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# Individual Differences in Moral Behaviour: A Role for Response to Risk and Uncertainty?

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**Abstract** Investigation of neural and cognitive processes underlying individual variation in moral preferences is underway, with notable similarities emerging between moral- and risk-based decision-making. Here we specifically assessed moral distributive justice preferences and non-moral financial gambling preferences in the same individuals, and report an association between these seemingly disparate forms of decision-making. Moreover, we find this association between distributive justice and risky decision-making exists primarily when the latter is assessed with the Iowa Gambling Task. These findings are consistent with neuroimaging studies of brain function during moral and risky decision-making. This research also constitutes the first replication of a novel experimental measure of distributive justice decision-making, for which individual variation in performance was found. Further examination of decision-making processes across different contexts may lead to an improved understanding of the factors affecting moral behaviour.

**Keywords** Decision making · Morality · Distributive justice · Risk · Uncertainty · Individual differences

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Moral scenarios have only recently begun to be explored in the neurobiology of decision making (DM), and little is as yet known about how moral DM relates to other kinds of DM or how a relationship between different forms of DM might be grounded in their neural substrates. Similarities have now emerged, however, between the processes linked to individual variation in moral distributive justice DM and in non-moral risky DM. For example, neuroimaging investigation of a distributive justice task revealed that individuals who tended to make decisions favouring equity over efficiency show greater activity in insular cortex during their DM [1]. Individual differences in insular cortex activity are also related to the tendency to reject inequitable offers in a financial sharing game [2]. These findings parallel studies examining risky

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DM, in which greater insula activity has been consistently linked to more cautious behaviour [3, 4]. There is also evidence that activity in insular cortex during DM relates to the emotional anticipation of adverse outcomes, a potential function of this being to bias the individual towards particular choices [3]. Thus, it can be hypothesised that individuals who have a tendency for greater anticipatory responses to potential adverse outcomes during DM may be more likely to choose both more equitable options (when making distributive justice choices) and more cautious options (when making choices entailing risk).[1]

Similarly, it has been suggested that there may be a common neural system that processes rewards in both moral and non-moral contexts [5, 6]. This contention has been supported by studies showing sensitivity of prefrontal cortex and striatum to rewarding outcomes in distributive justice- and risk-related DM [1, 6–8]. Several studies have linked individual differences in reward-related activation to individual differences in moral- and risk-related behaviour [3, 5, 9, 10]. Furthermore, there is evidence that a mechanism in which immediately appealing response options are inhibited may contribute to behaviour in both distributive justice and risky contexts [11].

The similarities between neural processes linked to individual differences in moral and risky DM, as described above, provided the impetus for directly assessing the overlap between these seemingly disparate DM domains. In particular, we sought to establish whether a relationship exists between distributive justice preferences and risk preferences in the same individuals. We hypothesised that given the overlap in neural substrates, equity-minded moral preferences would be positively correlated with risk-averse gambling preferences.

## Method

### Participants

The sample comprised 20 young adults (mean age= 22.8 years, SD=3.56 years; 13 male) with no personal history of psychiatric or neurological problems. Participants were recruited from the general Monash University population. Ethics approval for this study was obtained from the Monash University Standing Committee on Ethics in Research Involving Humans. All participants provided written informed consent and were naïve to the experimental hypotheses.

### Materials

*Distributive Justice Task (DJT)* The DJT is a computerized task that aims to provide a measure of an individual's preference for equity versus a form of utilitarian benefit [1].

Each trial of the task contained the names and images of three disadvantaged African children. The hypothetical scenario described to participants was that each child had been supplied with 24 meals, and that a number of meals had to be removed. In each trial, participants were required to choose between two options that differed in how these meals were removed from three children that appeared on screen. It was explained to participants that one option would entail a smaller number of meals removed in total, while the other option would entail a more even distribution of meal loss. The specific meal values differed between the 18 trials (see [1] for trial list). Trials were presented in a unique random order for each participant. Before beginning, participants were shown a slideshow containing biographical details of the children that were to appear in the task (for details, see Online Resource). In order to further encourage a sense of realism, participants were made aware that the researchers would donate $15 to a charity for disadvantaged children in conjunction with their performance of the task.

Following [1], a model of perceived utility was fitted to the choice data of each participant in order to estimate the weight given to inequity during the DJT. A single score of *inequity aversion* ($\alpha$) was thus estimated for each participant (for details, see Online Resource).

*Iowa Gambling Task (IGT)* The IGT is a computerized task that has been used extensively in studies of DM involving risk and uncertainty [12]. See [13] for a recent review of the validity and reliability of this task.

Participants were required to make a series of 100 selections from four decks of cards. Each selected card revealed a certain win or loss of virtual money. Participants were expected to firstly gain a sense of the

[1] See [5] for a further comparison of insula involvement in moral and non-moral decision-making outside of the distributive justice context.

potential outcomes associated with each deck and then choose between the riskier or safer alternatives. Participants began with $2,000, and a running total of money earned was presented on the computer screen throughout the task. The instructions and fixed schedule of wins and losses for each deck was the same as that presented in the original version of the task [12].

The proportion of selections from the two decks associated with lower wins and losses was used as a measure of risk aversion ($IGT_O$). Recent studies have suggested using the proportion of selections from these two decks as (a) a measure of risk aversion under uncertainty within the initial 40 trials ($IGT_{I40}$), and (b) a measure of risk aversion when potential outcomes are more explicitly known within the final 60 trials ($IGT_{F60}$; for discussion, see [14]).

*Cambridge Risk Task (CRT)* The CRT is another computerized task that was developed as a measure of risk aversion [15]. In support of the ecological validity of this task, drug abusers have been found to make a greater number of risky choices on the CRT than non-users [16].

Each trial of the CRT requires the participant to guess the location of a winning token, hidden randomly in one of six boxes that are coloured either pink or blue. The guesses involve choosing between two gambles, each of which is associated with a specific probability of winning and a specific number of points at stake. The number of points associated with each option differed between trials (i.e., 10:90, 20:80, 30:70, 40:60, or 50:50), as did the proportion of pink to blue boxes (i.e., 2:4, 3:3, or 5:1; which determined the probability of winning associated with each option). The gamble associated with a lower likelihood of winning always corresponds to a higher number of points at stake and hence is a riskier choice.There were 120 trials in the present study. Trial order was randomised for each participant, with each possible box proportion and points proportion occurring together an equal number of times. Participants began the task with 100 points, and were instructed to try to maximize their profits over the course of the task. The proportion of trials in which the participant chose the less risky option was used as a measure of risk aversion.

*Balloon Analogue Risk Task (BART)* The BART is another computerized task designed to assess risk-taking behaviour in a financial gambling scenario [17]. The construct validity of the BART as a measure of risk taking in a young adult population has been supported empirically [17, 18].

In the BART, participants choose how far to pump up an animated balloon, winning more virtual money from trials in which they pump up the balloon further (5¢ per pump) before choosing to end the trial and collect the accrued amount. All money accrued in a trial is lost if the balloon bursts before the participant chooses to collect. The point at which the balloon bursts varies across trials. Participants completed 30 trials in the present study. In accordance with past validity studies, the measure of risk taking used in the present study was the average number of pumps made for trials in which the participant chose to collect the accrued amount before the balloon burst (referred to as the adjusted average).

*Dahlbäck Risk-Taking Propensity Scale (DRPS)* The DRPS is a pen-and-paper questionnaire designed to assess general risk-taking propensity [19]. Self-reported responses to 11 statements were summed (true = 2 points; false = 1 point) to produce a single measure of trait risk-taking propensity for each participant.

## Procedure

Each participant separately completed a single testing session of 1.5–2 h duration, seated comfortably in front of a desk in a quiet room. No time limits were imposed for completion of any of the DM tasks. Task order was counterbalanced across participants using a digram-balanced Latin Square design [20]. Participants rested quietly for 3 min between each of the DM tasks. For the risky DM tasks, each participant received $5 per task if they finished with high enough amounts of virtual money (for the IGT and BART) or points (for the CRT). They were not told the specific amount of virtual money or points required to win in each task, and learnt how much prize money they had won only after completion of all four tasks. Participants each received $5 for completing the DJT. The DRPS was sent to participants a week after their testing sessions and completed electronically.

## Statistical Analyses

Spearman's rank correlation coefficient ($r_s$) was used to measure the relationship between DJT

scores and measures of risky DM (see Materials). Pearson's correlation coefficient ($r$) was used to measure the relationship between the different measures of risky DM, as these variables were judged to have adequately satisfied parametric assumptions. Bonferroni correction was applied separately for significance testing of the six bivariate correlations between DJT scores and risky DM preferences ($\alpha$=0.008), and for the 15 bivariate correlations between the different measures of risky DM ($\alpha$=0.003).

## Results

We found that performance on the DJT varies between individuals (mean $\alpha$=22.37, SD=10.96). This finding is consistent with previous reports involving both the DJT [1] and other measures of moral preference [2, 5]. Together such findings support the notion of examining factors underlying individual differences in moral behaviour. To our knowledge, this is the first replication of the DJT, supporting the use of this task as a measure of individual differences in moral DM. Mean inequity-aversion was notably higher in the present study than that reported previously (mean $\alpha$=6.95, SD=1.08; [1]). Further research is necessary to determine the cause of this difference, a potential contributor being the demographics of the young adult Australian university population sampled in the present study and older American participants (29–55 years) reported on in the previous use of the DJT [1]. Further descriptive statistics of distributive justice and risky DM measures are shown in Table 1.

Correlational analyses indicated that DJT inequity-aversion shared a strong positive correlation with IGT risk-aversion (Fig. 1), but was not significantly correlated with CRT, BART, or DRT measures of risk preference (Table 2). There were also no significant correlations between the different measures of risk preference (Table 2).

A post-hoc analysis was performed (using William's formula; [21]) to assess whether the correlation between DJT and $IGT_{I40}$ differed significantly from the correlation between DJT and $IGT_{F60}$. No significant difference was found between the magnitude of these two correlations, $t(16)=-0.31$, $p>0.05$ (two-tailed).

**Table 1** Individual variation in measures of moral DM and risky DM

| Measure | M (SD) | Range | $n$ |
|---|---|---|---|
| DJT | 22.37 (10.96) | −6.23–33.85 | 20 |
| $IGT_O$ | 0.63 (0.18) | 0.31–0.84 | 19 |
| $IGT_{I40}$ | 0.52 (0.11) | 0.33–0.70 | 19 |
| $IGT_{F60}$ | 0.70 (0.27) | 0.23–1.00 | 19 |
| CRT | 0.88 (0.11) | 0.69–1.00 | 19 |
| BART | 38.6 (9.3) | 17.07–52.88 | 20 |
| DRPS | 15.8 (2.9) | 11–21 | 19 |

Ninety-five per cent of participants returned the DRPS. A single score was missing from each of the CRT and IGT distributions due to a computer malfunction. Missing cases were excluded from correlational analyses in a pair-wise manner

## Discussion

Our main finding was that participants who favoured a more cautious approach in the IGT also tended to favour equity over efficiency in the DJT. This finding is consistent with research implicating similar cognitive and neural processes in moral and risky DM (see Introduction). The direction of the IGT-DJT correlation lends support to the hypothesis that the tendency for stronger anticipatory emotional responses to potential DM outcomes may generalise across moral and risky contexts to promote both equitable and cautious behaviour, respectively. In addition, previous research has suggested that regions of prefrontal cortex and

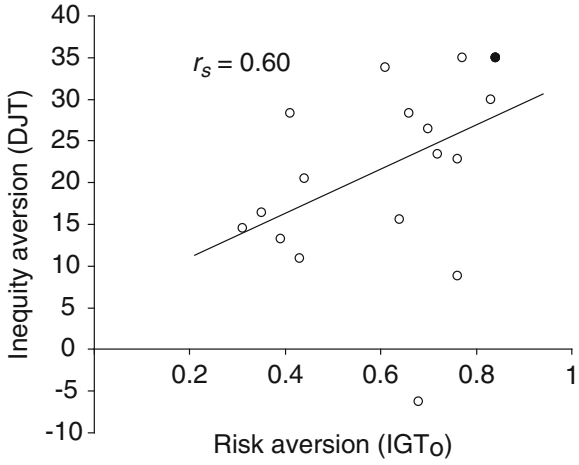


**Fig. 1** A significant positive correlation was observed between equitable behaviour during the DJT and $IGT_O$ risk aversion ($p$=.003). The *filled-in circle* indicates three participants who scored the same on both tasks

**Table 2** Correlations between measures of moral DM and risky DM

| | $IGT_O$ | $IGT_{I40}$ | $IGT_{F60}$ | CRT | BART | DRPS |
|---|---|---|---|---|---|---|
| DJT | .60** | .53* | .46* | .27 | −.23 | −.11 |
| $IGT_O$ | – | .57*** | .98**** | .23 | −.31 | .12 |
| $IGT_{I40}$ | | – | .38 | .16 | −.23 | −.14 |
| $IGT_{F60}$ | | | – | .22 | −.29 | .17 |
| CRT | | | | – | .32 | .31 |
| BART | | | | | – | .14 |

Correlations with DJT scores are $r_s$ values, while remaining values are *r*. The correlations of DJT inequity aversion with the individual IGT sub-components ($IGT_{I40}$, $IGT_{F60}$) were no longer significant after adjustment of the alpha level to control for Type I error. *$p<0.05$, one-tailed. **$p<0.008$, one-tailed. ***$p<0.05$, two-tailed. ****$p<0.003$, two-tailed

striatum are sensitive to rewarding outcomes in moral- and risk-related DM [1, 5–8]. Furthermore, a mechanism of cognitive inhibitory-control, underpinned by right dorsolateral prefrontal cortex function, has been suggested to contribute to choices in both moral and risky contexts [11]. It is possible that individual differences in these processes contribute to individual differences in both moral and risky DM, accounting for the present study's observed correlation.

It could be argued that potential negative outcomes associated with the choices made in moral contexts (for example, social punishment of norm-violating behaviour [22]) instill moral decisions with an element of risk, thus explaining the present finding. However, in the present study, several other measures of risky DM were found to be unrelated to participants' DJT preferences. Thus, the DJT likely involves an aspect of DM invoked to a greater extent in the IGT than in these other measures. In support of this contention, there were no significant correlations observed between the IGT and the other measures of risky DM. Past research has also reported mainly nonsignificant relationships between behavioural measures of risk taking (e.g., [18, 23–26]; for alternative findings, see [14, 27]). A likely explanation is that these measures each emphasise different processes involved in DM that can contribute to real-world risk behaviour [14, 18, 23–26]. The nonsignificant correlation between DJT and self reported risk-taking propensity (DRPS) observed in the present study is also consistent with the notion that the DJT shares an association with a specific aspect of DM involved in the IGT, rather than with risk-taking behaviour in general.

An aspect of the IGT that is not entailed in the other risky DM measures, and that may thus explain the present findings, is the degree of uncertainty regarding the magnitude of potential choice outcomes. In the IGT, participants can only approximate the contingencies of each choice based on their experience during earlier trials. In the CRT and BART, participants are informed of the exact outcomes at stake before making each choice. While real-world risky DM often involves uncertain outcomes, the self-report nature of the DRPS may bias responses to salient recollections of personal risk behaviour that are more likely to involve explicit risks.

The observed correlations were consistent with there being a stronger link between DJT and risky DM when potential choice outcomes were more uncertain. In particular, correlations with DJT were strongest for the earlier trials of the IGT, less strong for the later trials of the IGT, and were weakest for the other risk tasks involving explicitly stated potential outcomes.

It is conceivable that the DJT, and moral DM in general, involves a comparable form of uncertainty to the IGT, such as in the precise effect removing meals will have on the children's welfare. While the number of meals taken away from each child is explicitly known before participants make their choices in the DJT, the possible range of outcomes caused by depriving recipients of a certain number of meals is ambiguous. It may be objected that there is also uncertainty about outcomes in the CRT and BART; however, the DJT and IGT seem to share a form of uncertainty that isn't involved in the other risk-based DM tasks. Specifically, the DJT and IGT involve uncertainty regarding the range of possible outcomes that might occur (e.g., the effect that removing meals has on each child's welfare in the DJT; the magnitude of potential gains and losses in the IGT), while uncertainty in the CRT and BART relates to whether or not a specific, known reward will be obtained.

Thus, the findings presented here warrant examination of individual approaches to outcome-uncertainty as a factor that may contribute to the preferences displayed in both moral and risky contexts. Previous research has examined the influence of uncertain probabilities in moral and non-moral DM [5, 28]; however, it appears that the influence of uncertainty concerning

the nature and magnitude of potential outcomes has not been a focus of investigation thus far. More clearly defining the effects of the different sources of uncertainty that exist during moral- and risk-based DM is a consideration for ongoing research [29].

Another variable known to influence risk-taking behaviour is whether potential choice outcomes are presented as gains or losses. Specifically, empirical research has indicated that individuals tend to be risk-taking when gambling with potential losses, and risk-averse when gambling with potential gains [30]. Choices in the BART involve only gains, as no virtual money is lost from the running total when gambles fail (i.e., the balloon bursts). In contrast, choices in the IGT and CRT can result in either losses or gains in the running total of virtual money or points. Furthermore, individual losses in the IGT are frequently greater in magnitude relative to gains when compared to losses and gains in the CRT, potentially increasing the salience of the loss structure in the IGT. The DJT involves distributing losses, and hence if the presentation of losses is more salient for the IGT than the other risk tasks, this commonality might explain the stronger association between the DJT and IGT.

The suggested role for uncertainty in moral DM provides a widening of the view that moral dilemmas are fuelled by (a) conflict between reason and emotion [31], and (b) conflict between appeals to what is right versus what provides the best outcome [32]. That is, it may be that outcome-uncertainty also contributes to the difficult nature of moral DM. It is possible that part of the recently described emotional component in moral DM is a response to outcome-uncertainty rather than the distinctly moral elements, concerning the right and the good, of moral dilemmas. Reducing outcome-uncertainty (for example, concerning level of community approval or disapproval in the trolley problem) should then reduce the emotional component in moral DM. The DJT and IGT involve uncertainty regarding both the magnitude of potential outcomes and the probabilities of these outcomes occurring. Results of a recent neuroimaging study suggest that a third form of uncertainty, that of whether an outcome will occur when it has less than 100% chance of occurring, is unlikely to contribute to the involvement of emotion in moral DM [5]. Specifically, activity in brain regions thought to implicate emotion in DM was not affected by decreasing the certainty of potential outcomes occurring during a set of moral dilemmas (i.e., moving the probability of known outcomes occurring towards 50%). It seems intuitively plausible, however, that being required to make a decision when the nature and range of potential outcomes is uncertain might induce anxiety, and further, that this could be pronounced during personal moral dilemmas believed to engage emotion [24]. Analysing the influence of different forms of uncertainty [29] is of importance given the likely prevalence of uncertainty in both hypothetical and practical moral dilemmas, in terms of social outcomes for the decision-maker and indirect outcomes for third parties, for example. The present work also raises the possibility that individual and cross-cultural variation (e.g., [33]) in moral behaviour may be at least in part due to differences in approach to non-moral situational factors, rather than reflecting variation in the value placed in specific moral concerns.

Further research is required to examine in detail how cognitive processes involved in moral and risky DM are related and what underlies individual differences in each domain. Are there genetic contributions to such variation [34]? How is DM in these domains modulated? Are pathological conditions that are known to be associated with anomalies in risky DM [35] also likely to be associated with anomalies in moral DM?

The findings presented here indicate that within individuals, a relationship exists between distributive justice preferences and risk-based preferences in the IGT. This relationship suggests that further study is warranted into the commonalities between moral and risk-based preferences, with relevance to cognitive neuroscience and moral philosophy.

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