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Deficient fear conditioning and self-reported psychopathy: The role of fearless dominance

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Abstract

The role of the two dimensions of psychopathy —dispositional fearlessness (theorized to reflect variations in reactivity of the brain's defensive system) and externalizing proneness (presumed to reflect variations in function of anterior regulatory systems)— in fear learning was examined in a sample of undergraduates assessed using the Psychopathic Personality Inventory-Revised (PPI-R) who participated in a differential aversive conditioning task. Only scores on self-reported 'fearless dominance' —irrespective of scores on 'impulsive antisociality'— were related to diminished acquisition of physiological fear. Consistent with dual-process accounts of psychopathy proposing divergent etiological pathways for the interpersonal/affective and the social deviance features of the disorder, our results lend support to the existence of a deficit in reactivity of the brain's defensive system underlying the fearlessness dimension of psychopathy.

Keywords: Psychopathy, Aversive conditioning, Skin conductance, Psychopathic Personality Inventory-Revised, Fearlessness

Deficient fear conditioning and self-reported psychopathy: The role of fearless dominance

Psychopathy is a severe personality disorder that is marked by interpersonal/affective traits such as emotional detachment, callousness, grandiosity, glibness, and lack of empathy, along with antisocial deviance features including poor behavioral controls, impulsivity, and irresponsibility (Cleckley, 1941/1976; Hare, 1991, 2003). One of the classic theoretical approaches to explaining psychopathy is the low fear hypothesis (cf. Lykken, 1957). Mainly based on research with criminal populations, the low fear hypothesis considers deficient emotional responding to aversive stimulation as the core underlying substrate for the disorder (Fowles, 1980; Hare, 1965; Hare & Quinn, 1971; Lykken, 1957). Consistent with this hypothesis, empirical studies have demonstrated deficient acquisition of fear-conditioned responses in psychopathy (Birbaumer et al., 2005; Flor, Birbaumer, Hermann, Ziegler, & Patrick, 2002), providing evidence that this deficiency reflects impairments on an affective-evaluative level (i.e., psychopathic participants do not form emotional associations between the cue and the noxious event) as opposed to a cognitive-information-processing level (i.e., psychopaths display adequate evaluation of and reactivity to noxious stimuli themselves). In addition, research focusing on the neural systems known to be involved in emotional learning (i.e., the limbic-prefrontal circuit; cf. Blair, 2008; LeDoux, 2000) has provided evidence of underactivity in structures including the left amygdala, the right ventromedial orbitofrontal cortex, the insula, the anterior cingulate cortex, and the right secondary somatosensory cortex in psychopathic individuals during the acquisition phase of a fear conditioning task (Birbaumer et al., 2005).

However, an important issue in need of empirical clarification is whether deficits in aversive learning are characteristic of psychopathy as a whole, as the original low fear hypothesis posits, or whether such deficits are tied more specifically to the interpersonal/affective features of psychopathy. This question arises from findings of research on emotional deficits in psychopathy and differential physiological correlates of the interpersonal/affective and antisocial deviance components of the disorder that suggest

distinctive etiological pathways for these two symptomatic components: the former entailing a weakness in the brain's defensive motivational system, and the latter an executive-regulatory deficit reflecting impairments in higher representational systems that serve to moderate primary motivational systems (Fowles & Dindo, 2006; Patrick, 2007). This *dual-process* (Patrick, 2007; Patrick & Bernat, 2009) or dual-pathway (Fowles & Dindo, 2009) conception of psychopathy posits largely independent dispositional dimensions of fear/fearlessness (more relevant to the interpersonal/affective component of psychopathy) and externalizing proneness (more relevant to the social deviance component).

From this standpoint, individuals high on both psychopathy dimensions would exhibit many features of each (e.g., emotional resilience and social assertiveness combined with reckless, unrestrained behavior), but certain individuals could also exhibit a selective elevation on one dimension or the other. This perspective has implications for conceptualizing noncriminal ('successful') versus criminal ('unsuccessful') psychopathy (Ishikawa, Raine, Lencz, Bihrle, & Lacasse, 2001; Hall & Benning, 2006): The noncriminal psychopath would be characterized by high levels of trait fearlessness but normal-range levels of traits related to externalizing behavior (Patrick, 2007). From this perspective, criminal and noncriminal psychopathy can be viewed as entailing a degree of etiological continuity, with diminished fear reactivity underlying the trait fearlessness features shared by the criminal and noncriminal manifestations of the disorder. Consistent with this idea, psychophysiological indices of low fear in psychopaths such as reduced fear-potentiated startle during aversive stimulation (Herpertz et al., 2001; Levenston, Patrick, Bradley, & Lang, 2000; Pastor, Moltó, Vila, & Lang, 2003) have been associated specifically with the interpersonal/affective traits of the disorder — but not with its social deviance features— in both incarcerated (Patrick, 1994; Patrick, Bradley, & Lang, 1993; Poy et al., 2009; Vaidyanathan, Hall, Patrick, & Bernat, 2011) and nonincarcerated populations (Benning, Patrick, & Iacono, 2005; Dvorak-Bertsch, Curtin, Rubinstein, & Newman, 2009; Vanman, Mejia, Dawson, Schell, & Raine, 2003).

Recently, research on noncriminal psychopathy has dramatically increased in an effort to address fundamental questions regarding the etiological continuity of the differing phenotypic

manifestations of psychopathy (Hall & Benning, 2006). However, generalizing results about fear learning deficits observed in criminal psychopaths to noncriminal psychopaths is still problematic. Most of the research on deficient fear learning in psychopathy has focused on incarcerated samples, and the only study involving nonincarcerated psychopaths (cf. Flor et al., 2002) is limited by the use of a highly antisocial sample and of an unpleasant odor as unconditioned stimulus, hence examining aversive conditioning broadly rather than fear conditioning in particular.

To date, there have been no studies specifically designed to disentangle the differential contribution of the two dimensions of psychopathy to deficits in fear conditioning using aversive Pavlovian conditioning paradigms like those used in criminal psychopathy research (see Hare, 1965; Hare & Quinn, 1971; Lykken, 1957). Thus, a study examining fear learning in psychopathic individuals recruited from a nonincarcerated sample has the potential to yield valuable new insights into processes underlying the characteristic affective-interpersonal features of psychopathy.

Our study was conducted to replicate, in a mixed sample of undergraduates assessed for features of psychopathy, the finding of fear learning deficits previously reported in incarcerated psychopaths, and to explore the differential contributions of dispositional fearlessness and externalizing proneness to this deficit. To accomplish these objectives, we studied acquisition of fear in a sample of undergraduates assessed for psychopathy using the Psychopathic Personality Inventory-Revised (PPI-R; Lilienfeld & Widows, 2005). Physiological (conditioned skin conductance change) and expressive report (valence, arousal, and contingency awareness ratings) indices of fear (Lang, 1968, 1993) were recorded during a differential fear conditioning task in which electric shocks served as the unconditioned stimulus (UCS), paralleling tasks used to study fear learning in incarcerated individuals (see, for example, Hare & Quinn, 1971).

Most research on aversive conditioning in psychopathy has been conducted with incarcerated, Caucasian men, making it difficult to generalize findings to more diverse samples. This issue has been pointed out as a limitation by several authors (Skeem, Polaschek, Patrick, & Lilienfeld, 2011; Vitale & Newman, 2001). Here, we used a mixed sample in an effort to

address this limitation in regard to gender. In addition, most fear conditioning studies in the literature involving nonclinical participants have included both men and women, but few have reported tests for gender effects on autonomic indices of fear conditioning. When reported, tests of gender effects have usually yielded nonsignificant results (see, for example, López, Poy, Pastor, Segarra, & Moltó, 2009; Zorawski, Cook, Kuhn, & LaBar, 2005). In view of this previous research, we did not expect to find overall gender differences in the pattern of fear conditioning in the present study. However, gender effects were nonetheless carefully evaluated in order to determine whether gender might possibly moderate predicted effects of psychopathy on aversive conditioning.

Two primary hypotheses were evaluated. First, we hypothesized that high psychopathy scores, as indexed by overall scores on the PPI-R, would be related to diminished acquisition of physiological conditioned fear in our sample of undergraduates, similar to findings in psychopaths from prison settings. Second, we hypothesized that psychopaths' deficient fear conditioning would be associated specifically with the dispositional fearlessness component of psychopathy as indexed by scores on the fearless dominance factor of the PPI-R, but unrelated to the externalizing proneness dimension of the disorder as indexed by scores on the impulsive antisociality factor of the PPI-R.

Method

Participants

Seventy-four volunteers (42 women) were contacted from a base sample of 337 undergraduates from the Universitat Jaume I of Castellón participating in a wider study about psychopathic traits and personality (for sample details, see Ross et al., 2007).

The Spanish adaptation of the Psychopathic Personality Inventory-Revised (PPI-R; Lilienfeld & Widows, 2005) was used to evaluate participants. This questionnaire has emerged as one of the best-validated and most widely-used contemporary instruments for dimensional assessment of psychopathy in community samples. Dimensional assessment of psychopathic characteristics is justified by available evidence supporting conceptualization of psychopathy as a dimensional rather than a categorical (taxonic) construct (see, for example, Edens, Marcus,

Lilienfeld, & Poythress, 2006). The PPI-R is a 154-item measure developed as a self-report assessment of the core personality traits of psychopathy. Items are answered using a four-point Likert scale (1 = *false*, 2 = *somewhat false*, 3 = *somewhat true*, 4 = *true*). This instrument provides a total psychopathy score and eight subscales scores, as well as scores on two uncorrelated factors identified from exploratory factor analysis of the subscales (Benning, Patrick, Hicks, Bloningen, & Krueger, 2003; Benning, Patrick, Salekin, & Leistico, 2005; Lilienfeld & Widows, 2005; Patrick, Edens, Poythress, Lilienfeld, & Benning, 2006; Ross, Benning, Patrick, Thompson, & Thurston, 2009). The PPI-R 'fearless dominance' factor reflects interpersonal/affective features of psychopathy such as assertiveness, persuasiveness, imperturbability, and venturesomeness; scores on this factor are obtained by summing scores on Social Potency, Stress Immunity, and Fearlessness subscales (Lilienfeld & Widows, 2005). The 'impulsive antisociality' factor encompasses tendencies related to social deviancy such as impulsivity, alienation, aggressiveness, and rule-breaking; scores on this factor are obtained summing scores on Carefree Nonplanfulness, Blame Externalization, Rebellious Nonconformity, and Machiavellian Egocentricity subscales (Lilienfeld & Widows, 2005). The eighth PPI-R subscale (Coldheartedness) does not load appreciably on either factor, thus tapping a distinct third dimension.

The translation and adaptation of the PPI-R to the Spanish population was performed as suggested in Hambleton & Patsula (1998), with the participation of several independent translators and a back-translation. For this Spanish-language adaptation of the PPI-R, α coefficients for overall, fearless dominance and impulsive antisociality scores were .92, .90, and .91, respectively; α coefficients for PPI-R subscales ranged from .82 (Carefree Nonplanfulness) to .89 (Machiavellian Egocentricity). Mean item-total correlations for overall, fearless dominance and impulsive antisociality scores were .28, .39, and .33, respectively. Mean item-total correlations for PPI-R subscales ranged from .39 (Carefree Nonplanfulness) to .53 (Fearlessness). Pearson correlations of PPI-R scores with criterion variables consisting of personality trait measures and indices of DSM-IV personality disorders in the current study sample (see Table 1) provide evidence for the construct validity of the Spanish version of the

PPI-R and the clinical relevance of high PPI-R scores. The comparable internal consistency of PPI-R scores for the Spanish version in relation to the North American version, along with the consistency of its relations with personality trait and personality disorder measures, support its reliability and validity for assessing psychopathy and its constituent facets in Spanish community settings.

Table 2 reports overall PPI-R, fearless dominance, and impulsive antisociality factor score means and standard deviations for the entire sample, and for men and women separately. Men and women differed significantly in overall PPI-R and Coldheartedness scores, ts(72) > 2.07, ps < .05, ds > 0.48, but not in FD and IA factor scores, ts(72) < 1.93, ps > .06, ds < 0.45. To correct for any possible contributory role of gender in observed relations between PPI-R scores and dependent measures (cf. Carlson, Thái, & McLarnon, 2009), raw PPI-R total and factor scores were standardized (converted to T scores) separately for men and women, using gender-specific means and standard deviations. All subsequent analyses were performed using these gender-corrected scores.

No participant was undergoing psychiatric or pharmacological treatment at the time of testing, and none presented visual or auditory deficits. All participants were informed about the nature of the study and provided informed consent.

Materials and Design

The differential aversive conditioning procedure consisted of 4 practice trials followed by habituation (1 block of trials), acquisition (2 blocks), and extinction (1 block) phases. During acquisition, presentations of the unconditioned stimulus (UCS) were paired with all presentations of the excitatory conditioned stimulus (CS+), whereas the inhibitory conditioned stimulus (CS-) was presented alone. No UCS was delivered during practice, habituation, or extinction phases.

Each block of trials consisted of 6 CS+ and 6 CS− presented in a pseudorandom order, with no more than two consecutive presentations of each CS type; practice trials consisted of 2 CS+ and 2 CS- presented in a pseudorandom order. Each trial consisted of an 8-s presentation of one of two neutral faces (CS) selected from the standardized NimStim Face Stimulus database

(codes 23_m_NE_C and 25_m_NE_C; McArthur Foundation Research Network on Early Experience and Brain Development). Specific faces that served as CS+/CS− were counterbalanced across subjects, and projected onto a screen (with a maximum size of 120 cm × 85 cm) using a Toshiba TLP-T50 slide projector. The UCS consisted of a 500-ms train of 0.5-ms electric shocks at a rate of 64 Hz, generated with a Digitimer DS7A stimulator, and was administered during the last 500 ms of CS+ presentation through an electrode attached on the inside of the upper right arm. A pretest workup procedure was used to set the intensity of electric shocks individually, at a level rated by each subject as "highly annoying but not painful"; the mean intensity of electric shocks administered was 5.61 mA (range = 2.2 to 13 mA). Intensity of electric shocks was not related to any psychopathy measure, $r(74) = -.04, .10,$ and $-.08$, $ps > .41$, for scores on overall PPI-R, fearless dominance, and impulsive antisociality, respectively.

Data Acquisition and Reduction

Stimulus presentation was controlled and physiological data acquired with a Compaq V70-compatible computer (VPM software; Cook, 2002).

Skin conductance (SC) was recorded using two standard Ag/AgCl electrodes (K-Y lubricating jelly) placed on the thenar and hypothenar eminences of the left hand palm, using a Coulbourn V71-23 Isolated SC Coupler. Activity was acquired at 20 Hz, and mean SC values were calculated offline as half-second bins. For assessing reactions to CSs and UCSs, each half-second was deviated from a pre-trial 1-s baseline. SC change (ΔμS) was defined as the maximum change in SC level occurring between 1 and 4-s after picture onset (CSs reactivity; cf. Bradley, Codispoti, Cuthbert, & Lang, 2001), and after UCS offset (UCSs reactivity). Raw SC change scores were logarithmically-transformed (log [SC+1]) to normalize the score distribution.

Valence and arousal ratings (scale = 1 to 9) of the CS+, CS- and UCS stimuli were collected from participants twice during the experiment —once before practice trials (pre-experimental) and again after the extinction phase[1] (post-experimental)— using a paper-and-pencil version of the Self-Assessment Manikin, a non-verbal pictorial assessment technique

(SAM; Bradley & Lang, 1994). Post-experimental contingency awareness was assessed by means of a recognition questionnaire that directed the participant to estimate the probability of occurrence (from 0% to 100%) of the UCS after each CS type.

Statistical Analysis

Skin conductance change. Analyses of SC change were conducted on data from 72 participants (41 women). The remaining two participants in the experimental sample were excluded due to SC recording problems.

The effect of psychopathy-related differences on SC reactivity to UCS was evaluated using zero-order correlations between PPI-R scores (overall, fearless dominance and impulsive antisociality) and the mean SC change to the UCSs delivered during the acquisition phase.

To test for psychopathy-related differences in reactivity to CS+ versus CS-, two sets of repeated measures general linear models (GLMs) were performed on SC change scores separately for each phase of the conditioning procedure. Hence, in one set, scores on overall PPI-R were included as continuous between-subjects factor. In the second set of analyses, scores on fearless dominance and impulsive antisociality were included concurrently as continuous between-subjects factors. Thus, for habituation and extinction phases, separate CS Type (CS+ vs. CS-) repeated measures GLMs were performed and for the acquisition phase, separate CS Type x Block (1st half, 2nd half) repeated measures GLMs were performed.

As expected, neither scores on the PPI-R overall nor scores on either PPI-R factor showed significant effects on mean SC reactivity to CS+ versus CS- during the habituation phase of the experiment ($ps > .28$, $\eta_p^2 s < .02$), and thus the Results section focuses on findings for the acquisition and extinction phases.

The relationship between SC conditioning and self-reported 'fearless dominance' and 'impulsive antisociality' was further examined using zero-order and partial correlations between scores on PPI-R factors and SC difference scores (CS+ minus CS-) across blocks, taking the CS+/CS- electrodermal difference as an index of differential conditioning (cf. Hamm & Vaitl, 1996). To evaluate the selectivity of the relationship to one PPI-R factor versus the other, Steiger's (1980) *t* test for dependent correlations was used. Additionally, following our

hypothesis, a three-step hierarchical linear regression model was performed on the mean CS+/CS- difference during the acquisition phase, in which gender and scores on PPI-R Coldheartedness were entered as predictors at step one, scores on impulsive antisociality were entered at step two, and scores on fearless dominance were entered at step three, thus allowing to evaluate the increase in variance explained by self-reported 'fearless dominance' above and beyond the other distinctive components of the PPI-R.

Self-report measures. The effect of psychopathy-related differences on subjective evaluations of the UCS was evaluated using zero-order correlations between PPI-R scores (overall, fearless dominance and impulsive antisociality) and mean valence and arousal ratings of the UCSs delivered during the acquisition phase.

To test for psychopathy-related differences on valence and arousal evaluations of CSs and in line with the analyses of SC change, two different sets of CS Type x Time (pre. vs. post-experimental) repeated measures GLMs were performed for each affective dimension (one set including scores on overall PPI-R as continuous between-subjects factor, and the other set concurrently including scores on fearless dominance and impulsive antisociality as continuous between-subjects factors). Post-experimental contingency awareness ratings were analyzed by means of separate CS Type repeated measures GLMs.[2]

Results

Skin Conductance Change

Reactivity to the UCS. Neither scores on overall PPI-R nor scores on PPI-R fearless dominance or impulsive antisociality showed significant correlations with mean SC change to the UCS, *r*s(72) = .01, -.12, and .08, respectively, *p*s > .33.

Overall PPI-R and reactivity to CSs. Table 3 presents the descriptive statistics for mean SC change in all experimental conditions (CS Type x Block). Significant CS Type main effects in acquisition and extinction phases, *F*s(1, 70) > 4.27, *p*s < .05, η_p^2s = .06, revealed that SC change was larger during CS+ than during CS- in both phases, demonstrating the effectiveness of the conditioning manipulation and the acquisition-extinction continuity in electrodermal conditioned responses. Scores on overall PPI-R did not show a significant relationship with SC

differentiation (CS+ versus CS-) during either acquisition or extinction phases (*p*s > .08, η_p^2s < .03).

PPI-R factors and reactivity to CSs. Interestingly, PPI-R factor GLMs revealed that fearless dominance scores moderated CS+/CS- differentiation for SC during the acquisition phase, Fearless Dominance x CS Type, $F(1,69) = 7.73$, $p < .01$, $\eta_p^2 = .10$, but not during the extinction phase ($F < 1$). By contrast, impulsive antisociality scores did not show a significant effect on SC differentiation (CS+ versus CS-) during either the acquisition or the extinction phase (*p*s > .07, η_p^2s < .05).

Zero-order and partial correlations between scores on each PPI-R factor and the CS+/CS- electrodermal difference across blocks clarified the above effects. Correlations and descriptive statistics for CS+/CS- electrodermal difference are presented in Table 4. Impulsive antisociality scores were not significantly related to CS+/CS- difference in any condition (*p*s > .10). However, consistent with the GLM results, fearless dominance scores were inversely related to CS+/CS- electrodermal differences in both halves of the acquisition phase. These relations were explained by change in skin conductance response to CS+ (Pearson correlations with fearless dominance scores of .25 and -.28, *p*s < .05, for the first and the second half of acquisition, respectively), but not to CS- (*p*s > .30). No significant correlations with skin conductance change to CS+ or CS- were found for impulsive antisociality scores, *r*s(72) < -.19, *p*s > .12. Moreover, as shown in Table 5, fearless dominance scores accounted for a significant proportion of variance in CS+/CS- electrodermal difference during acquisition (9.4%) when entered on the third step of the hierarchical regression model. Neither gender nor scores on PPI coldheartedness or impulsive antisociality contributed independently to the prediction of the dependent measure.

In order to make results more illustrative, participants were assigned to high (*n* = 36, 14 men) or low (*n* = 36, 17 men) fearless dominance subgroups according to whether their fearless dominance factor *T* score was above or below the median for the experimental sample (*Mdn* = 50.70).[3] Raw fearless dominance score means for these high and low groups fell into the highest and lowest quartiles, respectively, of the PPI-R American norms (Lilienfeld & Widows, 2005).

Thus, high fearless dominance scorers could in fact be considered highly fearless and socially dominant relative to unselected individuals from the general population. As expected, high and low fearless dominance groups differed significantly in their mean *T* scores on the fearless dominance factor, $M = 58.75$, $SD = 6.40$ for the high, and $M = 40.11$, $SD = 7.01$ for the low fearless dominance group, $t(70) = 11.78$, $p < .0001$, $d = 2.78$. Groups also differed in mean scores on the impulsive antisociality factor, $M = 56.20$, $SD = 11.64$ for the high, and $M = 47.71$, $SD = 12.12$ for the low fearless dominance group, $t(70) = 3.03$, $p < .005$, $d = 0.71$. Group differences in impulsive antisociality were statistically controlled by including scores on the impulsive antisociality factor of the PPI-R as a covariate in the analyses involving fearless dominance groups. Thus, corresponding differences in reactivity to CS+ versus CS- for fearless dominance groups during acquisition and extinction were evaluated using a Fearless Dominance group (high vs. low) x CS type x Block (acquisition: 1st half, 2nd half; extinction) ANCOVA, with scores on the impulsive antisociality factor included as a covariate. Figure 1 shows mean skin conductance change for high and low fearless dominance groups when viewing CS+ and CS- during acquisition and extinction phases of the fear conditioning procedure. A significant Fearless dominance group x CS type interaction was evident, $F(1, 69) = 11.66$, $p < .005$, $\eta_p^2 = .15$, reflecting a clear CS+/CS- electrodermal differentiation for the low fearless dominance group during the two halves of acquisition, ts$(35) > 3.42$, ps $< .005$, ds > 0.62, and also during extinction, $t(35) = 2.42$, $p < .05$, $d = 0.43$, as compared to a lack of CS+/CS- differentiation in the high fearless dominance group during these same blocks, ts$(35) = 1.53$, 1.98, and 0.21, respectively, ps $> .05$, ds < 0.33. Given that no significant effects of the covariate (impulsive antisociality factor scores) on skin conductance change were evident (all ps $> .16$, η_p^2s $< .03$), the observed physiological differences between high and low fearless dominance groups could not be attributed to differing levels of impulsive antisociality.

Self-Report Measures

Subjective evaluation of the UCS. Neither overall PPI-R scores nor scores on PPI fearless dominance or impulsive antisociality factors showed significant correlations with mean

valence or arousal ratings of UCS, valence: $r(74) = -.05$, $-.02$, and $-.08$, respectively, ps $> .50$; arousal: $r(74) = -.13$, $-.12$, and $-.10$, respectively, ps $> .27$.

Subjective evaluation of CSs. The mean values for valence, arousal, and contingency awareness ratings of CSs are also shown in Table 3. Significant CS Type x Time interactions for both valence, $F(1, 72) = 6.06$, $p < .05$, $\eta_p^2 = .08$, and arousal, $F(1, 70) = 6.69$, $p < .05$, $\eta_p^2 = .09$, revealed that, in the sample as a whole, the CS+ showed a significant increase in rated aversiveness and arousal after conditioning relative to the CS-. In addition, the CS+ was rated as more predictive of the UCS than was the CS-, $F(1, 72) = 20.84$, $p < .0001$, $\eta_p^2 = .22$.

No main effects or interactions involving PPI-R scores (overall, fearless dominance, impulsive antisociality) were obtained for this rating measure (ps $> .15$, η_p^2s $< .03$).

Discussion

Consistent with a priori predictions, the major finding of this study was that participants high in PPI-R fearless dominance showed an abnormal pattern of acquisition of physiological fear —i.e., reduced CS+/CS- electrodermal differentiation— while nonetheless developing commensurate cognitive awareness of the CS+/UCS contingency and equivalent reported perceptions of CS aversiveness. These results provide further evidence of a clear dissociation between physiological and expressive elements of fear response in individuals high in affective-interpersonal features of psychopathy, in line with prior reports in the literature (Benning, Patrick, & Iacono, 2005; Dindo & Fowles, 2011; Flor et al., 2002; Patrick et al., 1993; Pastor et al., 2003). Most interestingly, the current results are in accordance with the proposal that the reduced acquisition of physiological fear in high fearless psychopathic individuals, occurring in the context of intact cognitive awareness, could be indicative of a deficit in emotional learning (cf. Birbaumer et al., 2005; Flor et al., 2002) —specifically, a deficit in reactivity of the defensive motivational system to fear-conditioned cues.

The observed psychopathy-related effect in acquisition of fear is not readily explainable by differences in general physiological reactivity to aversive stimuli —as there was no relation between psychopathy scores (overall or factor) and attenuated autonomic reactivity to the

UCS— nor by differences in the intensity of the shock used as UCS. Thus, our results add to a growing body of evidence indicating that psychopathic individuals are not globally deficient in emotional responding, but rather exhibit a specific deficit in the capacity to develop affective associations in aversive learning contexts (cf. Flor et al., 2002). This interpretation of the current results coincides in turn with recent demonstrations of abnormal functioning of the limbic-prefrontal circuit of the brain in incarcerated psychopaths (Birbaumer et al., 2005; see Blair, 2008, 2010 for a review). Along this line, neural correlates of deficient fear conditioning in high psychopathic individuals from the community should be investigated in future studies using neuroimaging methods. Besides this, the results of the current study confirm that exploring deficient fear conditioning in psychopathic individuals from community is a fruitful line of investigation. Future research in this field would also benefit from inclusion of other physiological indices of fear learning as blink startle potentiation, facial EMG reactivity, or heart rate change.

In addition, our findings provide empirical support for a multi-faceted conceptualization of psychopathy (Skeem, Polaschek, Patrick, & Lilienfeld, 2011). Diminished fear conditioning in our study was specifically predicted by the fearless dominance component of PPI-R (believed to be most indicative of an underlying fearless disposition; Patrick, Fowles, & Krueger, 2009), and unrelated to the impulsive antisociality component (believed to reflecting externalizing proneness; Patrick et al., 2009), supporting the dual-process account of psychopathy (Fowles & Dindo, 2009; Patrick & Bernat, 2009). Notably, the finding of diminished acquisition of fear did not emerge clearly when explored using overall psychopathy scores: contrary to expectations, overall PPI-R scores were unrelated to physiological as well as expressive fear-conditioned responses.

As a further point, our finding of reduced aversive conditioning in high fearless-dominance individuals from the general population points to an etiological continuity of trait fearlessness in criminal and noncriminal manifestations of psychopathy (cf. Patrick, 2007; Patrick & Bernat, 2009). This weakness in fear learning and in the capacity to acquire fear associations may allow fearless psychopathic individuals to approach stimuli and situations that

others have learned to readily and cautiously avoid (Benning, Patrick, & Iacono, 2005). However, when moderated by appropriate parenting and socialization, a underlying low fear predisposition could in some cases give rise to a bold phenotypic style marked by high self-assurance, social efficacy, and a capacity to remain calm in threatening situations (Patrick et al., 2009) —qualities that may in fact facilitate success when dissociated from externalizing tendencies.

In sharp contrast with perspectives that consider noncriminal psychopathy as a less severe manifestation of the disorder (for example, Gustafson & Ritzer, 1995; cf. Hall & Benning, 2006), our results are consistent with the dual-process perspective. Specifically, the clear divergences in physiological, temperamental and behavioral correlates of the interpersonal/affective and social deviance factors of psychopathy coincide with the idea of separate etiologic pathways for these distinctive symptomatic components. One pathway entails a lack of normal defensive fear functioning, and the other a dispositional vulnerability to externalizing problems (Fowles & Dindo, 2009; Patrick, 2007; Patrick & Bernat, 2009). Concretely, affective-interpersonal features of psychopathy have been related to diminished startle potentiation during aversive cues (Benning, Patrick, & Iacono, 2005; Dvorak-Bertsch et al., 2009; Patrick, 1994; Patrick et al., 1993; Patrick et al., 1994; Poy et al., 2009; Vaidyanathan et al., 2011; Vanman et al, 2003), reduced electrodermal activation during anticipation of a physical stressor (Dindo & Fowles, 2011), higher levels of reported social dominance (Hare, 1991; Harpur, Hare, & Hakstian, 1989; Verona, Patrick, & Joiner, 2001), and lower scores on measures of negative affect including low anxiety, high stress resistance, low fear, and low depression (Harpur et al., 1989; Hicks & Patrick, 2006). Conversely, externalizing features of psychopathy have been related to general physiological underarousal (Benning, Patrick, & Iacono, 2005; Poy et al., 2009), reduced amplitude of the visual P3 ERP component (Carlson et al., 2009), maladaptive response perseveration (Moltó, Poy, Segarra, Pastor, & Montañés, 2007), and higher scores on measures of trait aggression, impulsivity, and risk taking (Hare, 1991; Harpur et al., 1989), and alcohol and drug dependence (Hare, 2003; Patrick, Hicks, Krueger, & Lang, 2005; Smith & Newman, 1990). These relations highlight the importance of

distinguishing between distinct components of psychopathy in evaluating relations with external criterion measures in differing domains (e.g., physiological, self-report, diagnostic, behavioral, etc.).

In conclusion, the dual-process framework is presented as a promising avenue for future research of psychopathy. Based on this perspective, and in light of the current results, we encourage further systematic laboratory research on the physiological, cognitive, behavioral and expressive correlates of the distinct dimensions of psychopathy in order to clarify and reconcile results of prior studies, and to extend what is known about understudied topics such psychopathy subtypes and successful versus unsuccessful psychopathy (cf. Patrick & Bernat, 2009).

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Footnotes

1. We considered it most appropriate methodologically to assess valence, arousal, and contingency awareness after extinction. An alternative trial-by-trial (or phase-by-phase) rating procedure, while potentially more informative about changes in affect and perception as they occur on-line, is disadvantageous in that it can draw the participant's attention to the contingency and thus lead to artificially enhanced awareness (cf. Martin & Levey, 1994).

2. Supplemental analyses including gender and scores on the PPI-R Coldheartedness subscale as between-subjects factors yielded no significant main effects or interactions for these factors in any analysis. In addition, to further rule out the possibility of gender-specific patterns of fear conditioning linked to psychopathy, separate analyses were performed for men and women. Results demonstrated the effectiveness of the conditioning manipulation for both genders, thus corroborating the absence of gender differences in the pattern of fear conditioning observed in the current sample as a whole. Moreover, the effect of psychopathy scores on the conditioning pattern was comparable across gender groups (i.e., gender did not significantly moderate this effect). The full dataset (men and women together) was used in subsequent analyses in order to avoid a reduction in *N,* and a loss of statistical power in evaluating relations between psychopathy and conditioning effects.

3. Fearless dominance factor score means (and standard deviations) for men and women in the high and the low fearless dominance groups were as follows: High fearless dominance: 135 (10.30) for men and 127.27 (12.33) for women; Low fearless dominance: 103.82 (14.81) for men and 92.63 (9.95) for women. According to PPI-R American norms at age 18-24 for community/college samples (Lilienfeld & Widows, 2005), these scores translate to percentiles of 77 and 84 for men and women in the high group, respectively, and to percentiles of 16 and 15 for men and women in the low group, respectively.

Table 1. PPI-R Overall and Factor scores: Correlations with personality measures and with MMPI-2-based indices of DSM-IV Personality Disorders (Ben-Porath, 1999) for participants in the current study ($N = 74$)

		PPI-R			
		Fearless Dominance (FD)	***Impulsive Antisociality (IA)***	***Coldheartedness (C)***	***Overall***
Personality measures					
SPSRQ	***SP***	**-.69***	**-.31***	-.29*	-.54*
	SR	.57*	.64*	.29*	.70*
STAI	***Trait***	**-.30***	**.24**	-.30*	-.03
NEO PI-R	***Neuroticism***	**-.35***	**.20**	-.26	-.08
	Extraversion	**.65***	**.33***	.14	.52*
	Openness	**.41***	**.21**	.04	.32*
	Agreeableness	**-.53***	**-.77***	-.52*	-.80*
	Conscientiousness	**-.20**	**-.67***	-.20	-.53*
MMPI-2 Personality Disorders					
Cluster A	***Paranoid***	**.21**	**.68***	.23	.55*
	Schizoid	**-.31***	**.05**	.11	-.09
	Schizotypal	**.26**	**.63***	.12	.52*
Cluster B	***Antisocial***	**.52***	**.83***	.41*	.81*
	Borderline	**.25**	**.70***	.19	.57*
	Histrionic	**.59***	**.35***	.14	.50*
	Narcissistic	**.49***	**.09**	.18	.31*
Cluster C	***Avoidant***	**-.51***	**-.04**	-.08	-.26
	Dependent	**-.42***	**.11**	-.25	-.15
	Obsessive-Compulsive	**-.11**	**.20**	-.15	.05

Note: PPI-R = Psychopathic Personality Inventory-Revised (Lilienfeld & Widows, 2005); SPSRQ = Sensitivity to Punishment and Sensitivity to Reward Questionnaire (Torrubia, Ávila, Moltó, & Caseras, 2001), STAI = State Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970), NEO PI-R = Revised NEO Personality Inventory (Costa & McCrae, 1992). Correlations significantly differing ($p < .05$) between PPI-R FD and IA with Steiger (1980) test for related samples are presented in bold.

*$p \leq 0.01$, two-tailed.

Table 2. PPI-R Overall and Factor scores Means, standard deviations and range for participants in the current study ($N = 74$)

	All participants (n = 74)			*Men (n = 32)*			*Women (n = 42)*		
PPI-R	*M* (*SD*)	*Max.*	*Min.*	*M* (*SD*)	*Max.*	*Min.*	*M* (*SD*)	*Max.*	*Min.*
Fearless Dominance (FD)	114.74 (20.77)	158	69	118.41 (20.16)	158	69	111.95 (21.03)	157	71
Impulsive Antisociality (IA)	150.85 (28.72)	209	97	158.09 (29.72)	206	97	145.33 (26.99)	209	97
Coldheartedness (C)	30.46 (6.86)	52	20	**32.31** (7.09)	50	20	**29.05** (6.42)	52	20
Overall	296.05 (46.75)	414	210	**308.81** (44.73)	414	221	**286.33** (46.43)	396	210

Bold: Comparison of men versus women is significant at $p < .05$

Note: PPI-R = Psychopathic Personality Inventory-Revised (Lilienfeld & Widows, 2005).

Table 3. Top: Mean skin conductance change (and *SD*) to CS+ and CS- during habituation, acquisition and extinction phases. Bottom: Means (and standard deviations) for affective valence, arousal, and contingency awareness ratings for CS+ and CS- before (pre-experimental) and after conditioning (post-experimental).

	CS Type			
	CS+		**CS-**	
Mean skin conductance change (log [μS + 1])				
Habituation	0.012	(0.045)	0.018	(0.046)
Acquisition (1st half)	**0.019**	(0.074)	**-0.013**	(0.039)
Acquisition (2nd half)	**0.013**	(0.056)	**-0.020**	(0.034)
Extinction	0.010	(0.038)	0.002	(0.023)
Affective Valence				
Pre-experimental	4.73	(1.16)	4.66	(1.05)
Post-experimental	***3.16***	(1.48)	***5.27***	(1.60)
Arousal				
Pre-experimental	3.43	(1.88)	3.56	(2.06)
Post-experimental	***6.20***	(2.26)	**4.01**	(2.08)
Awareness				
Post-experimental	**66.96**	(17.14)	17.64	(23.06)

Bold: Comparison of CS+ versus CS- is significant at $p < .05$
Italics: Comparison of Pre versus Post-conditioning ratings is significant at $p < .05$

Table 4. Means and *SDs* for CS+/CS- skin conductance difference scores (log [μS + 1]) across experimental phases, and their zero-order (and partial) correlations with PPI-R factors.

			Zero-order correlation (partial correlation)			
Phase	***M***	***SD***	**Fearless dominance**	**Gender-corrected**	**Impulsive antisociality**	**Gender-corrected**
Habituation	-0.006	0.041	.06	(-.01)	.14	(.12)
Acquisition (1st half)	0.032	0.075	**-.18**	(**-.24***)	**.06**	(**.18**)
Acquisition (2nd half)	0.034	0.058	**-.27***	(**-.30***)	**-.04**	(**.13**)
Acquisition (collapsed)	0.033	0.056	**-.26***	(**-.32****)	**.02**	(**.19**)
Extinction	0.008	0.042	-.18	(-.09)	-.19	(-.12)

Note: Partial correlations for fearless dominance are controlling for impulsive antisociality and vice versa. Significant differences ($p < .05$) between correlations involving fearless dominance and impulsive antisociality using Steiger's (1980) *t* test for differences between dependent correlations are indicated in **bold**.
* $p < .05$. ** $p < .01$.

Table 5. Summary of the hierarchical regression model for mean CS+/CS- skin conductance difference scores during acquisition phase, using scores on PPI-R factors as predictors.

Step and predictor variable		**ΔR^2**	**$F\Delta R^2$**	***df***	**βs in final model**	***p* value for β**
Step 1:	Gender	.011	0.380	69	-.061	.60
	Coldheartedness				-.010	.94
Step 2:	Impulsive antisociality	.001	0.037	68	.208	.16
Step 3:	Fearless dominance	**.094**	**7.006**	**67**	**-.361**	**.01**

Note: ΔR^2 is the change in variance relative to the previous step in the regression. $F\Delta R^2$ is the *F* ratio for the test of significance of the change in variance for each new step in the regression model. βs are standardized partial regression coefficients from the model fit with all predictors in step 3. **Bold** indicates a significant effect.

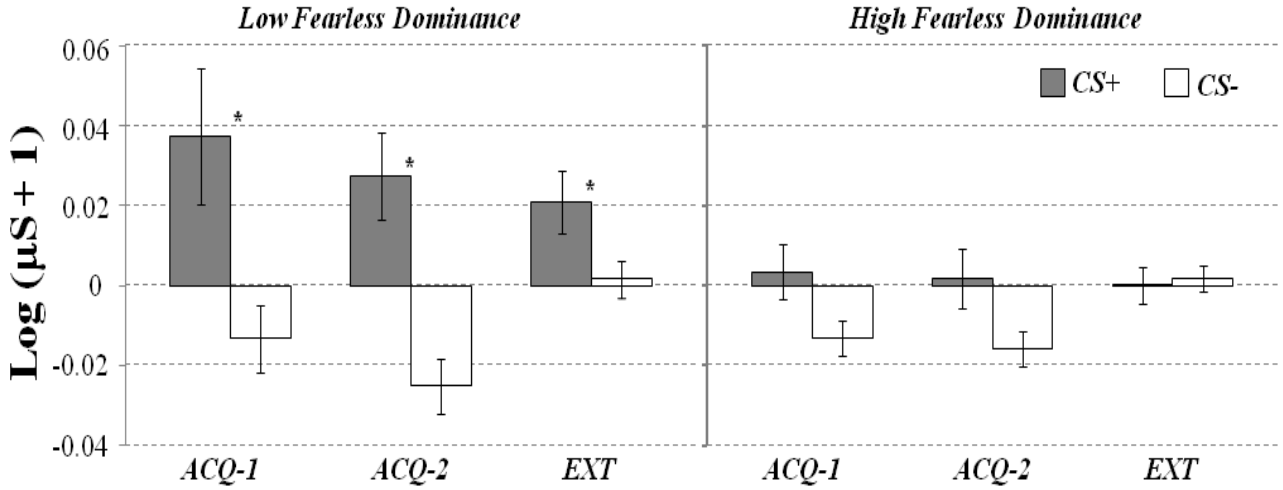

Figure 1. Mean skin conductance change (log [μS + 1]) for high and low fearless dominance groups when viewing CS+ and CS- during acquisition (ACQ-1 and ACQ-2) and extinction (EXT) phases of the fear conditioning procedure.