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Social discounting rate is negatively correlated with fluid intelligence

Jerzy Osiński, Paweł Ostaszewski, Adam Karbowski

Abstract

The purpose of the study was to verify a hypothesis, inspired by the handicap principle, of a positive relationship between subjective value of a hypothetical monetary reward shared with others and the level of fluid intelligence. Manipulation involved the amount of reward to be shared (small vs. large amount) and subject's relationship to recipients (related vs. unrelated). As expected, a positive correlation was found between the subjective value of a reward to be shared with others, measured as the area under the curve for the discounting function and Raven Advanced Progressive Matrices scores, but the relationship was only present for rewards shared with relatives. In addition, participants who made altruistic choices in all items scored higher in RPM than those who were not as consistent. The implications of results for the evolutionary interpretation of the relationship between intelligence and altruism are discussed.

Keywords: Altruism, Social discounting, Temporal discounting, Intelligence, Costly signalling

1. Introduction

According to the handicap principle (Zahavi, 1975; 2003; Smith & Bliege Bird, 2001) costly altruistic behaviour may serve as a so-called “costly signal”, providing a reliable indication of individual characteristics relevant to survival. The signal’s costliness means that individuals with “inferior” genes cannot afford or are unable to emit it. This way its recipients can obtain reliable information about the genetic quality of potential sexual or social partner. Consequently, altruists benefit by enhancing their sexual and social attractiveness. Natural selection should therefore favor both the individuals capable of emitting costly signals, and those that choose their partners on the basis of such signals.

Altruism can thus be a costly signal available only to individuals with high fitness levels. According to Millet & Dewitte (2007), one of the traits signalled by altruistic behaviour may be intelligence defined as the *g* factor (Spearman, 1927). Intelligence can be an all-purpose survival tool for solving a variety of adaptation problems, from challenges presented by the physical environment to issues encountered in social interaction. From the perspective of Millet & Dewitte’s hypothesis referenced above, particularly important is the relationship between intelligence and access to resources. Studies have demonstrated that as a predictor of socioeconomic status intelligence is more accurate than the status of parents (Gottfredson, 2004). Whether measured in childhood or adulthood, intelligence is predictive for the social status of occupation and income (correlation of 0.51 and 0.31, respectively) (Judge, Higgins, Thoresen & Barrick, 1999). Indirectly, the relationship between intelligence and access to resources is confirmed by studies that have shown the level of general intelligence to be correlated with offspring survival rates (Čvorović, Rushton & Tenjevic, 2008) and life span (Gottfredson & Deary, 2004; Rushton, 2004).

Thus, taking the handicap theory as our point of departure, we can assume that sharing or giving away resources is less costly for highly intelligent individuals than for those with

lower IQ. In accordance with that hypothesis, Millet & Dewitte (2007) posited that altruistic individuals (contributing above the minimum required to obtain the provision point in a public goods game) score higher in the Raven Advanced Progressive Matrices test compared to egoists investing below the minimum and cooperating individuals investing exactly the minimum. Dewitte & De Cremer, 2005 (quoted in: Millet & Dewitte, 2007) also found that students investing in public good above the minimum share had better grades than students investing the minimum or below, which may suggest that altruism is related to intelligence (as far as grades are associated with intelligence). In a study on twins, Segal & Hershberger (1999) found a relationship between results in Wechsler's test and choices in the iterated prisoner's dilemma: higher IQ of players was associated with more choices of simultaneous cooperation ($r = 0.31$) and fewer of mutual exploitation ($r = -0.27$).

In that approach, altruism is one of the possible factors for assessing potential partner's intellectual capacity. Although there is no direct evidence that altruism is perceived as a characteristic of intelligent individuals (Möttus, Allik, Konstabel, Kangro & Pullmann, 2008), research has shown that it is a desirable trait in sexual partners (although this could be a function of direct benefits from interaction with such individuals rather than the signalling functions of altruism) (Phillips, Barnard, Ferguson & Reader, 2008) and that individuals making high contributions for the public good are elected to be leaders (Hardy & Van Vugt, 2006). Thus, altruists benefit by enhancing their sexual and social attractiveness, which, due to the high cost of altruistic behaviours, should be more available to people with higher IQ.

The handicap principle-inspired interpretation of the relationship between intelligence and altruism refers to ultimate causes, i.e. the adaptive implications of that relationship: signalling one's quality through altruistic behaviour promotes biological interests of highly intelligent individuals. However, since psychology focuses on proximate causes, we should address the issue of mental mechanisms underlying that relationship. Some clues are offered

by studies investigating how the rate of temporal discounting is related with intelligence and altruism/cooperation. Firstly, there is an empirically confirmed negative relationship between intelligence and temporal discounting, which means that self-control increases with intelligence while preference for smaller but immediate rewards decreases (Shamosh & Gray, 2008). The mechanism of this relationship is unclear. Since working memory load is associated with faster temporal discounting (Hinson, Jameson & Whitney, 2003), the relationship in question may stem from the working memory's involvement in intelligence by maintaining an active mental image of the goal and integrating diverse information (Shamosh & Gray, 2008). An alternative explanation is offered in the meta-analysis by Shamosh & Gray (2008), which showed that taking into account non-verbal intelligence resulted in only a slight increase in the relationship between intelligence and temporal discounting. We can therefore assume that high verbal intelligence is what primarily facilitates the use of verbal strategies helping to maintain self-control (Olson, Hooper, Collins & Luciana, 2007).

Secondly, temporal discounting is correlated with choices that can be located on the altruism vs. egoism continuum. We know from research that temporal discounting is negatively correlated with the size of contributions in a public goods game (Curry, Price & Price, 2008) and the number of cooperative choices in the iterated Prisoner's Dilemma (Harris & Madden, 2002; Yi, Buchhalter, Gatchalian & Bickel, 2007), and positively correlated with social discounting, i.e. decreased subjective value of a reward due to it being consumed in part or in whole by others (Jones & Rachlin, 2009). A possible explanation of this relationship could be the delay in reinforcement for altruistic behaviour. Altruistic acts carry immediate costs, while potential benefits (which may compensate or even overcompensate these costs, such as social approval, prestige, reciprocation) emerge in a long-term perspective (Rachlin, 2000; 2002). Consequently, individuals who find a delay in obtaining a reward more devaluing may be less willing to engage in altruistic behaviour.

According to Millet & Dewitte (2007), individuals with higher IQ may find it easier to adopt a wider, more temporally extended perspective, which enables them to forego the immediate benefits associated with egoistic choices. However, the aspect of time does not have to be the sole determinant of this effect. According to Rachlin & Locey (2011), another important factor is the ability to see how the interests of others overlap with our own goals, which is the main factor reflected in the rate of social discounting. These authors point out the parallels between temporal and social discounting, since the former can be described as perceiving the relationships between present and future self, and the latter as awareness of the relationships between self and others. If the rate of temporal discounting depends on intelligence, it begs the question whether a similar relationship obtains with respect to discounting in the social sphere.

A mutual relationship is stronger, and consequently easier to recognize in the case of relatives. Consequently, the association of kin altruism with intelligence may be weaker than in the case of non-kin altruism, where a mutual relationship is less evident. For that reason we decided to take kinship into account in our analysis of the relationships between intelligence and altruism. From the handicap principle perspective, this relationship is expected to be more pronounced when beneficiaries are unrelated than in the case of relatives (being less attractive recipients of the signal since they cannot be sexual partners) or relatedness to beneficiaries should have no effect on.

The purpose of our study was to assess the relationship between altruism defined as the rate of social discounting and general intelligence. We decided to measure social discounting using the method proposed by Rachlin & Raineri (1992), i.e. through choices between a reward for oneself only and a reward to be shared with an increasing number of other people. This method of measuring altruistic tendencies should detect the relationship between altruism and intelligence predicted by the handicap principle, since the participants'

personal benefit diminishes as the number of people rises (driving up the cost of altruistic behaviour). Consequently, in order to avoid participants' doubts resulting from having different numbers of kin at particular degrees of relatedness, the kinship manipulation involved the most general level - by specifying the group with which the reward was to be shared as kin or non-kin.

To sum up, in view of the empirical findings discussed above, social discounting is likely to be associated with intelligence, at least to the extent temporal discounting is involved in subjective evaluation of a reward to be shared with others. People with higher IQ should demonstrate a lower rate of social discounting (i.e. there should be a positive correlation between the level of intelligence and subjective value of a reward to be shared with others). In addition, subjective value of a shared reward should depend not only on expected future benefits, but also on the degree to which the subject sees his interests as compatible with the interests of others. The degree to which those interests are perceived as common appears to rely, among other things, on the ability to recognize the mutual dependence, which may be enhanced by intelligence. We can therefore predict that when the rate of temporal discounting is controlled for, the relationship between social discounting and intelligence should still be present. Finally, we expect the relationship between intelligence and social discounting to be present regardless of kinship manipulation, or to be stronger when the beneficiaries are non-kin.

2. Methods

2.1. Participants

Participants were 60 students of two higher education institutions – the Faculty of Psychology at the University of Warsaw ($n = 44$) and the Warsaw School of Economics

($n = 16$) aged 18-30 years (mean age 21.25, standard deviation 2.350), 30 females and 30 males.

2.2. *Materials*

The rate of social discounting and temporal discounting was measured using computer software.

In the social discounting portion, participants made hypothetical choices between a smaller monetary reward exclusively for themselves (option A) or a larger reward which they had to share equally with a specific number of people (1, 3, 9, 19; option B). Participants solved six choices for each value of the “number of recipients” factor. The amount of money in option B was fixed, while in option A it changed according to a titration algorithm described by Holt, Green and Myerson (2003), i.e. in the first item it was half of the amount in option B, and in subsequent items it was increased or decreased depending on a given participant’s choices. If in the first choice the participant preferred option A (amount for himself), in the second the amount of option A was reduced by half; if he chose option B (amount to be shared), the amount of option A was increased by 50%. With each choice the amount in option A was titrated by half of the preceding change. The amount A achieved after the sixth choice was accepted as indifference point, i.e. the approximate measure of the subjective value of the reward to be shared equally with a given number of people. Each participant solved four series of items including six choices for each number of people. Each series featured a different combination of the two characteristics of option B: relation to recipients (relatives or unrelated) and the amount of reward (PLN 600 or PLN 100,000; the larger amount was the equivalent of approximately 40 average monthly salaries). The sequence of the series varied on the basis of the Latin square. Within a series, items appeared in a fixed sequence determined by increasing numbers of people in option B. The first items of individual series were as follows:

- (1) option A: PLN 300 for you alone
option B: PLN 600 to be shared with one person related to you (PLN 300 each)
- (2) option A: PLN 50,000 for you alone
option B: PLN 100,000 to be shared with one person related to you (PLN 50,000 each)
- (3) option A: PLN 300 for you alone
option B: PLN 600 to be shared with one person unrelated to you (PLN 300 each)
- (4) option A: PLN 50,000 for you alone
option B: PLN 100,000 to be shared with one person unrelated to you (PLN 50,000 each)

The same titration procedure was used to measure the rate of temporal discounting. Participants made hypothetical choices between a changing amount of money available immediately and the amount of PLN 100,000 available with delay (1 month, 6 months, 1 year, 5 years). The following choice was presented first:

- (1) option A: PLN 50,000 for you immediately
option B: PLN 100,000 for you in a month's time

Intelligence was measured using Raven Advanced Progressive Matrices (RPM).

2.3. Procedure

Participants completed the study individually. They started with the social discounting problems, followed by the temporal discounting choices (there was no time limit). IQ measurement was the last procedure in order to avoid subjective impressions associated with anticipated results on the rate of discounting. Following a 5-minute trial session (12 items),

participants were asked to solve as many items in the test series (out of 36) as they could in 20 minutes.

3. Results

In order to verify the predictions, the rate of discounting was calculated using the method proposed by Myerson, Green and Warusawitharana (2001). This method involves computing the area under the curve obtained by connecting successive points representing the subjective values of the reward as the quantity of the independent variable increases (here: number of people with whom the reward was to be shared or length of delay). The area under the curve (AUC) is inversely proportional to the rate of discounting.

As noted by Johnson and Bickel (2008), a phenomenon commonly observed in research on discounting is that data obtained from some participants demonstrate non-systematic variability in successive estimate indifference points. For example, as delay time increases in successive items, the subjective value of reward oscillates (either increases or decreases). For those participants, it is difficult to determine if their decisions are governed by some underlying, irrational principle, or whether they make their choices carelessly or randomly. Johnson and Bickel (2008) recommend removing any dubious results from the dataset before analysis.

Accordingly, the analysis was conducted only on participants who made consistent choices in each series of items used to measure the rate of discounting (i.e. all items in a given combination of relatedness and reward amount for social discounting; only one series of items was used in the measurement of temporal discounting). Choices were considered consistent if the subjective value of the reward (to be shared or delayed) for the lower value of the discounting factor (number of people or length of delay) was always greater than/equal to or always lower than/equal to the one determined for the higher value of the discounting factor.

The procedure eliminated 9 participants from the dataset. There were no differences in RPM scores between that group and participants who made consistent choices ($n = 51$) ($U = 766$, n.s.; means 22 and 22.941 respectively, medians 22 and 23). No gender differences were found in the analysed group ($t(48) = 0.72$, n.s., mean for females 22.48, $n = 25$, mean for males 23.40, $n = 26$). There were also no differences between the students of the Warsaw School of Economics ($n = 14$) and the University of Warsaw ($n = 37$) ($U = 257.5$, n.s.; means 22.64 and 23.05 respectively, medians 23 and 24).

--Fig. 1--

As shown in Figure 1 and Table 1, there was a statistically significant positive correlation between RPM scores and AUC for rewards shared with relatives, regardless of the actual size of reward (small reward: $r = 0.357$, large reward: $r = 0.309$). By contrast, there was no significant correlation between RPM score and AUC for rewards shared with unrelated people. No significant correlation was found between the rate of temporal discounting and intelligence, although the correlation coefficient between RPM score and AUC was relatively high ($r = 0.231$, $p = 0.103$). The rate of temporal discounting was not correlated with the rate of social discounting.

--Tab. 1--

The analysis of partial correlations in which the rate of temporal discounting was controlled for did not alter the picture of the relationships between RPM scores and social discounting rate (Table 2).

--Tab. 2--

Similarly to the analysis conducted by Milette and Dewitte (2007), we planned to compare RPM scores of altruists and egoists. However, analysis yielded only the “altruists” category ($n = 42$), i.e. those participants for whom the subjective value of a reward to be shared with others in all variations (number of people, relatedness, reward size) was higher than their own share in that reward (“consistent altruists”). None of the remaining 9 participants fulfilled the egoism criterion (subjective value of the reward to be shared below own share in all variations) (“inconsistent altruists”). Comparison of the two groups’ RPM scores using Mann-Whitney’s U test revealed no significant differences ($U = 124.5$, $p = 0.112$), although consistent altruists scored slightly higher (mean 23.381, median 24) than inconsistent altruists (mean 20.889, median 22).

In the "reward to be shared with relatives" condition only 2 participants did not meet the "consistent altruism" criteria, compared with 8 in the "reward to be shared with unrelated recipients" condition. A comparison of “consistent” and “inconsistent” altruists identified on the basis of choices made when the reward was to be shared with unrelated recipients showed that the former scored higher in RPM (mean 23.535; median 24) than the latter (mean 19.751; median 21.5) ($U = 85.5$; $p < 0.05$).

4. Discussion

The aim of the study was to assess the relationships between intelligence and rate of social discounting. It was expected that: first, there would be a negative correlation between the two variables (i.e. there should be a positive correlation between the level of intelligence and subjective value of a reward to be shared with others), and second, that the relationship would still be present if the rate of temporal discounting was controlled for.

Our results confirmed these predictions. There was a moderate positive relationship between the level of intelligence (RPM score) and subjective value of a reward to be shared (area under discounting curve), and the magnitude of this relationship remained the same with statistical control of the temporal discounting rate.

However, analysis of correlation revealed the expected interrelation only in the case of discounting a reward shared with relatives. On the other hand, we also found that participants for whom the value of shared rewards in all choices was greater than their own share scored slightly higher in RPM than less consistent altruists. When the comparison was narrowed down to individuals who differed in terms of consistency of altruism in choices regarding the reward shared with unrelated beneficiaries (the criterion of consistent altruism in the "reward shared with relatives" condition was met by almost all participants), the difference became statistically significant. The results obtained for that comparison confirm the interpretation proposed by Shamosh and Gray (2008) that the effect of intelligence may be reflected in the consistency of choices: people with lower IQ may be less consistent. Although the underlying cause of poorer consistency could be working memory, in the light of our results (including the fact that the subset of participants removed from the dataset due to unsystematic response variability did not differ from others in terms of intelligence) a more likely explanation seems to be the involvement of a motivational variable. The fact that consistency was higher in the case of rewards shared with relatives may indicate that participants were more involved when making these choices.

It is worth noting the high level of altruism, manifested by the clear advantage in the number of participants who valued a reward to be shared higher than their own share in that reward. An equally high level of altruism was found in another study (Ostaszewski & Osiński, 2011), which employed similarly structured choices. To some extent, participants' responses may be modified by the social approval factor, but it seems unlikely that this variable could

significantly affect the relationship between intelligence and social discounting. There is a possibility that people with higher IQ were more adept at recognizing the aim of the study and attempted to present themselves in a better light. However, if self-presentation were the underlying principle of the correlation between intelligence and social discounting, the relationship would be less dependent on relations with the recipient.

In contrast to Jones and Rachlin (2009), we found no significant relationship between the rate of social discounting and the rate of temporal discounting, which nevertheless can be explained by the differences in the structure of choices used in the two studies (in Jones & Rachlin participants were choosing between a reward for themselves only and a reward for another person at a particular social distance from the subject). No significant correlation was found between intelligence and the rate of temporal discounting, although the correlation coefficient between RPM score and AUC ($r = 0.231$) was relatively high compared to other correlations obtained for the rate of temporal discounting variable. This result is consistent with previous reports identifying verbal intelligence as the main cause of the relationship between the rate of temporal discounting and general intelligence (Shamosh & Gray, 2008).

In conclusion, it is necessary to determine whether the present results have confirmed the evolutionary interpretation of the relationship between intelligence and altruism. Theoretically, if we accept the handicap principle, being related or unrelated to recipients should not affect that relationship or the effect should be more pronounced in the case of altruistic behavior towards non-relatives. Yet, our findings indicate that intelligence may have a greater effect on altruistic behaviour towards relatives. It seems to suggest that our results may reflect the mechanism involved in increasing inclusive fitness rather than costly signalling. Hamilton's (1964) inclusive fitness theory holds that genetically promoted tendencies to help kin have a selective advantage. Relatives of people with high IQ (whose likelihood of being highly intelligent themselves is proportional to the degree of relatedness)

would have better chances of survival, and the high level of intelligence in humans could be partly interpreted as the result of kin selection.

However, the demonstrated relationship between intelligence and altruism may be affected by the ecological validity of the social situation. In the Millet and Dewitte (2007) study, which demonstrated this relationship for choices concerning relations with unrelated persons, participants thought they were involved in a game with actual people. Such circumstances could facilitate the activation of an evolutionarily developed psychological mechanism. In our study, participants were fully aware that their choices were hypothetical, so the information on being related to recipients may have been the sole impulse which stimulated their involvement on the emotional level and increased the chances of activating the adaptive mode of decision-making.

To sum up, the present study has found a positive relationship between intelligence and altruism with respect to economic decisions. This result is consistent with reports from a handful of other studies that have investigated this issue. In addition, our findings indicate that the relationship between intelligence and altruism may depend on the relationship with the recipient, which is a valuable addition to existing knowledge. It should be noted that this study was not free of limitations. Firstly, due to a relatively small sample null results should be approached with caution. Secondly the choices it employed referred to hypothetical alternatives, it would be advisable to verify the results in a study in which decisions would be made in a more realistic setting. Furthermore, no egoists were identified among the participants. Finally, intelligence is one of those traits which may affect choices made by people across a range of aspects. Therefore, our findings do not provide the ultimate answer to the question of the mechanism underlying the relationship between intelligence and altruism but rather pave the way for further enquiry.

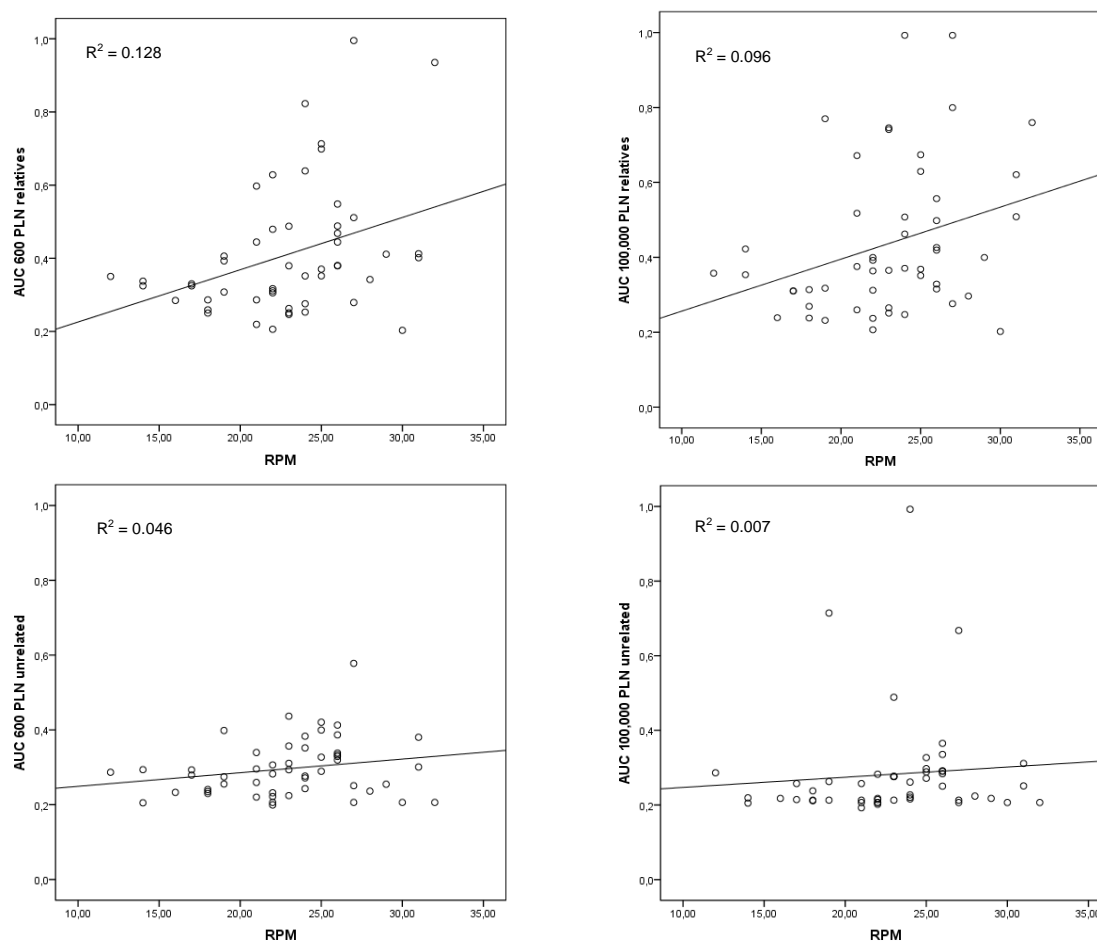
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Fig. 1. Scatter plots of correlations between the RPM scores and AUC depending on the combination of reward amount (PLN 600 vs. PLN 100,000) and relationship to beneficiaries (relatives vs. unrelated).



Tab. 1

Pearson's correlations between RPM score and discounting AUC.

	AUC 600 PLN relatives	AUC 100,000 PLN relatives	AUC 600 PLN unrelated	AUC 100,000 PLN unrelated	AUC delayed 100,000 PLN
RPM	0.357*	0.309*	0.214	0.085	0.231
AUC 600 PLN relatives		0.634*	0.296	0.058	0.106
AUC 100,000 PLN relatives			0.502*	0.615*	0.025
AUC 600 PLN unrelated				0.609*	0.009
AUC 100,000 PLN unrelated					-0.171

* $p < 0.05$

Tab. 2

Partial correlations (rate of temporal discounting controlled for) between RPM score and discounting AUC.

	AUC 600 PLN relatives	AUC 100,000 PLN relatives	AUC 600 PLN unrelated	AUC 100,000 PLN unrelated
RPM	0.344*	0.312*	0.218	0.130
AUC 600 PLN relatives		0.638*	0.270	0.077
AUC 100,000 PLN relatives			0.502*	0.628*
AUC 600 PLN unrelated				0.620*

* $p < 0.05$