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Psychopathy-related traits and decision-making under risk and ambiguity: An exploratory study

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ABSTRACT

Studies on the association between psychopathy and decision-making in laboratory tasks have revealed mixed results. These might be due to an insufficient consideration of the different aspects related to both psychopathy and decision-making. Here we measured different facets of psychopathy in a non-clinical sample using the triarchic psychopathy measure. Decision-making was assessed using a task that measured risk taking in both gain and loss domains under different levels of probability and ambiguity. Boldness was positively associated with risk taking in a gain context; Disinhibition was positively associated with risk taking in a loss context, especially under a high loss probability level. These results provide a differentiated picture of the relation between psychopathy-related traits and decision-making, which might be useful for the interpretation of results of previous studies and the design of future studies.

1. Introduction

Psychopathy is a personality disorder typified by a cluster of interpersonal, affective, and behavioral characteristics, such as social dominance, a shallow affect, and antisocial and risk-taking behaviors. The psychopathy construct has been operationalized in a number of assessment instruments, such as the Psychopathy Checklist-Revised (PCL-R; Hare, 2003). Recent research suggests that, rather than constituting a distinct entity or taxon, psychopathy can be conceptualized as a constellation of extreme scores on personality traits that are continuously distributed and present in samples from the general community (Guay, Ruscio, Knight, & Hare, 2007), allowing for an extension of the construct towards non-clinical samples.

A recent self-report inventory to measure psychopathy-related traits in community samples is the triarchic personality measure (TriPM; Patrick & Drislane, 2015). This questionnaire is based on a conceptualization of psychopathy in terms of three distinct constructs: Boldness, Meanness, and Disinhibition. Boldness refers to interpersonal facets, reflecting social dominance and emotional resilience. Meanness is primarily associated with manipulative behavior and affective features, such as callousness and lack of empathy. Finally, Disinhibition captures antisocial and erratic lifestyle components. Each of the constructs is believed to have unique neurocognitive correlates. In this regard, the triarchic framework converges with (neuro)cognitive accounts of psychopathy that highlight the role of various cognitive impairments in explaining dysregulated and antisocial behavior (Blair, 2005).

One such approach views psychopathy as a disorder primarily typified by disturbed affective processing and decision-making (Blair, 2015). This model assumes that maladaptive behaviors seen in relation to psychopathy are (partly) caused by a reduced ability to optimally use rewards and punishments to guide choices (Blair, 2013). For example, a study in non-offenders found hyper-activation of the reward circuit in the brain with increasing levels of impulsive-antisocial traits (Buckholtz et al., 2010). Moreover, Blair et al. (2004) found individuals with psychopathy to be especially insensitive to different levels of punishment, which is indicative of a hyposensitivity to aversive stimuli.

Hypersensitivity to rewards and hyposensitivity to punishments can bias the generation of expectancies of reward and punishment and ultimately lead to poor decisions. Importantly, in order to increase the precision of the predictions regarding the outcome of our choices, we try to reduce the amount of uncertainty in the information on which the predictions are based (Mathys et al., 2014). From this perspective, aversion to excessive uncertainty plays a central role in decision-making, and might also play a role in explaining some of the learning impairments seen in relation to psychopathy (Brazil, Mathys, Popma,

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Importantly, not all choices involve the generation of predictions and decision-making is influenced by different sources of uncertainty, such as risk and ambiguity Tymula, Rosenberg Belmaker, Ruderman, Glimcher, & Levy, 2013). People typically show an aversion towards both risk and ambiguity when making choices, at least when these choices involve options that differ in terms of magnitude and probability of gaining positive outcomes (Tymula et al., 2013). We define risk preferences as the willingness to accept offers with exact probability information and ambiguity preference as the willingness to accept offers with (partially) unknown probabilities. Thus, ambiguity includes an additional source of uncertainty relative to risk. Moreover, risk and ambiguity have been shown to be associated with distinct neural mechanisms (Krain, Wilson, Arbuckle, Castellanos, & Milham, 2006). The influence of ambiguity on decision-making has received little attention in psychopathy research, but risky decision-making has been more prominent.

Most studies have examined the association between psychopathic features and risky choices using the Iowa Gambling Test (IGT). However, the results are mixed, with some studies reporting a positive association (e.g., Beszterczey, Nestor, Shirai, & Harding, 2013; Dean et al., 2013), some failing to find any strong relations (Kuin & Masthoff, 2016; Takahashi, Takagishi, Nishinaka, Makino, & Fukui, 2014), and yet others finding a negative association (Hughes, Dolan, Trueblood, & Stout, 2015).

There may be many reasons for these mixed results, including the use of different psychopathy measures and samples (e.g., children, adults, clinical or non-clinical populations). However, in the present study we aimed to circumvent three specific likely causes: i) the failure to untangle the individual roles of risk and ambiguity during decision-making, ii) a lack of systematic assessment of the role of the reinforcement domain (i.e., gain vs. loss) in which those choices are made, and iii) the use of tasks known to engage many different cognitive mechanisms that are difficult to disentangle (e.g., Stocco, Fum, & Napoli, 2009). For example, the IGT involves an initial learning phase and requires monitoring and updating of choice outcomes in working memory. The involvement of such additional processes complicates the generation of conclusions about individual cognitive processes involved in decision-making. In order to understand if and how the dimensions of psychopathy are related to suboptimal decision-making, we need to investigate the links with the cognitive mechanisms involved more precisely and systematically. Therefore, the main goal of the present study was to probe for unique relations between psychopathy-related dimensions and risky and ambiguous choices that do not require any learning or working-memory processes.

Because the links between the triarchic framework with risk and ambiguity during decision-making are unknown, our novel approach makes it difficult to generate firm hypotheses. However, the TriPM subscales can be linked to subscales from other psychopathy questionnaires (Drislane, Patrick, & Arsal, 2014), which in turn *have* been assessed for their relation with decision-making tasks, albeit mostly the IGT. Accordingly, Disinhibition is strongly linked to other measures of impulsive antisociality (Patrick & Drislane, 2015), which mostly have been found to be associated with a relative positive attitude towards risky and ambiguous choices (e.g., Beszterczey et al., 2013; Dean et al., 2013; Miranda, MacKillop, Meyerson, Justus, & Lovallo, 2009). Boldness includes interpersonal features like social dominance and tolerance for unfamiliarity and danger (Patrick & Drislane, 2015). These features may be expected, and partially have been found, to encourage risk-taking (e.g., Anderson & Galinsky, 2006). Meanness primarily entails affective features, such as a deficient empathy and coldheartedness, but also incorporates interpersonal aspects, such as manipulation and exploitativeness (Drislane et al., 2014). This mix of features makes it particularly difficult to make predictions, but the (primarily) affective aspects may be hypothesized to have no strong link with risk taking (see also references above reporting a link with impulsive antisociality: these studies found no significant association with interpersonal-affective traits).

2. Materials and methods

2.1. Participants

The original sample consisted of 205 young adults. This concerned a convenience sample, collected from two separate studies (Study 1: $N = 80$; Study 2: $N = 125$) that each included the TriPM, the risk and ambiguity task (RAT; Tymula et al., 2013), and Raven's Advanced Progressive Matrices test (RAPM; Raven, Raven, & Court, 1998). The data of four participants were excluded because of their relatively low score on the RAPM test (4–6 correct items of the 12 items). However, inclusion or exclusion of these cases did not affect the conclusions reported below. The data of one additional participant were excluded because of an excessively high number of irrational choices in the task (more than half of the corresponding trials, see Supplementary Material). The remaining 200 participants (81 men) had a mean age of 23.0 years (SD = 2.56; range = 18–30). The majority of the participants (71%) were students, 91% of which had received 6 years of primary education in addition to 5 years of high-level secondary education or a university degree, 9% had 6 years of primary education and 4 years of average level education, and 1 participant had < 6 years of primary education. The participants were recruited via social networks and at the university. The studies from which the present data were derived were approved by the local ethical committee and all experimental manipulations were performed in accordance with the approved guidelines. All participants gave written informed consent and either received course credit or participated without receiving any compensation.

2.2. Materials

2.2.1. RAPM Set 1

As intelligence is known to modulate risk-taking during decision-making (Deakin, Aitken, Robbins, & Shahakian, 2004), we corrected for IQ in all analyses, using the score on Set 1 of Raven's Advanced Progressive Matrices test as measure of general intelligence. This test consists of 12 problems of increasing difficulty. The outcome variable is the number of items with a correct response.

2.2.2. TriPM

We used a Dutch translation of the TriPM as measure of psychopathy-related traits (Van Dongen, Drislane, Nijman, Soe-Agnie, & van Marle, 2017). The questionnaire consists of 58 statements, each scored on a 4-point Likert scale. Boldness and Meanness are each covered by 19 items, Disinhibition by 20 items. Higher scores indicate a stronger agreement to items such as “I am a born leader” (Boldness), “I don't mind if someone I dislike gets hurt” (Meanness), and “I often act on immediate needs” (Disinhibition).

2.2.3. RAT

We used a short version of the RAT to measure decision-making. Briefly, each participant was asked to make a series of binary choices between a certain monetary amount and a lottery. Across trials, the lottery option varied in three features: amount to be gained or lost, outcome probability, and ambiguity level. The task consisted of 42 unique lotteries [(4 outcome probabilities + 3 ambiguity levels) × 3 amounts × 2 blocks (gain/loss)]. Each lottery was presented twice resulting in a total of 84 experimental trials. The main output from this task were the proportion of trials on which the participant made risky gain choices, risky loss choices, ambiguous gain choices, and ambiguous loss choices, for each outcome probability and ambiguity level. See Supplementary Material and Tymula et al. (2013) for further details.

2.3. Procedure

The participants completed the TriPM (among other questionnaires) via an online service. The experimental test session lasted about 30 min and took place in a quiet room within two weeks after completion of the questionnaires. During the test session, all participants first completed the RAPM, followed by the RAT. The participants from Study 2 also performed an attentional cuing task and the order of presentation of the RAT and this task was counterbalanced. The results of the additional task and questionnaires are not discussed here.

2.4. Statistical analyses

In the main analyses, we performed a set of exploratory regression analyses in which we performed a hierarchical regression analysis for each of the domains, outcome probabilities, and ambiguity levels, using the proportion risky or ambiguous choices as criterion. We explicitly focused on the different probability and ambiguity levels for each domain rather than (also) considering the variations in amount of risky and ambiguous gains and losses for two reasons. First, the number of trials was not sufficient to perform meaningful analyses that would further separate the data according to reward or loss magnitude. Second, one key assumption here is that optimal decision-making is driven by the need to reduce uncertainty in various types of information processed by the brain (e.g., Mathys et al., 2014), and that the poor choices seen in psychopathy should be related to impaired reduction of uncertainty at the cognitive level (see Brazil et al., 2017). In our task, such impairment would be reflected by deviant preferences for choice options as a function of different levels of gain or loss probabilities and/or ambiguities. In each of the regression analyses, IQ was first included as sole predictor (Model 1), and then each of the three TriPM scales were added as additional predictors (Model 2). We used bootstrapping (5000 samples) in these analyses to reduce the impact of potential outliers and considered a regression coefficient as significant if it complied to *all* of the following criteria: The R^2 (for Model 1) or ΔR^2 change (for Model 2) was significant ($p < 0.05$), the *p*-value associated with the regression coefficient was < 0.05, and the 95% bias-corrected and accelerated confidence interval (BCa) for the coefficient did not contain zero.

3. Results

Table 1 presents the results of the regression analyses. Of primary importance, across all risky gain trials, increased Boldness was uniquely associated with a stronger tendency to choose the risky option, $\beta = 0.21$, 95% CI[0.06, 0.35], $p = 0.008$. Increased Disinhibition was uniquely associated with more risk taking on trials with the highest loss probability, $\beta = 0.19$, 95% CI[0.03, 0.34], $p = 0.02$. Finally, IQ was negatively associated with the number of risky choices on the 25% ($\beta = -0.23$, 95% CI[−0.35, −0.09], $p = 0.001$), 50% ($\beta = -0.17$, 95% CI[−0.30, −0.03], $p = 0.02$), and overall loss risk trials ($\beta = -0.22$, 95% CI[−0.35, −0.07], $p = 0.003$). All other associations were not significant. See Supplementary Material for information on demographic variables, RAPM and TriPM scores, and analyses on proportion of risky and ambiguous choices.

4. Discussion

The present study revealed that, in terms of proportion of risky choices, the participants displayed a regular and plausible pattern (suggesting a clear understanding of the task), taking more risks when the probability of gain was large, and the probability of loss was low. IQ was negatively associated with risk taking in the loss domain, especially under intermediate risk levels. Of primary importance, increased Boldness was uniquely associated with increased overall risk taking in a gain context, while Increased Disinhibition was associated with higher risk taking in a loss context, but only for the highest loss probability. Meanness was not significantly associated with any of the task measures.

Including IQ in the regression analyses yielded significant negative associations specifically for intermediate levels of outcome probabilities in the loss domain. General intelligence and closely related aspects of executive functioning have also been found to be negatively associated with risky decisions in previous studies (Schiebener & Brand, 2015). Notably, this association may be restricted to decision-making tasks with explicit and fixed probabilities, like the RAT or the Game of Dice Task (Brand, Heinze, Labudda, & Markowitsch, 2008), rather than tasks with to-be-learned and changing probabilities like the IGT. Putatively, in the former tasks, selection of strategies and computation of objective expected values may place a heavy demand on executive functioning, such as working-memory (WM) capacity. Accordingly, individuals with a relatively low IQ, and corresponding weak WM (Friedman et al., 2006), would be more prone to make suboptimal decisions, especially under conditions in which the computation of objective expected value is relatively difficult. Such computation may be more difficult for intermediate than extreme risk levels, and more difficult for problems that are framed in a loss than a gain context.

Meanness was not significantly associated with any of the criterion measures. This could reflect that this subscale is more strongly associated with affective aspects than each of the other two TriPM subscales, and that affective aspects do not play a major role in the type of decision-making as measured by the RAT. The RAT putatively involves more ‘cold’ rather than ‘hot’ cognition (e.g., Krain et al., 2006), as also suggested by the found associations with IQ.

The enhanced risk taking seen in participants with high levels of Boldness was to be expected, as this construct consists of features such a propensity towards thrill-seeking and a high tolerance to uncertainty, features that are related to risk-taking. This also holds for features of Boldness that address the domain of emotional experience, like emotional resiliency and optimism, and those targeting interpersonal behavior, such as social dominance. A high score on such items may be associated with feeling relatively less bothered about making risky choices (e.g., Anderson & Galinsky, 2006). The positive association between Disinhibition and risk taking fits well with the strong link between Disinhibition and impulsivity (Patrick & Drislane, 2015) and with previous research using the IGT (e.g., Dean et al., 2013).

Using the RAT allowed us to further specify the conditions under which Boldness and Disinhibition are associated with increased risk seeking. For Boldness, the association was only significant in the gain domain when considering the overall risky choice measure. For Disinhibition, the association was significant specifically with highly probable losses. In general, the finding that associations between measures of personality, cognition, and risk taking are only significant under specific task conditions is not novel. For example, Brand et al. (2008) found a significant association between general intelligence and risk taking exclusively for the riskiest decisions in their task.

Risk taking in relation to psychopathy has often been explained in the context of Gray's reinforcement sensitivity theory (RST; Gray, 1975), which makes a distinction between a Behavioral Activation System (BAS) and a Behavioral Inhibition System (BIS). The BAS and BIS are activated in response to rewarding and aversive stimuli, respectively. In both clinical and non-clinical samples, interpersonal-affective psychopathic traits have been reported to be associated with a hyposensitive BIS and sometimes also to a hypersensitive BAS. Instead, impulsive-antisocial traits have mostly been found to be associated with a hypersensitive BAS and to be largely unrelated to BIS (Hoppenbrouwers, Neumann, Lewis, & Johansson, 2015; Roose, Bijttebier, Claes, & Lilienfeld, 2011). Except for the null results for Meanness, which contains both interpersonal-affective and impulsive-antisocial traits and may therefore have no clear association with the BIS or BAS, our results for Boldness and Disinhibition are clearly not in line with these suggestions. These relations might imply that strong

Table 1
Relation between psychopathy (sub-)scales and RAT performance measures: regression coefficients.

Criterion	Predictor					
	IQ	Boldness	Meanness	Disinhibition	Model 1	Model 2
	β	β	β	β	R^2	ΔR^2
Gain 13% risk	0.06	0.14	0.04	− 0.01	0.00	0.02
Gain 25% risk	0.05	0.17	0.02	0.01	0.00	0.03
Gain 50% risk	0.02	0.02	0.03	− 0.11	0.00	0.01
Gain 75% risk	− 0.03	0.15	− 0.17	0.15	0.00	0.04
Gain overall risk	0.04	0.21**	− 0.02	0.02	0.00	0.04*
Loss 13% risk	− 0.13	0.06	− 0.04	0.01	0.02	0.00
Loss 25% risk	− 0.23**	0.02	− 0.14	0.07	0.05**	0.01
Loss 50% risk	− 0.17*	− 0.02	− 0.08	0.14	0.03*	0.02
Loss 75% risk	− 0.04	− 0.10	0.06	0.19*	0.00	0.05*
Loss overall risk	− 0.22**	− 0.01	− 0.08	0.14	0.05**	0.02
Gain 24% amb	0.01	0.13	− 0.03	− 0.02	0.00	0.02
Gain 50% amb	− 0.02	0.03	0.02	− 0.04	0.00	0.00
Gain 74% amb	− 0.14	0.10	0.10	− 0.05	0.02*	0.02
Gain overall amb	− 0.07	0.09	0.04	− 0.05	0.01	0.01
Loss 24% amb	− 0.11	− 0.07	− 0.00	0.11	0.00	0.01
Loss 50% amb	− 0.05	0.03	− 0.06	0.11	0.01	0.00
Loss 74% amb	− 0.13	− 0.09	− 0.02	0.07	0.00	0.01
Loss overall amb	− 0.12	− 0.05	− 0.03	0.11	0.00	0.00

Note. Model 1 includes the RAPM (IQ) score as sole predictor; Model 2 incorporates the RAPM and the TriPM subscale scores. Criteria are proportion of trials on which the participant chose the risky (risk) or ambiguous (amb) option. β = standardized regression coefficient.
* $p < 0.05$.
** $p < 0.01$.

interpersonal-affective psychopathy traits, including TriPM-Boldness, are primarily linked to risky decisions in loss contexts, whereas impulsive-antisocial traits, including TriPM-Disinhibition, primarily relate to risky choices in gain contexts. From this perspective, the direction of our results runs counter expectations, especially the increased tendency to make high-risk choices in the loss domain in those scoring high on Disinhibition. However, it is important to note that the IGT, which was frequently used in this BIS/BAS framework, entails the gradual learning of outcome probabilities based on response feedback. Psychopathy is associated with impaired learning of stimulus-outcome contingencies (Von Borries et al., 2010). Hence, it is well possible that specifically this feature of the IGT (learning based on feedback) is responsible for the associations found in some previous studies. Importantly, in the RAT no feedback is given. Therefore, the task specifically taps into isolated decision-making processes, thus separating them from feedback-related processes. This might be of special importance given that many important choices in real life, such as deciding to invest a large amount of money or buying a house, are also made in the absence of immediate feedback (see also Volz & Gigerenzer, 2012). The results indicate that disinhibitory tendencies further enhance the overall propensity towards risk-seeking that is commonly seen in a loss compared to gain context (Tymula et al., 2013), and that Boldness components (e.g., high self-assurance) enhance risk-seeking in contexts that in general result in relatively less risk-taking (gain contexts). These accounts are speculative, and the absence of a clear mechanistic explanation for these associations highlights the need for further research.

Our lack of significant associations for ambiguous choices seems to contradict the hypothesis that antisocial individuals may be typified by inappropriate management of ambiguity. Brazil et al. (2012) suggested that a reduced ability to disentangle information in specific offender populations could be partly driven by a larger amount of perceived ambiguity when interpreting sensory information. The present findings, failing to reveal an association between psychopathy-related traits and response to ambiguity, indicate that this prediction does not hold for the type of decision-making processes targeted in our study. A similar lack of association was found in a recent study examining decision-making in a community-based sample with a high risk of displaying antisocial behavior, using a task specifically targeting ambiguous choices (Buckholtz, Karmarkar, Ye, Brennan, & Baskin-Sommers, 2017). Although various aspects of antisociality, such as externalizing psychopathology, self-report antisocial behavior, and antisocial personality disorder diagnosis, were significantly negatively associated with ambiguity aversion, this was not the case for self-reported psychopathic traits. The latter finding suggests that our results may generalize to other populations.

However, the type of sample used in the present study still provides a limitation in that the associations we did find may not parallel those obtained in offender populations. Another limitation concerns the rather low effect sizes. The present study was exploratory in nature and the result found for Disinhibition would not be significant if we would have applied an a priori control for Type I error. A final potential limitation concerns the fact that we used hypothetical monetary gains and losses, and our results may not generalize to situations with real monetary rewards. This issue has received much experimental attention in the literature on choice behavior, especially in the context of delay discounting studies. Although a few studies did find greater risk-aversion for real versus hypothetical (monetary) rewards (e.g., Holt & Laury, 2002), other studies reported similar findings for the two reward types (e.g., Lagorio & Madden, 2005; Wiseman & Levin, 1996). Future research should examine whether the Boldness- and Disinhibition-related differences in risk taking in the present task are related to more real-life risk taking, as measured by tasks with real rewards, questionnaires, or case records.

5. Conclusions

The present results suggest that different psychopathy-related traits have specific links with decision-making in risky choice situations in gain and loss contexts. Specifically, Boldness was associated with increased risk taking in a gain context, whereas Disinhibition was associated with enhanced risk taking in a loss context with a high loss probability level. These results suggest that, in future research on the association between psychopathy and decision-making in experimental settings, it is important to carefully separate the different aspects involved in both constructs.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.paid.2017.10.017. Further supplementary data (raw data) are available from the Donders Institute for Brain, Cognition and Behaviour repository at https://data.donders.ru.nl/collections/shared/di.dcc.DSC_2017.00085_206/.

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