

The Understanding of Cognitive Abilities in Asperger's Disorder by Using a Modified Prisoner's Dilemma Game with a Variable Payoff Matrix

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Abstract The subjects with Asperger's Disorder (ASP) have difficulties in social interaction. The Prisoner's Dilemma (PD) is a well-known model in game theory that illustrates the paradoxical disposition of interaction between two individuals. We investigated the cognitive characteristics of ASP by using a PD game. The subjects were 29 individuals with ASP and 28 healthy controls. In the PD game, each player has two cards: card 1 (cooperation) and card 2 (betrayal). The score each player obtains is decided depending on the combination of their selections according to a 2 x 2 payoff matrix. The P-score ("P" for punishment) is defined as the score that is given when they both select betrayal. Both the P-score at the end of the PD game and the total score were significantly higher in the ASP group although the rate of cooperative selection (the choice of Card 1) revealed no statistically significant difference between ASP and controls. ASP might be free of the dilemma that commonly arises among two persons because of social deficits in ASP subjects. The PD game might be a useful diagnostic support tool to understand the cognitive abilities in ASP.

Keywords: *Asperger's Disorder, Pervasive Developmental Disorders, Autism, Prisoner's Dilemma, game theory*

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1. Introduction

Asperger's Disorder (ASP) is one of the five subgroups of Pervasive Developmental Disorders (PDD) [1]. Individuals with ASP have difficulties in social reciprocity, in providing appropriate sympathy and cooperative behaviors and in the use of multiple nonverbal behaviors such as eye-to eye contact, facial expression, and gestures to regulate social interaction. As a result, patients with ASP can misinterpret feelings and intentions of others.

The Prisoner's Dilemma (PD) is a well-known model in game theory, which illustrates the paradoxical disposition of interaction between two individuals with opposing interests [2]. PD is frequently cited to describe the situations in which two persons choose different actions in an attempt to maximize their returns and as a result, often cause irrational results.

In this study, we investigated the cognitive characteristics of ASP by using a modified PD game with a variable payoff matrix in which the payoffs are determined not only by their own immediate behaviors but also by the past history of their interaction.

2. Subjects

The subjects of this study were 29 adolescent individuals (male/female =17/12) who met the following inclusion criteria: 1) age of 15 and over, 2) complete the Japanese version of Wechsler Adult Intelligence Scale (WAIS)-III, 3) be diagnosed with ASP based on DSM-IV-TR criteria, and 4) full-scale IQ (FSIQ) on WAIS-III of 85 or higher. The normal control group consisted of 28 age- and IQ-matched subjects (male/female =18/10). All control subjects were interviewed to exclude psychiatric or developmental disorders. Informed written consent was obtained from all subjects

3. Methods

In the PD game used in this study, two players receive two cards: Card 1 (cooperation) and Card 2 (betrayal). The score each player obtains is decided according to the 2 x 2 payoff matrix making four different patterns of scores; (from the viewpoint of player A) Reward for mutual cooperation (both selected Card 1, score 4/4 for A/B), Punishment (P-score) for mutual defection (both selected Card 2, both were given P-score which was set -4 at the beginning of the game and varied by their behaviors later on), Temptation (Card 2 by A and Card 1 by B, score 5/-5 for A/B) and Sucker (Card 1 by A and Card 2 by B, score -5/5 for A/B). Regarding the variable P-score, if both

players indicate Card 1 at trial N, the P-score for trial N+1 was increased by 1, whereas both players indicate Card 2 at trial N, the P-score for trial N+1 was decreased by 1. Thus, to reach higher points together, both players need to cooperate for this purpose. The details of the PD game used in this study were published previously [3].

4. Results

The selection behaviors of the subjects are categorized into 3 groups according to the following definitions: Defect, player B chose Card 2 (betrayal) at the N trial, although player A showed Card 1 at the N-1 trial; Concession, player B chose Card 1 (cooperation) at the N trial, although player A showed Card 2 at the N-1 trial; Fit for Tat (TFT), at the N trial, player B chose the same card that player A selected the previous (N-1) trial.

Both the P-score at the end of the game and the total score were significantly higher in the ASP group compared to the control. The rate of cooperative selection (the choice of Card 1) revealed no statistically significant difference between the 2 groups. Regarding the pattern of card selection behavior, the rate of concession was significantly higher in the control group suggesting an attitude of cooperation with the other player.

5. Conclusions

The essential features of ASP are severe impairment in reciprocal social interaction and the restricted, repetitive patterns of behavior, interests, and activities. The results of our present study suggest that the subjects with ASP might be free of the dilemma that commonly arises among two persons because of social deficits in ASP. The analysis of the shape of the fluctuation of P-score revealed that in the ASP group only 2 cases (6.9%) showed continuous decrease of P-score compared to 8 control cases (28.6%), which could be related to the dilemma in game theory. Taken together, we hypothesize that the ASP group was not affected by the dilemma and ultimately achieved higher scores compared to the control group. The PD game might be used as a diagnostic support tool for ASP.

Statement of Competing Interests

The author has no competing interests.

References

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