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Brief Communication

Affective forecasting in Parkinson's disease

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Abstract

Objectives: While emotional responses experienced *in-the-moment* appear to remain intact in Parkinson's disease (PD), no study has tested whether this extends to the prediction of *future* emotional responses. The present study aimed to provide the first assessment of affective forecasting capacity in this cohort. **Methods:** A positively and negatively valenced affective forecasting task and broader clinical battery were completed by a PD group (*ns* = 28 and 37, respectively) and a demographically matched neurotypical control group (*ns* = 38 and 39, respectively). **Results:** No group differences emerged on the two tasks, with the two groups underestimating their level of happiness and overestimating their level of negative affect to a similar degree. Affective forecasting error scores were unrelated to clinical characteristics. **Conclusions:** Given that affective forecasting relies on self-projection into the future, a skill shown to often be disrupted in this cohort, impairments were expected. However, this study provides initial evidence that this may not be the case. These findings are potentially important given that how we think about and envisage the future affectively is a major determinant of goal-directed behavior. Further work is now needed to establish whether these findings are robust and generalize to other types of affective stimuli.

Keywords: affective forecasting; affective intensity; emotional experience; future behavior; neuropsychology; Parkinson's disease

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Although Parkinson's disease (PD) is associated with difficulties recognizing emotions in others (see Coundouris et al., 2019a for a review), the experiential component of this process appears to remain intact. Indeed, research shows that even in the advanced stages of the disease, people living with this disorder do not differ from neurotypical controls in their affective responses to *in-the-moment* events (e.g., Ille et al., 2016; Schwartz et al., 2018). However, it remains to be established whether these findings extend to the ability to predict one's own *future* situational emotional responses. The aim of the present study was to provide the first test of this possibility.

The ability to make hypothetical judgements about future states is known as affective forecasting, and is a critical determinant of future-oriented behaviors. Affective forecasting allows one to anticipate whether, and to what degree, an event will be a positive or negative experience, and therefore one's likelihood to engage (e.g., Wilson & Gilbert, 2003). Indeed, affective forecasts are critical in guiding approach and avoidance behaviors (Elliot et al., 2013). For example, anticipating the pain of losing an arm motivates us to avoid risky behaviors, whereas the anticipated joy of winning a contest may make us work harder in preparation for it.

Of particular interest to this study was the objective accuracy of affective intensity forecasts made by people with PD compared to neurotypical controls. Studies using neurotypical volunteers have revealed a tendency to overestimate both the intensity and duration of future events, collectively referred to as the impact bias (Buechel et al., 2017; Miloyan & Suddendorf, 2015; Wilson & Gilbert, 2003). Importantly, such biases appear highly functional, motivating us to avoid negative outcomes (by overestimating how bad it will be) and pursue positive ones (by overestimating how good it will be). Thus, a key question to be addressed here is whether people with PD also display this bias in their affective intensity forecasts, and if so, whether this holds for both positively and negatively valenced events.

As the ability to engage in other future-oriented cognitions and behaviors are disrupted in PD (see Coundouris et al., 2019b for a review; Coundouris et al., 2022), it seems highly plausible that there may also be difficulties with affective forecasting in this cohort. Clinically, errors in affective forecasting may drive suboptimal decisions regarding health behavior, treatment, and end of life care, and in turn reducing quality of life (Martin et al., 2020), making this an incredibly relevant and critical ability to examine in PD. The preregistered hypotheses and research questions were as follows:

1. In line with previous literature, no between-group differences in affective intensity scores for the *actual experience* of the tasks were predicted.
2. Given PD-related impairments in other prospective abilities, significant between-group differences in *forecasted* affective intensity scores for the tasks were expected. No hypotheses regarding the directionality of these differences were made;
3. In accordance with the intensity bias, controls were expected to significantly overestimate their affective response to each event.

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Although of interest, no specific predictions were made for the PD group.
4. Finally, the present study was also interested in establishing the broader mental health (apathy, negative affect), neuropsychiatric, and disease-related (quality of life, sleep) correlates of any observed affective forecasting errors.

Methods

This study forms part of a larger pre-registered testing protocol (https://osf.io/rvgh5/?view_only=414e3f3db9d04dfeb19928275ad3650e) detailing four distinct studies. Only relevant methods are described below.

Participants

The full eligibility criteria are outlined elsewhere (Coundouris et al., 2022). The PD group comprised 50 individuals on stable medication being treated at Princess Alexandra Hospital, in Brisbane, Australia. Eight participants were excluded due to psychiatric illness and/or brain trauma ($n = 6$), a low score on the Mini-Mental State Examination ($n = 1$; Folstein, Folstein, & McHugh; 1975), or problems with comprehension ($n = 1$). A further three PD participants did not complete the positively valenced task due to health reasons (i.e., allergic to chocolate, poorly controlled diabetes), creating a final PD sample of 39 participants for this task (51.28% Male; age $M = 64.18$ years, $SD = 10.00$ years; education $M = 13.10$ years, $SD = 4.26$ years; MMSE $M = 28.85$, $SD = 1.18$). Similarly, one PD participant chose not to complete the negatively valenced task, leaving this final PD group to consist of 41 participants (48.78% Male; age $M = 65.10$ years, $SD = 10.16$ years; education $M = 13.13$ years, $SD = 4.21$ years; MMSE $M = 28.78$, $SD = 1.24$). Table Supplementary 1A outlines the diagnosis and treatment information for each task's PD group.

The control group comprised 61 older adults with no neurological disease, psychiatric illness, or development disorder, recruited online, through media outlets, and word of mouth. One participant was excluded due to psychiatric illness, and 19 to ensure that the two groups were demographically matched[1] ($n = 42$; 50% Male; age $M = 65.00$ years, $SD = 8.92$ years; education $M = 14.61$ years, $SD = 3.16$ years; MMSE $M = 28.79$, $SD = 1.09$; see Supplementary Table 1B for a complete demographic breakdown).

Chi-squares and independent t-tests were completed to compare the groups on gender, age, years of education, and scores on the MMSE. Results showed that the PD and control group for each task were demographically matched (positively valenced: ps = .912, .698, .072 and .812, respectively; negatively valenced: ps = .913, .963, .073 and .984, respectively).

Materials

Affective forecasting

Buechel et al.'s (2017) methodological approach was followed, because it examines affective intensity forecasts in the context of both a positively and a negatively valenced event. An adapted version involving only the stimuli found to generate and maximize the intensity bias were used. Specifically, the large magnitude, small probability condition for the positively valanced task, and the long duration, short psychological distance condition for the negative (see Buechel for a detailed explanation). For both tasks, the forecast portion asks individuals to *imagine* a scenario. At least 20 min later, participants then *experience* the scenario in real-life (experience portion). Identical verbal and written event descriptions were provided. Identical attention tests as used by Buechel were included in both tasks[2].

Positively valenced task. This event was playing a game of chance to win a 345gram bag of M&M's (large magnitude). The game involves drawing a ball marked with an "X" from an opaque box, for which participants are told there is a 10% chance of winning (small probability; one ball marked; unbeknown to participants all balls marked). Participants rate their happiness if/when they win the prize from 1 (*very unhappy*) to 13 (*very happy*). Participants also rate their like of chocolate from 1 (*not at all*) to 13 (*very much*).

Negatively valenced task. The event was watching a 10-minute video (long duration) of a puppy trapped in a sewer from two days ago (short psychological distance). Participants rate their sadness, distress, and absorption if/when they watch this footage on three scales from 1 (*not at all*) to 9 (*very sad/distressed/absorbed*), which are aggregated into a single index of negative affect (Buechel et al., 2017). After experiencing the video, participants also rate its believability from 1(*not at all*) to 7(*very*).

Background measures

Background measures comprised both self-report and one informant-rated questionnaire. Informants were close contacts of the participant (see Supplementary Tables 2 and 3 for a breakdown). To index mental health and neuropsychiatric comorbidities the Apathy Evaluation Scale (AES; Marin et al., 1991), Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), and the informant-rated Neuropsychiatric Inventory (NPI-Q; Kaufer et al., 2000) were administered. The Parkinson's Disease Sleep Scale (PDSS-2; Trenkwalder et al., 2011) and the Parkinson's Disease Questionnaire-39 (PDQ-39; Peto et al., 1995) were also administered to the PD group only to assess disease-related consequences. For each of these measures higher scores are indicative of greater apathy, negative affect, psychiatric illness, and PD sleep-related problems, and lower PD related quality of life respectively.

Procedure

The procedure complied with the Declaration of Helsinki for medical research involving human subjects and was approved by the Human Research Ethics committee of The University of Queensland (Approval No. 2018001920). The entire testing battery was completed in person, one-on-one, with no limit on the amount and/or length of breaks. For a full breakdown of the procedure see Coundouris et al. (2022).

Statistical analyses

The *Hmisc*, *ggpubr*, *rstatix*, and *tidyverse* packages were used within RStudio (version 4.0.0). Two independent *t*-tests were conducted to identify group differences in liking of chocolate and video believability. Mixed-model analyses of variance (ANOVA) were then

[1]Due to COVID restrictions, The PD and control group were recruited and tested concurrently, as opposed to the PD group first to assist demographic matching. Early checks of matching revealed many group differences in key demographics. Accordingly, prior to running any analyses, 18 participants were removed from the control group. These exclusions were based solely on demographic characteristics. Ten new control participants (with the required demographic characteristics) were then tested as their replacements.

[2]Eleven PD and four control participants failed the positively valenced attention check of restating the probability of winning. Four PD and three controls failed the negatively valenced instructional attention check. As results were unaltered with their exclusion, all participants were retained in the analyses.

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conducted for each valenced task, in which the within-subject factor was *task* (forecast, experience), and the between-subjects factor *group* (PD, control)[3]. This was complemented by two Bayesian independent samples t-tests conducted using JASP (version 0.16.1), to test the null prediction of no group differences in affective scores for the actual experience of the tasks. Pearson's correlations were calculated to explore mental and disease-related correlates. All statistical analyses were two-tailed and *p*s < .05 considered significant. Missing data only occurred in the informant rated NPI-Q (five severity and four distress cases). In these instances, the mean response from the relevant participant group were inputted.

Results

Descriptive statistics for affective forecasting related scores and background measures by task valence and group are reported in Table 1.

The two groups for the positively valenced task, were comparable in their liking of chocolate, $t(79) = 0.50$, $p = .612$. The ANOVA[4] revealed a main effect of task, $F(1, 79) = 18.40$, $p < .001$, $\eta_p^2 = 0.19$, which reflected participants significantly underestimating their level of happiness (Forecast: $M = 10.11$, $SD = 3.30$; Experience $M = 11.65$, $SD = 2.31$). However, there was no main effect of group ($F(1, 79) = 0.08$, $p = .784$, $\eta_p^2 < .001$), nor any significant interaction between group and task, $F(1, 79) = 0.40$, $p = .527$, $\eta_p^2 = 0.01$. A two-sided analysis revealed a Bayes factor (BF_{01}) that the actual experience data were 3.45 times more likely under the null, than the alternative hypothesis with a median effect size of −0.14.

For the negatively valenced task, the two groups were comparable in their rating video's believability, $t(81) = 0.19$, $p = .849$. The ANOVA identified a main effect of task ($F(1, 81) = 30.33$, $p < .001$, $\eta_p^2 = 0.27$), which reflected participants significantly overestimating their level of negative affect (Forecast: $M = 6.69$, $SD = 1.90$; Experience $M = 5.58$, $SD = 2.43$). Again though, neither the main effect of group, or interaction were significant, $F(1, 81) = 0.00$, $p = .936$, $\eta_p^2 < 0.01$ and $F(1, 81) = 0.44$, $p = .511$, $\eta_p^2 = 0.01$, respectively. A two-sided analysis revealed a Bayes factor (BF_{01}) that the actual experience data were 4.31 times more likely under the null, than the alternative hypothesis with a median effect size of −0.04.

Finally, it can be seen in Table 2 that no background measure correlated with affective forecasting error scores for the PD group. The only significant correlate was found for the control group, for negative affect.

Table 1. Means and standard deviations of affective forecasting related scores and broader mental health and disease-related consequence measures

	Positive[a]		Negative[b]	
Measure	PD *M (SD)*	Control *M (SD)*	PD *M (SD)*	Control *M (SD)*
Affective Forecasting				
Forecast	10.15 (3.27)	10.07 (3.37)	6.78 (1.79)	6.61 (2.02)
Experience	11.46 (2.40)	11.83 (2.23)	5.53 (2.46)	5.63 (2.44)
Error Score	1.31 (3.30)	1.76 (3.14)	−1.25 (2.05)	−0.98 (1.63)
AES	29.62 (7.77)	26.83 (6.49)	29.78 (7.71)	26.83 (6.49)
HADS	12.64 (7.67)	9.00 (4.77)	12.71 (9.47)	9.00 (4.77)
NPI-Q Severity	4.71 (5.91)	1.15 (1.98)	4.63 (5.74)	1.15 (1.98)
NPI-Q Distress	4.78 (7.21)	1.55 (2.89)	4.56 (6.92)	1.55 (2.89)
PDQ-39	28.37 (18.40)	–	28.27 (18.04)	–
PDSS-2	23.46 (12.77)	–	23.34 (12.29)	–

AES, Apathy Evaluation Scale; HADS, The Hospital Anxiety and Depression Scale; NPI-Q, The Neuropsychiatric Inventory Informant Rated; PD, Parkinson's disease; PDQ-39, Parkinson's Disease Questionnaire-39; PDSS-2, Parkinson's Disease Sleep Scale Revised.
[a]Parkinson's disease $n = 39$ (18 for NPI) and Control $n = 42$ (29 for NPI).
[b]Parkinson's disease $n = 41$ (20 for NPI) and Control $n = 42$ (29 for NPI).

Table 2. Pearson's bivariate correlations of broader mental health and disease-related consequence measures and affective forecasting error scores

Group and measure	AES	HADS	NPI-Q Severity	NPI-Q Distress	PDQ-39 Summary Index	PDSS-2
Parkinson's disease						
Positive Error Score[a]	.14	.04	.11	.05	.03	.15
Negative Error Score[b]	−.08	−.07	.19	.14	−.08	.00
Control group						
Positive Error Score[a]	.05	.10	.31	.37	–	–
Negative Error Score[b]	-.01	.47*	.09	.16	–	–

AES, Apathy Evaluation Scale; HADS, The Hospital Anxiety and Depression Scale. NPI-Q, The Neuropsychiatric Inventory Informant Rated; PDQ-39, Parkinson's Disease Questionnaire-3; PDSS-2, Parkinson's Disease Sleep Scale Revised.
[a]Parkinson's disease $n = 39$ (18 for NPI) and Control $n = 42$ (29 for NPI).
[b]Parkinson's disease $n = 41$ (20 for NPI) and Control $n = 42$ (29 for NPI).
*$p < .01$.

Discussion

This study provides a novel extension to both the emotional processing and prospection PD literatures, examining for the first time how the ability to forecast the intensity of affective states is affected in this cohort. Contrary to predictions, the two groups were comparable in their ratings, suggesting that PD does not disrupt the ability to engage in affective forecasting for either positively or negatively valenced affective stimuli. This preservation of ability was surprising given the PD-related impairment has consistently been identified across many other important future-oriented cognitions and behaviors (planning and prospective memory, Coundouris et al., 2019b; episodic foresight, Coundouris et al., 2022). However, this does align with a separate literature which shows that the experiential component of emotional processing is preserved in PD (Ille et al., 2016; Schwartz et al., 2018), and further, shows for the first time that this is not only limited to affective responding to *in-the-moment* events. The absence of any association between affective forecasting error scores and clinical characteristics of PD also suggests that this preservation is seen even in more moderate or severe cases of the illness, with the important caveat of course that the current sample was highly skewed towards mild and moderate clinical presentations.

Also of interest was the finding that, although the two groups displayed comparable affective forecasting errors across the negatively and positively valenced tasks, only the former was in line with the impact bias (Buechel et al., 2017; Miloyan & Suddendorf, 2015; Wilson & Gilbert, 2003). Specifically, while both neurotypical older adults and people with PD overestimated their level of negative affect in the negatively valanced task, both groups also *under*estimated their level of happiness in the positive. This finding is quite striking, as the present study's stimuli were selected based on prior research designed to maximize the impact bias (i.e., overestimation of intensity; Buechel et al., 2017).

This latter finding was unanticipated, and consequently interpretation needs to be appropriately cautious. However, one possible interpretation is that while people with PD do not differ from neurotypical older adults in their estimation of future happiness, both cohorts may differ from younger adults, which most of the affective forecasting research has relied on (including Buechel et al., 2017's study, in which

[3]Prior to running analyses, assumptions testing was completed to ensure the data was suitable for the parametric analyses described.

[4]Assumption testing revealed five extreme control outliers. However, as the pattern of result did not change with their exclusion, these participants were retained

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this paper's methodological approach was based). Of the few studies that have considered forecasting accuracy for positive events in older adults, mixed results have been obtained (e.g., Lang et al., 2013; Nielsen et al., 2008; Scheibe et al., 2011), but certainly it is well-documented in the broader literature that, as we progress through adulthood, there is shift in goal-orientation from predominantly striving for gains towards a more maintenance and loss avoidance mind-set. There are also systematic changes in the *types* of goals considered most meaningful, with older adults especially motivated to prioritise experiences that enhance emotional well-being (Henry et al., in press).

Further research is therefore now needed that uses different types of affectively valenced stimuli to establish the robustness of the effects (and absence of effects) identified here. Indeed, while a strength of the study was the use of an already validated paradigm, the stimuli was limited in some respects in its generalisability. For example, the two valenced tasks differed in relation to the type of event, as well as the rating scales used, preventing a direct comparison between the positively and negatively valenced situations. Further, stimuli could be used that more closely resembles events that commonly occur in everyday life, with more ecologically valid, social stimuli needed to better ascertain the role of affective forecasting in approach and avoidance behaviors.

To conclude, this study provides important initial evidence of preserved affective forecasting capacity within this cohort. Given the importance of how we think affectively about future events for motivated goal-directed behavior, and particularly health-related behaviors, continuing to understand the functionality of this skill in PD is critical.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/S1355617722000388

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Authors' contribution. S.P.C. was involved in research project conception, organization, and execution, statistical analysis design and execution, and manuscript writing of the first draft and revisions; J.D.H contributed to research project conception, and organization, statistical analysis design, and manuscript review and critique; T.S. took part in research project conception, and manuscript review and critique; and A.C.L. assisted with research project recruitment, and manuscript review and critique.

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Conflicts of interest. None.

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