson's correlations were run to evaluate the relationship between IOC and the following measures: depressive symptoms (BDI-II, MASQ AD and MASQ GDD), anxiety symptoms (MASQ AA, MASQ GDA), positive and negative affect (PANAS PA and NA), and perceived stress (PSS). To test whether reward processing deficits mediated the relationship between stress and IOC, we used: (1) the causal steps method (Baron and Kenny 1986) and (2) non-parametric bootstrapping using 10,000 resamples (Preacher and Hayes 2004). In the causal steps method (see Fig. 1a), we used linear regressions to determine whether: (1) stress perception was related to IOC (path c), (2) stress perception was related to AD (path a), (3) anhedonia was related to IOC (path b), and (4) the prediction of IOC by stress perception became non-significant when AD was entered separately with PSS (path c′). Bootstrapping approaches test for mediation by describing the confidence intervals of indirect effects while making no assumptions about the distribution of indirect effects (Preacher and Hayes 2004). The results of bootstrapping are interpreted by determining whether the 95% confidence interval includes 0; a confidence interval not including 0 would indicate significant mediation. Similar analyses were used to examine whether PSS mediated the relationship between IOC and AD scores (see Fig. 1b).

Results

As hypothesized, IOC ratings were negatively correlated with PSS scores ($r = -.27$, $P = .04$, Fig. 2a) and MASQ AD scores ($r = -.36$, $P = .004$, Fig. 2b) and positively correlated with trait PANAS positive affect ($r = .30$, $P = .02$). IOC ratings were not correlated with trait PANAS negative affect ($r = .13$, $P = .32$), BDI scores ($r = -.05$, $P = .69$), AA (MASQ AA; $r = .15$, $P = .23$) or GDA or depression (GDA: $r = .10$, $P = .42$; GDD: $r = -.09$, $P = .51$). Highlighting the specificity of these associations, a hierarchical regression predicting IOC ratings with BDI-II, MASQ AA, GDA, and GDD scores entered in the first step and PSS scores in the second step yielded a significant overall model, $F(5,56) = 3.42$, $P = .01$. More importantly, after accounting for MASQ AA, GDA, and GDD as well as BDI-II scores, PSS scores continued to predict reduced IOC,

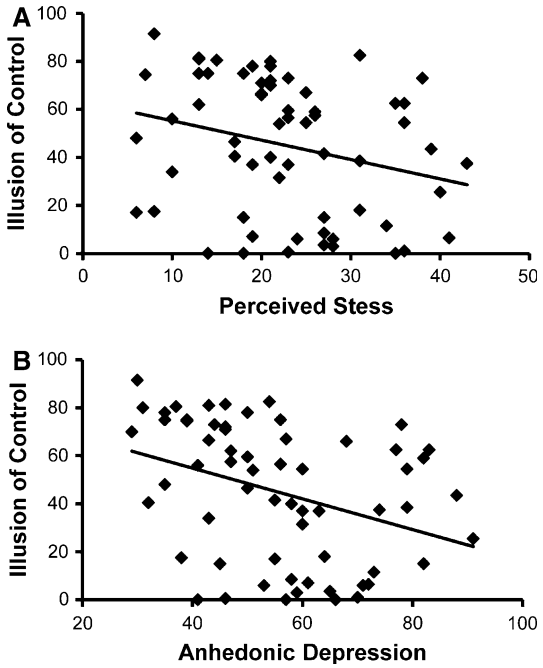

Fig. 2 Overall effect of PSS on IOC. **a** *Scatterplot* of the negative correlation between IOC and PSS, $r = -.27$, $P = .04$. **b** *Scatterplot* of the negative correlation between IOC and MASQ AD, $r = -.36$, $P = .004$

$\Delta R^2 = .13$, $\Delta F(1,56) = 9.55$, $P = .003$. MASQ AD scores were excluded from this model due to the hypothesized meditational effect tested later. Similarly, a hierarchical regression with MASQ AA, GDA, and GDD as well as BDI total entered in the first step and MASQ AD entered in the second step produced a significant model, $F(5,57) = 3.74$, $P = .005$, indicating that elevated MASQ AD continued to predict reduced IOC after accounting for these other mood measures, $\Delta R^2 = .17$, $\Delta F(1,57) = 12.74$, $P = .001$. PSS scores were excluded from this model due to the hypothesized meditational effect tested later.

Using two separate tests of mediation, we evaluated whether: (1) anhedonia mediated the relationship between PSS and IOC, and/or (2) PSS mediated the relationship between IOC and anhedonia. Evidence of mediation was found for both models. Specifically, anhedonic symptoms fully mediated the relationship between PSS and IOC (Fig. 1a, indirect effect −.93, bias-correcting bootstrapping 95% confidence interval {−1.71, −.05}; unstandardized regression coefficients: $a = 1.33$, $P < .0001$; $b = -.69$, $P < .05$; $c = -.81$, $P < .04$; $c' = .12$, $P = .84$). The relationship between anhedonic symptoms and IOC was partially mediated by PSS (Fig. 1b, indirect effect −.11, bias-correcting bootstrapping 95% confidence interval {−.21, −.02}; unstandardized regression coefficients: $a = -.09$, $P < .04$; $b = 1.26$, $P < .0001$; $c = -.20$, $P < .01$; $c' = -.09$, $P = .05$).

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Discussion

Our three primary goals were to assess: (1) putative relationships among stress, anhedonia, and IOC, (2) whether anhedonic symptoms mediated the relationship between stress and IOC, and (3) whether stress mediated the relationship between IOC and anhedonic symptoms. Results confirm that elevated levels of PSS and anhedonia are associated with reduced IOC. Most interestingly, this study found support for two independent, but not mutually exclusive, meditational models. First, anhedonia fully mediated the relationship between PSS and IOC. Second, PSS partially mediated the relationship between IOC and anhedonia. In light of research suggesting that stress can reduce reward processing (Anisman and Matheson 2005; Berenbaum and Connelly 1993; Bogdan and Pizzagalli 2006), anhedonia is a promising mediating mechanism underlying the association between stress, reduced IOC, and depressive symptoms (Fig. 1a). Furthermore, consistent with theoretical speculations that low IOC may reduce an individual's ability to effectively confront stress (Alloy and Abramson 1979; Alloy and Clements 1992), a low IOC may promote increased stress perception which may, in turn, lead to anhedonic symptoms (Fig. 1b).

Reward, Stress and IOC

A low IOC has been associated with depression as well as maladaptive responses to stressors (Alloy and Clements 1992; Thompson et al. 2004). Consistent with non-human animal research suggesting that stress induces behavioral despair (Maier and Watkins 2005), as well as theoretical speculations that low IOC may leave individuals vulnerable to depressogenic effects of stress (Alloy and Clements 1992), elevated perceptions of life stress and anhedonic symptoms were associated with reduced IOC (Fig. 1). Due to the correlational and cross-sectional nature of the current study, the directional nature of these relationships cannot, however, be determined.

On one hand, stress promotes the development of anhedonic symptoms and behavior (Berenbaum and Connelly 1993; Bogdan and Pizzagalli 2006), which may in turn reduce one's perceptions that he/she is contributing to positive environmental outcomes (i.e., low IOC to positive outcome). Consistent with this interpretation, anhedonic symptoms mediated the relationship between PSS and IOC. Thus, alongside recent research (Carson et al. 2010), in the case of depression, reduced IOC may not reflect a general reduction in perception of agency, but rather a specific reduction in agency perception in relation to positive outcomes. Of note, the only study we are aware of using negative outcomes found no differences between individuals with depression and healthy controls (Experiment 3; Alloy and Abramson 1979). Given that depression is characterized by anhedonia and that cognitive theories hypothesize that depression is associated with a reduced interpretation that positive events are the result of one's own actions (but elevated perception that negative events are the result of one's own actions) (Beck 2005), the results of this study highlight the possibility that reduced IOC and related cognitive biases may be a downstream consequence of dysfunctional reward processing (stress-induced or otherwise). This interpretation is consistent with recent research suggesting that a positivity self-judgment bias is uniquely related to anhedonic symptoms of depression (Dunn et al. 2009).

On the other hand, a low IOC may promote stress perception by reducing one's perception of his/her ability to confront stressors, which may, in turn, result in anhedonic symptoms. This interpretation is consistent with theoretical speculation that a low IOC provides a diathesis for depression (Alloy and Clements 1992). Interestingly, and inconsistent with previous research (e.g., Alloy and Clements 1992), we failed to observe a relationship between IOC and general depressive symptoms; this highlights possible specificity linking low IOC to anhedonic symptoms, which may, in turn, promote the development of additional depressive symptoms.

Limitations and Future Directions

The limitations of this study warrant attention. First, one of our goals was to investigate whether an acute laboratory stressor further modulated links among PSS, anhedonia, and IOC. Unfortunately, in contrast to previous studies (e.g., Bogdan and Pizzagalli 2006; Grillon et al. 1993), the laboratory stress manipulation (threat-of-shock) was unsuccessful, precluding us from evaluating the additional role of acute stress on study variables (see footnote 1). Second, the PSS provides a valid measure of stress perception; however, this measure assesses the degree to which individuals believe they have control over stressful experiences. As such, it is possible that the PSS measure itself contains elements of IOC which might affect associations between PSS and IOC. Third, we evaluated IOC only in the context of positive outcomes to test hypotheses regarding the role of anhedonia and stress perception in its expression. It will be important for future studies to evaluate IOC in the context of both positive and negative outcomes and to examine if anhedonia, or other depressive symptoms (e.g., sad mood), are specifically related to individual differences in IOC in the context of negative outcomes. Finally, while the results of mediation analyses are consistent with two independent, but not mutually exclusive hypotheses, the causal relationship of PSS, anhedonia and IOC cannot be inferred due to the cross-sectional design. Future studies will be needed before definitive causal interpretations can be advanced.

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Conclusions

This study is the first to show associations among IOC, stress perception, and anhedonia. Furthermore, the current findings suggest that anhedonia mediates the relationship between PSS and IOC and that stress perception mediates the relationship between IOC and anhedonia. Thus, two promising and not mutually exclusive mechanisms suggest that: (1) stress may induce anhedonic-like behavior which may blunt IOC in regard to positive outcomes, and (2) a low IOC may predispose individuals to the depressogenic effects of stress. These findings have important implications for the conceptualization of the IOC construct and suggest that reduced IOC to positive outcomes may reflect a downstream consequence of reward processing dysfunction and/or that IOC may leave individuals vulnerable to the development of depression via anhedonia-related mechanisms. Regardless of the interpretation, the results of this study suggest that stress, anhedonic symptoms and IOC are integrally related. It will be important for future research to utilize validated laboratory stress manipulations and longitudinal study designs to infer directional relationships among these important variables.

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