The Contribution of Apathy and Increased Learning Trials to Risky Decision-Making in Parkinson’s Disease

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Abstract

Impairments in executive functioning are commonly found in Parkinson’s disease (PD); however, the research into risky decision making has been mixed. The present study sought to investigate three potential hypotheses: difficulty learning the task probabilities, levodopa equivalent dose (LED), and the presence of apathy. Twenty-four individuals with idiopathic PD and 13 healthy controls completed the Frontal Systems Behavior Scale to assess current apathy, the Iowa Gambling Task, and the Balloon Analog Risk Task (BART). Results indicated that individuals with PD selected more from Deck B, a disadvantageous deck. However, with an additional set of trials, participants with PD and apathy selected more from the most risky deck (Deck A). Apathy was not related to the BART, and LED was not related to either task. Results indicate that apathy is associated with decision-making in PD, and providing additional learning trials can improve decision-making in PD without apathy.

Keywords: Parkinson’s disease; Decision making; Apathy; Iowa Gambling Task; Balloon analogue risk task

Introduction

Parkinson’s disease (PD) is a chronic neurological disorder associated with the depletion of dopamine in the substantia nigra and associated structures. Prominent executive dysfunction is the most common cognitive correlate in the disorder (Daum et al., 1995; Dubois, Pillon, Lhermitte, & Agid, 1990; Lees & Smith, 1983). Risky decision-making is one area of executive functioning that has gained recent research interest in PD, likely due to reports of increased impulse control disorders and risk-taking behavior in PD and the use of dopamine agonist medications (Dodd et al., 2005; Weintraub et al., 2006, 2010). As individuals with PD face numerous important decisions regarding treatment, work, and other aspects of life, it is important for clinicians and researchers alike to understand the nature of decision-making impairments that accompany PD.

Risky decision-making is typically assessed through lab-based behavioral tasks, such as the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994). On the IGT, participants select cards one at a time from one of four decks, learning the relative risks and benefits associated with each deck during the course of the 100 selections. Two decks are disadvantageous (i.e., higher immediate rewards but long-term negative outcomes) and two decks are advantageous (i.e., lower immediate rewards but long-term positive outcomes; Bechara et al., 1994). Impaired performance on the IGT has been linked to prefrontal cortex functioning such as focal frontal lobe damage, damage to the amygdala and frontotemporal dementia (see Buelow & Suhr, 2009, for a review).

To date, research into IGT performance in PD has been mixed. Of the published studies, nine have shown riskier performance in PD versus age-matched controls (Delazer et al., 2009; Gescheidt et al., 2012; Ibarretxe-Bilbao et al., 2009; Kawamura &
Kobayakawa, 2009; Kobayakawa, Koyama, Mimura, & Kawamura, 2008; Kobayakawa, Tsuruya, & Kawamura, 2010; Mimura, Oeda, & Kawamura, 2006; Pagonabarraga et al., 2007; Perretta, Pari, & Beninger, 2005). In contrast, four studies showed no significant between-group differences (Czernecki et al., 2002; Euteneuer et al., 2009; Stout, Rodawalt, & Siemers, 2001; Thiel et al., 2003). Two additional studies compared subgroups of PD participants: individuals post-Deep Brain Stimulation (DBS) surgery (with no statistically significant change in medication dose post-surgery) showed improved decision-making on the IGT in comparison with matched-PD participants without DBS surgery (Oyama et al., 2011), and those with a diagnosis of PD with pathological gambling made riskier decisions on the task than those with PD only (Rossi et al., 2010). Of note, the examination of the patterns of performance in these two studies indicated that the DBS group would likely still be categorized as showing risky decision-making on this task in comparison with healthy controls (HCs), whereas the performance of those in the PD without the pathological gambling group would likely be consistent with HC performance. In sum, significant variability exists between studies in the pattern of performance on the IGT and in the relationship of risky decision-making with PD status.

It is unclear why there are such discrepant findings in studies of the IGT in PD. Both depression and dementia would not account for discrepancies, since they were exclusion criteria in several studies (Czernecki et al., 2002; Euteneuer et al., 2009; Ibarretxe-Bilbao et al., 2009; Kobayakawa et al., 2008; Mimura et al., 2006; Pagonabarraga et al., 2007; Perretta et al., 2005; Stout et al., 2001; Thiel et al., 2003) Also, no correlations were found between IGT performance and performance on other executive function measures (Mimura et al., 2006; Oyama et al., 2011; Rossi et al., 2010), so impaired executive functioning cannot alone account for this discrepancy on the IGT. There is some evidence that dopamine dosage levels can affect risk-taking behaviors (Frank, 2005; Frank, Seeberger, & O’Reilly, 2004), and thus further examination of the potential relationship between dopamine dosage and decision-making task performance is needed.

Risk decision-making and risk-taking have been investigated in PD utilizing another behavioral measure, the Balloon Analogue Risk Task (BART; Lejuez et al., 2002). On the BART, participants earn money by pumping up a balloon, but the earned money is lost if the balloon pops. Thus, participants have to weigh the relative risks and benefits of each successive pump. No differences were found in level of risk-taking on the BART when individuals with PD were compared with HC participants (Simioni, Dagher, & Fellows, 2012), but on a variation of the BART with 50 extra trials, Claasen and colleagues (2011) found that individuals with PD and an impulse control disorder performed riskier on the BART than those with PD but no impulse control disorder. Thus, it may be the presence of an impulse control disorder, not the presence of PD per se, that affects decision-making on this task. In sum, inconsistencies have been seen in performance on the IGT, and results with the BART have shown that impulse control disorders, not PD itself, may affect decision-making.

Apathy could also be affecting risky decision-making. Apathy can be defined as a loss of motivation and difficulty with initiation, persistence, and social engagement (Dujardin et al., 2007; Marin, 1991) and is associated with frontal lobe dysfunction (Cummings, 1993; Levy & Dubois, 2006). Prevalence of apathy in PD is difficult to assess, but estimates place it between 16.5% and 70% (Aarsland et al., 1999; Isella et al., 2002; Pluck & Brown, 2002). Apathy can occur in the absence of depression (Kirsch-Darrow, Fernandez, Marsiske, Okun, & Bowers, 2006), which supports the hypothesis that apathy and not depression affected performance on the IGT and BART. In addition, high levels of apathy can negatively affect performance on cognitive tasks among individuals with PD (Dujardin et al., 2007; Pluck & Brown, 2002), including on other measures of executive functions (Isella et al., 2002; Pessiglione et al., 2005). Good decision-making on the IGT and BART requires understanding of and sensitivity to rewards and punishments, and the presence of apathy in PD may help to explain the previous inconsistencies.

A final hypothesis is that individuals with a diagnosis of PD are experiencing difficulties learning the relative risks/benefits of each deck on the IGT, which would mimic impaired performance on the typical 100 trial IGT. In fact, several studies showed a pattern of performance among PD participants that could potentially reflect this slowed learning (i.e., switching to advantageous selections after 80 trials instead of 40–60 trials; Delazer et al., 2009; Ibarretxe-Bilbao et al., 2009; Oyama et al., 2011; Perretta et al., 2005). Individuals with PD may need additional trial-and-error attempts to learn from both positive and negative outcomes. Poorer outcomes have been shown on other cognitive tasks when individuals with PD must utilize trial-and-error feedback to learn (Ashby, Alfonso-Reese, Turken, & Waldron, 1998; Knowlton, Mangels, & Squire, 1996; Shohamy et al., 2004); thus, it is possible that risky decision-making in PD may disappear when additional learning trials are administered.

The present study sought to examine risky decision-making in PD as a function of levodopak equivalent dose (LED), apathy, and additional learning trials. The first study aim was to examine performance on the IGT and BART as a function of PD diagnosis, in order to attempt to clarify the discrepant findings on previous studies of the IGT and BART in PD. The second aim was to examine the effect of apathy on IGT and BART performance. It was hypothesized that individuals with PD and high levels of apathy would exhibit riskier performance on the tasks than individuals with PD but low levels of apathy and HCs. The third aim was to examine whether difficulties learning the relative risks and benefits on the IGT were due to a slowed rate of learning. It was hypothesized that performance on the IGT among individuals with PD would not be significantly different from performance on the IGT among controls during an additional 100 trials of the task. The final aim was to examine whether LED was associated with decision-making.
Method

Participants

PD patients were recruited from the Movement Disorders Clinic at a local hospital. Interested patients at the clinic completed a contact form to allow for telephone screening. Inclusion criteria included: (a) diagnosis of idiopathic PD made by movement disorders neurologist using UK Brain Bank criteria; (b) aged 45–79; and (c) stable on medication regimen for the previous 30 days. Participant age was restricted to 45–79 due to age-related changes on the IGT (Denburg, Recknor, Bechara, & Tranel, 2006; Denburg, Tranel, & Bechara, 2005; Fein, McGillivray, & Finn, 2007). Exclusion criteria included: (a) clinically significant depressive symptoms on the Geriatric Depression Scale, Short Form (GDS-S; total score greater than 7 for adequate sensitivity and specificity per Sheikh & Yesavage, 1986a, 1986b); (b) previous diagnosis of dementia or mild cognitive impairment (as indicated by patient or neurologist report); (c) history of pathological gambling (due to effects on the IGT; Buelow & Suhr, 2009); (e) history of significant head injury (i.e., loss of consciousness greater than 10 min); or (f) Mini-Mental Status Examination (MMSE) score less than 25.

An a priori power analysis for an analysis of variance (ANOVA) comparing three groups to detect a medium effect size with $\alpha = 0.05$ indicated that a sample size of 12 participants per group was needed to obtain a power of 0.95. Inclusion and exclusion criteria, with the exception of MMSE score, were assessed via a preliminary telephone screening. Of the 37 PD patients who completed the telephone screening, 11 had one or more exclusion criteria ($n = 5$ over age 79, $n = 4$ with history of head injury, $n = 1$ with clinically significant depression, $n = 1$ with a diagnosis of dementia). In addition, two eligible participants declined to participate, leaving a final sample of 24 PD patients. All but two patients were currently treated with levodopa or a dopamine agonist, with an average LED across participants (calculated according to Pahwa et al., 1997) of 468.35 ($SD = 319.74$). Disease severity was in Hoehn and Yahr stages II–IV ($n = 21$ Stages II and III; $n = 1$ Stage IV).

Ten of the PD participants either self-reported or a family member or friend reported, a clinically significant level of current apathy (“PD with apathy” group) as assessed with the Frontal Systems Behavior Scale (FrSBe; Grace & Malloy, 2001). An additional 14 HC subjects were recruited from the friends and family members of PD participants. Participants in the HC group had no history of neurological disorder, and the exclusion criteria for the PD group were also applied to the HC group. One HC participant endorsed a significant level of apathy and was removed from further analysis.

Measures

Iowa Gambling Task. Participants completed the standard computerized version of the IGT (Bechara, 2008; Bechara et al., 1994). Individuals start with $2,000 and are told to maximize profit by selecting 100 cards, one at a time, from one of the four decks. On each draw, selections from Decks A and B yield an average profit of $100, whereas selections from Decks C and D yield an average profit of $50. But, after 10 selections from Decks A and B, individuals have incurred a net loss of $250, whereas 10 selections from Decks C and D results in a net gain of $250. Based on these long-term outcomes, Decks A and B are “disadvantageous” and Decks C and D “advantageous” (Bechara et al., 1994). Of note, participants in the present study completed an additional 100 trials of the IGT in order to examine the effects of learning on performance. Participants first completed the standard 100 trial IGT, which was then restarted for the second 100 trials. All decks refilled prior to the administration of the additional 100 trials.

IGT scores were calculated as follows. On the IGT, the first series of selections is termed decision-making under ambiguity, as participants do not know much about the relative risks and benefits of each deck (Brand, Recknor, Grabenhorst, & Bechara, 2007). The final 60 (Brand et al., 2007) or 40 (Ko et al., 2010; Noel, Bechara, Dan, Hanak, & Verbanck, 2007) trials are considered decision-making under risk, with risky decision-making on this task defined as continued selection from disadvantageous decks during these trials. We examined only Trials 61–100 (Ko et al., 2010; Noel et al., 2007), as we were concerned with decision-making under risk and not decision-making under ambiguity. In addition, recent research has suggested the presence of differences in individual deck preferences (e.g., Buelow & Suhr, 2013; Caroselli, Hiscock, Scheibel, & Ingram, 2006; Fernie & Tunney, 2006). Decks A (a disadvantageous deck) and C (an advantageous deck) both incur immediate losses on 50% of trials, whereas Decks B (a disadvantageous deck) and D (an advantageous deck) both incur immediate losses on only 10% of trials (Bechara, 2008). These differences in the frequency of immediate losses between decks has led to investigation of individual deck selections on the IGT, as this analysis could show differences in preference for infrequent losses versus long-term gains. In the present study, we calculated the percentage of cards chosen from each individual deck on Trials 61–100 and Trials 161–200. Trials 101–160 were removed from analysis as in a separate study of additional trials in college students, participants tended to “revisit” each of the decks at the start of the additional trials, increasing the variability in their responses when compared with Trials 61–100 and Trials 161–200. Removing these analyses also allowed for the most parsimonious analyses with our small sample.
Balloon Analog Risk Task. The BART was developed to assess real-world risk-taking behavior (Lejuez et al., 2002). Individuals are told to pump up 30 balloons, one at a time, to earn money (5 cents per pump). The balloons could pop at any time, and any earned money on that balloon would be lost. To keep the earned money on a balloon, participants must stop pumping up the balloon before it pops and bank the money. Any money banked in this manner cannot then be lost. Each balloon has a different explosion point, ranging from 1 to 128 pumps (Lejuez et al., 2002). Riskiness is rewarded up to a point, after which continued involvement produces increased risk with diminished rewards. The most risk-avoidant strategy is to collect the earned money after fewer pumps per balloon, lowering the risk of an explosion and hence additional loss of money. In the present study, the total number of pumps per balloon adjusted for only the unexploded balloons was used as the dependent variable.

Frontal Systems Behavior Scale. The FrSBe is a 46-item behavior rating scale designed to assess behavioral changes associated with frontal lobe functioning and has been used in multiple studies of PD (Grace & Malloy, 2001). Three subscales have been developed and validated: Apathy, Disinhibition, and Executive Dysfunction (Grace & Malloy, 2001; Stout, Ready, Grace, Malloy, & Paulsen, 2003). For the present study, both the Self- and Informant-rating versions were utilized. Participants (Self-rating) and their family members or friends (Informant-rating) rated current behaviors on a 5-point Likert-type scale. For individuals in the HC group, their family member in the PD group completed the Informant-rating version. For individuals in the PD group, their family member (who may or may not have been in the HC group) completed the Informant-rating version. The Apathy subscale score was then calculated, with higher scores indicating greater levels of apathy. As per the FrSBe manual (Grace & Malloy, 2001), inclusion in the PD-apathy group was determined by a \( T \)-score of 65 or higher on either the Self- or Informant-rating Apathy subscale. Of note, there was a significant correlation between scores on the Self- and Informant-rated Apathy subscale (\( r = .535, p = .002 \)) among PD participants.

Procedure

The study was approved by the Institutional Review Board at both involved hospitals (Memorial Hospital of Rhode Island, Butler Hospital). All potential PD participants first provided written consent to be contacted for a telephone screening to determine eligibility for the study. As part of the telephone screening, participants were asked questions about their age; history of substance abuse, head injury, or pathological gambling; diagnosis of dementia or MCI; current PD medications; and current depressive symptoms (as measured by the GDS-S). Participants who met initial inclusion criteria for the study based on this screening were invited to schedule a study session and were informed that their spouse, family member, or friend might also be eligible for participation.

At the start of the in-person study session, all participants provided written informed consent. Participants then completed a brief cognitive screening, which included administration of the MMSE, Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005), and National Adult Reading Test (NART; Nelson, 1982). Participants then completed the two computerized tasks, the BART and the IGT, in a counterbalanced order. Finally, participants completed several questionnaires, including the FrSBe, presented in a counterbalanced order. A caregiver, spouse, or family member was also asked to complete the FrSBe Informant-Rating version. At the end of the study, each participant received $20 for their participation and was given brief feedback regarding performance on the cognitive screenings.

Data Analysis

Data were first examined for between-group differences in the demographic variables. One-way ANOVA, independent-samples \( t \)-tests, and Pearson’s chi-square tests were used as appropriate, with Tukey’s HSD post hoc comparisons used for any significant omnibus tests. In order to test the first aim of the study, independent-samples \( t \)-tests were conducted comparing the HC with the combined PD group on the IGT and BART. To test the second aim, one-way ANOVAs were conducted comparing performance on the IGT and BART in the HC, PD-apathy, and PD-no apathy groups. To test the third aim, one-way ANOVAs were conducted on the extra 100 trials of the IGT. In addition, learning scores were calculated by subtracting the percentage of selections from each IGT deck during Trials 61–100 from the percentage of selections from each IGT deck during Trials 161–200 (thus, positive scores indicated increased selections from the deck during the additional trials and vice versa). One-way ANOVAs were then used to assess for between-group differences on IGT learning. Finally, correlations were found between LEDs and performance on the IGT and BART.
Results

PD Status

**Demographics.** There were no significant differences between the control and the combined PD group in terms of age (p = .540), educational attainment (p = .748), gender (p = .217), or estimated premorbid verbal intellectual level (p = .244). No differences emerged between groups on the MMSE (p = .063), but individuals with PD had lower scores on the MoCA than HCs, t(35) = 1.990, p = .054 (Table 1). In addition, individuals in the PD group had greater GDS-S scores than those in the HC group, t(35) = 2.169, p = .037. No significant correlations were found between MoCA, MMSE, GDS-S, and the percentage of deck selections on the IGT (both Trials 61–100 and 161–200) and the average number of adjusted pumps on the BART (ps > .164), and thus these variables were not included as covariates in remaining analyses. PD participants had higher self-reported, t(35) = 2.043, p = .049, and informant-reported apathy, t(29) = 2.199, p = .036, than controls.

**IGT analyses.** No significant correlations emerged between LED and IGT deck selections (ps > .159). The PD group selected significantly more from Deck B than did the HC group (p = .017, d = 0.86; Table 2). No significant differences emerged for selections from Decks A (p = .491), C (p = .223), or D (p = .142).

On the additional 100 trials, participants in the PD group selected significantly more from Deck A than participants in the HC group (p = .038, d = 0.84). No differences emerged for selections from Decks B (p = .715), C (p = .421), or D (p = .448).

**BART analyses.** No significant between-groups differences emerged (p = .065), and LEDs were not correlated with performance (p = .159).

**Effect of Apathy**

**Demographics.** Comparing the HC, PD-apathy, and PD-no apathy groups, no significant differences emerged with regard to age (p = .630), educational attainment (p = .204), gender (p = .380), NART score (p = .512), or performance on cognitive screening (MMSE: p = .059, MoCA: p = .131; Table 1). Self- and informant-reported apathy was significantly higher in the PD-apathy group compared with the PD-no apathy and HC groups—self: F(2,34) = 9.218, p = .001; other: F(2,28) = 10.773, p < .001. Due to the small size of the PD-apathy and PD-no apathy groups, the following analyses should be considered preliminary.

**IGT analyses.** There was a trend toward the HC group selecting significantly less from Deck B than the PD-apathy group (p = .059, partial η² = .16; Table 3). No significant differences emerged for selections from Decks A (p = .410), C (p = .294), or D (p = .163).

Table 1. PD and HC study variables presented as mean (SD)

<table>
<thead>
<tr>
<th></th>
<th>HC (n = 13)</th>
<th>PD-combined (n = 24)</th>
<th>PD-apathy (n = 10)</th>
<th>PD-no apathy (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>69.62 (6.36)</td>
<td>68.04 (7.86)</td>
<td>66.70 (9.96)</td>
<td>69.00 (6.19)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td>15.92 (2.25)</td>
<td>15.63 (2.87)</td>
<td>14.50 (2.95)</td>
<td>16.43 (2.62)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td>6 men</td>
<td>13 men</td>
<td>7 men</td>
<td>6 men</td>
</tr>
<tr>
<td><strong>H&amp;Y</strong></td>
<td>—</td>
<td>2.36 (0.54)</td>
<td>2.56 (0.73)</td>
<td>2.23 (0.33)</td>
</tr>
<tr>
<td><strong>UPDRS</strong></td>
<td>—</td>
<td>29.73 (9.62)</td>
<td>29.89 (13.14)</td>
<td>29.62 (6.85)</td>
</tr>
<tr>
<td><strong>MMSE</strong></td>
<td>29.31 (1.11)</td>
<td>28.33 (1.63)</td>
<td>27.80 (1.87)</td>
<td>28.71 (1.38)*</td>
</tr>
<tr>
<td><strong>MoCA</strong></td>
<td>27.77 (1.48)</td>
<td>26.33 (2.35)*</td>
<td>26.00 (2.31)</td>
<td>26.57 (2.44)</td>
</tr>
<tr>
<td><strong>NART</strong></td>
<td>119.54 (7.29)</td>
<td>116.92 (5.93)</td>
<td>116.90 (6.15)</td>
<td>116.93 (5.99)</td>
</tr>
<tr>
<td><strong>GDS-S</strong></td>
<td>1.15 (1.57)</td>
<td>2.50 (1.91)</td>
<td>3.00 (2.45)</td>
<td>2.14 (1.41)</td>
</tr>
<tr>
<td><strong>FrSBe-S</strong></td>
<td>50.46 (10.39)</td>
<td>59.25 (13.46)</td>
<td>68.60 (14.68)</td>
<td>52.57 (7.49)*</td>
</tr>
<tr>
<td><strong>FrSBe-I</strong></td>
<td>50.23 (10.32)</td>
<td>59.78 (12.95)</td>
<td>70.86 (12.90)</td>
<td>52.73 (6.66)*</td>
</tr>
</tbody>
</table>

*Notes: HC = healthy control; PD = Parkinson’s disease; H&Y = Hoehn and Yahr staging; UPDRS = Unified Parkinson’s Disease Rating Scale; MMSE = Mini-Mental Status Examination; MoCA = Montreal Cognitive Assessment; NART = American National Adult Reading Test; GDS-S = Geriatric Depression Scale, Short Form; FrSBe = Frontal Systems Behavior Scale, Self- (S) or Informant (I) Apathy subscale T score.

*HC > PD-apathy, p < .05.
*1HC > PD, p < .05.
*2HC < PD, p < .05.
*3HC and PD-no apathy < PD-apathy, p < .01.
As there was a trend toward a relationship between apathy and IGT performance over the first 100 trials, we decided to examine whether apathy played a role in the additional 100 trials. In fact, individuals in the HC and PD-no apathy groups selected significantly less from Deck A than individuals in the PD-apathy group (\( p = 0.005 \), partial \( \eta^2 = 0.28 \)). HC and PD-no apathy groups also selected significantly more from Deck D on Trials 161–200 than those in the PD-apathy group (\( p = 0.013 \), partial \( \eta^2 = 0.23 \)). No differences emerged for Decks B (\( p = 0.331 \)) or C (\( p = 0.727 \)). Finally, the examination of the learning scores indicated that individuals in the PD-apathy group selected more from Deck A over time than individuals in the HC group (\( p = 0.021 \), partial \( \eta^2 = 0.21 \)).

### Discussion

The present study sought to clarify inconsistent findings regarding the relationship between risky decision-making, as assessed by the IGT and BART, and PD status by examining the effects of apathy, LEDs, and difficulties learning to choose advantageously. The first aim was to clarify the relationship between PD status and risky decision-making. We found that on a deck-level analysis of the standard IGT, individuals with PD selected more from Deck B than HCs. This is the first investigation of the IGT in PD in which individual deck selections were examined, and although Deck B is considered a disadvantageous deck based on negative long-term outcomes, it is not considered as disadvantageous as Deck A (Bechara, 2008). It is possible that PD participants selected from Deck B based on its high immediate rewards (which Deck A also has) and its low frequency of losses (losses on 10% of trials vs. losses on 50% of trials with Deck A). Previous research with IGT variations has shown that HC participants will choose more from decks with a lower frequency of losses but long-term losses than decks with a higher frequency of losses but long-term gains (Caroselli...
et al., 2006; Chiu et al., 2008; Lin, Chiu, & Huang, 2009). This Deck B preference may help explain some of the previous inconsistencies in the IGT in PD that have utilized the standard scoring (i.e., advantageous minus disadvantageous selections; Czernecki et al., 2002; Delazer et al., 2009; Euteneuer et al., 2009; Gescheidt et al., 2012; Ibarretxe-Bilbao et al., 2009; Kawamura & Kobayakawa, 2009; Kobayakawa et al., 2008, 2010; Mimura et al., 2006; Pagonabarraga et al., 2007; Perretta et al., 2005; Stout et al., 2001; Thiel et al., 2003).

No significant differences between the HC and PD groups were found on the BART, consistent with previous studies suggesting that it is the presence of impulse control disorders, not PD itself, affecting performance on this task (Claasen et al., 2011; Simioni et al., 2012). The differing findings based on the type of risky decision-making task administered are consistent with previous research showing little overlap in the predictive utility of the IGT and BART in substance use and other risk-taking behaviors (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Lejuez et al., 2003; Upton, Bishara, Ahn, & Stout, 2011). It is believed that the BART and IGT assess different components of risky decision-making. For example, the advantages and disadvantages of each deck must be learned on the IGT, whereas on the BART the amounts to be gained/lost are provided. In addition, the amounts of money won/lost are significantly greater on the IGT. It is possible that the IGT assesses learning from feedback, and the BART assesses more frank risk-taking. Future research into decision-making in PD should continue to utilize multiple assessment measures to more fully assess the construct.

The second aim was to investigate whether individuals with PD experienced difficulties learning the risks/benefits on the IGT, in turn leading to poorer performance on this task. Increasing the number of learning trials resulted in similar performance between the HC and PD-no apathy groups, as both groups preferred Deck D, the most advantageous deck. However, with an additional 100 trials, individuals with PD and apathy selected more from Deck A on Trials 161–200 than those in the PD-no apathy group, and less from Deck C than those in the HC and PD-no apathy groups. The present findings indicate that with an additional 100 trials and more time to learn the risks/benefits of decisions, a subgroup of PD participants (those with apathy) selected from the deck associated with “pathological” risk-taking (Bechara, 2008), whereas those with PD but no apathy learned to select advantageously.

The third study aim was to investigate whether individuals with PD experienced difficulties learning the risks/benefits on the IGT, in turn leading to poorer performance on this task. Increasing the number of learning trials resulted in similar performance between the HC and PD-no apathy groups, as both groups preferred Deck D, the most advantageous deck. However, with an additional 100 trials, individuals with PD and apathy selected more from Deck A on Trials 161–200 than those in the PD-no apathy group, and less from Deck C than those in the HC and PD-no apathy groups. The present findings indicate that with an additional 100 trials and more time to learn the risks/benefits of decisions, a subgroup of PD participants (those with apathy) selected from the deck associated with “pathological” risk-taking (Bechara, 2008), whereas those with PD but no apathy learned to select advantageously.

The final aim was to examine the effect of LED on decision-making. No correlations were found between decision-making and LED. Although previous research has shown a link between reward-based learning, risk-taking, and dopamine levels (Frank, 2005; Frank, Seeberger, & O’Reilly, 2004; Ljungberg, Apicella, & Schultz, 1992; Mirenowicz & Schultz, 1994; Moustafa, Cohen, Sherman, & Frank, 2008; van Eimeren et al., 2009; Voon et al., 2010), we failed to find a relation between LED and reward-based decision-making in the present study.

The present findings have important implications for clinical practice. We recommend that clinicians utilize multiple behavioral measures of the decision-making construct in order to fully assess its facets. Utilizing the IGT, for example, may provide evidence of impaired learning of risks and benefits associated with different decisions, differing emphases on short- versus long-term risks and benefits, and poor emotion-based decision-making. Use of the BART may instead help to assess impaired risk-taking behaviors (i.e., impulsivity). We also recommend that clinicians assess for both depression and apathy in patients with PD, as both conditions can affect performance on measures of decision-making and other cognitive abilities. Finally, we recommend that clinicians consider administering an additional 100 trials of the IGT, in order to differentiate between slowed learning of the risks/benefits of their decisions and frank decision-making impairment.

There were several limitations to the present study. As previously discussed, our sample of individuals with PD and clinically significant apathy was small. Thus, it is important for the present findings to be replicated in a larger sample of PD participants with and without apathy. In addition, individuals with a significant level of current depressive symptoms were excluded from the present study. We found between-group differences in depression scores, although GDS-S scores were not correlated with the decision-making variables. In future studies, the effect of a combination of depression and apathy in individuals with PD on risky decision-making should be examined, as both apathy and depression on their own can influence decision-making. In addition, future research with larger samples should investigate whether the presence of depressive symptoms affects decision-making independent of apathy. Future research should also clarify whether overall level of cognitive functioning, such as that assessed with the
MMSE or MoCA, is associated with performance on behavioral decision-making tasks in PD. Our sample was highly educated (average 15–16 years), and additional research with lower educational levels is warranted as educational level and premorbid cognitive ability have been shown to influence performance on some decision-making tasks. Finally, only two participants in the present study were not currently prescribed levodopa or a dopamine agonist, preventing direct examination of whether the presence or the absence of levodopa or other agonist medication affected decision-making.

Taken together, our results provide the first evidence that apathy is related to risky decision-making in PD, and providing additional learning trials can result in improved decision-making in those without apathy. Future research should utilize multiple measures of risky decision-making, such as the IGT, BART, Columbia Card Task (CCT; Figuer & Voelki, 2004), and Game of Dice Task (GDT; Brand et al., 2005), to determine what aspects of risky decision-making are affected by PD staging, LEDs, apathy, and other variables. The CCT and GDT both utilize more explicit information about the risks and benefits of decisions and may provide clinicians and researchers alike with information about whether the lack of explicit information on the IGT is affecting performance in PD. In addition, future research should continue to examine how apathy—with and without comorbid depression—can affect cognition and quality of life in PD. Researchers could choose to evaluate and then control for apathy in studies, or use apathy as a variable of exclusion in participant recruitment. In addition, the manipulation of the apathy level would allow for the understanding of the potential cause-and-effect relationship between apathy and cognitive task performance.

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Conflicts of Interest

The authors’ financial conflicts of interest are as follows. JG: Psychological Assessment Resources (royalties). JHF: Teva, Ingelheim Boehringer, General Electric (lectures); United Biosource, Bubaloo Halsted & Reitman LLC, EMD Serono, Genzyme, Teva, Acadia, Addex Pharmaceuticals, Schwarz Pharmaceuticals, Roche (consulting); Michael J. Fox Foundation, National Institutes of Health, Cephalon, EMD Serono, Teva, Acadia (research); and Demos Press (royalties).

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