Power corrupts co-operation: cognitive and motivational effects in a double EEG paradigm

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This study investigated the effect of interpersonal power on co-operative performance. We used a paired electro-encephalogram paradigm: pairs of participants performed an attention task, followed by feedback indicating monetary loss or gain on every trial. Participants were randomly allocated to the power-holder, subordinate or neutral group by creating different levels of control over how a joint monetary reward would be allocated. We found that power was associated with reduced behavioural accuracy. Event-related potential analysis showed that power-holders devoted less motivational resources to their targets than did subordinates or neutrals, but did not differ at the level of early conflict detection. Their feedback potential results showed a greater expectation of rewards but reduced subjective magnitude attributed to losses. Subordinates, on the other hand, were asymmetrically sensitive to power-holders’ targets. They expected fewer rewards, but attributed greater significance to losses. Our study shows that power corrupts balanced co-operation with subordinates.

Keywords: attention; cooperation; dual-EEG; ERP; power

INTRODUCTION
To survive in a complex and challenging world, humans depend on resources like money, information and emotional security. These resources are not, however, evenly distributed. It is often the case that one individual has to depend on another to obtain them. Thus, we define power as asymmetrical control over a desired resource (Kipnis, 1972; Fiske, 1993). Although the effect of power on task performance has received considerable attention (Guinote, 2007a; Smith et al., 2009), such a social construct would benefit from more contextualized, interactional paradigms (e.g. Sebanz et al., 2007).

We are particularly interested in the effect of power on cooperation, due to its relevance to workplace dynamics in institutions where power hierarchies exist. Cooperation, in this context, refers to a scenario where power-holders and subordinates work towards a communal gain, without task interdependence. Who is the more diligent co-operator? Is it the power-holder, who is ultimately in control of the final outcome? Or is it the subordinate, who has to depend on the power-holder to obtain a share? Do power-holders and subordinates perceive joint losses and gains in the same way? Behavioural performance, although informative, is preceded by a complex chain of cognitive and motivational events that are also sensitive to power (Keltner et al., 2003). In this study, we investigated the effect of power on cooperation, and we used electro-encephalogram (EEG) recordings to understand the cognitive and motivational processes that might be at play.

Power and attention
A subordinate’s world is full of uncertainties and constraints (Keltner et al., 2003). When individuals are deprived of control, they adaptively become more vigilant, paying careful attention to multiple stimuli in their environment to improve their chances of survival (Pittman and Agostino, 1989). Thus, it has been proposed that subordinates process information in a systematic yet indiscriminate way, which may cause impairments when a task requires focus on specific items and inhibition on others (Guinote, 2007a; Smith et al., 2008). This process has been proposed to occur even at a basic attentional level, where subordinates would find it hard to inhibit responses primed by peripheral information in a visual stimulus (Guinote, 2007b).

Attention is not, however, a unitary function supported by one common neural system (Posner and Dehaene, 1994). Executive attention refers to the ability to resolve a response-related conflict arising from distracting stimuli (Posner and Petersen, 1990) and is distinct from the ability to orient attention to task-relevant events (Posner and Dehaene, 1994). In response to target stimuli, early event-related potentials (ERPs) like the N2 (Kopp et al., 1996) are an index of conflict detection and a need to inhibit distracting information, providing a marker of executive attention (Van Veen and Carter, 2002). Later potentials may reflect top–down motivational factors that come after basic attentional processes. The P3b is one such potential observed after viewing targets (Sutton et al., 1965; Polich, 2007). P3b amplitude is sensitive to the attention paid to, or motivational significance attached to, the stimulus (Nieuwenhuis et al., 2005). Thus, ERPs can provide a more precise idea of whether any behavioural effects could be attributed to changes at a basic cognitive level, or in later, top–down processes (Luck, 2005).

Power and feedback
From another perspective, it is unlikely that the effect of power on task performance happens exclusively through its effect on attention. Humans pursue goals in various affective and motivational contexts, and they receive feedback from the world around them. To our knowledge, research has not investigated power directly in the context of feedback indicating rewards or punishments. The way feedback is processed and attributed may have important consequences for behaviour (Kluger and DeNisi, 1996). Due to the suggestion that subordinates engage in high self-monitoring, and selectively attend to threat and punish signals at the expense of rewards (Keltner et al., 2003), we also investigated feedback processing to shed some light on how co-operative gains and losses are perceived.

ERPs show us that feedback is processed at multiple levels, in both a decision-making, reward-expectancy perspective and an affective-motivational perspective (Yeung and Sanfey, 2004; Wu and Zhou, 2009). The feedback-related negativity (FRN) (Miltner et al., 1997),
an index of feedback valence, is suggested to code reward prediction errors (Holroyd and Coles, 2002), where reward expectation may be coloured by subjective/motivational factors (Gehring and Willoughby, 2002). Using the FRN, we are able to see whether power-holders and subordinates differ in the extent to which they expect losses. Feedback stimuli are emotionally valent stimuli that have been associated with larger P3s than emotionally neutral stimuli (Johnston et al., 1986), and the feedback P3 has been shown to correlate with absolute reward magnitude (Yeung and Sanfey, 2004). Feedback P3 is interpreted to represent a top-down controlled process of outcome evaluation, into which allocation of attentional resources and reward valence and magnitude may come into play (Wu and Zhou, 2009). Feedback P3 would be helpful to indicate whether feedback coding the same wins and losses would be perceived as larger in subjective magnitude, or importance, among either power-holders or subordinates.

The FRN can also be elicted when viewing other people’s feedback (oFRN), and the literature suggests that it is sensitive to the relationship between the actor and the observer (Itagaki and Katayama, 2008; Marco-Pallarés et al., 2010). These studies propose that other’s feedback, at the level of the oFRN, is processed according to the effect that it represents on own outcomes. For example, either a competitor’s gain or a co-operator’s loss is processed as a loss, whereas a competitor’s loss or a co-operator’s gain is processed as a gain. Thus, it would be interesting to explore how participants perceive their relationship to the other under the context of power.

In this research, we employed a paired EEG paradigm as pairs of individuals interacted in an attention task. Power was allocated randomly by giving one participant monopoly over winnings made co-operatively by both participants in a subsequent session, thus providing us with pre- and post-manipulation measures. Participants believed that the allocation was based on their performance in the first session. Feedback indicating monetary gains and losses was received and was seen by both parties. We were interested in seeing how power or subordination changed the way hierarchically arranged pairs of individuals co-operated, compared with non-hierarchical pairs, and we used ERPs to understand the underlying cognitive and motivational processes.

METHODS

Participants

The initial sample consisted of 34 healthy, right-handed males, aged 18-21 years. Participants were randomly allocated to the power-holder, subordinate or neutral group (12 power-holders, 12 subordinates, 10 neutrals). Each experimental session included a pair of participants who were previously unacquainted. Power-holders were paired with subordinates (hierarchical pairs), and neutrals were paired together. Participants received 15 GBP plus an amount (detailed later) that was said to depend on task performance. We had to remove three hierarchical pairs because of excessive blinking, poor EEG signal or outlying behavioural performance. We were left with 9 power-holders, 9 subordinates and 10 neutrals. The experiment was approved by the University’s research ethics committee, and the participants provided the written consent.

Power manipulation

Participants were randomly pre-assigned to their group without being told. They first performed a session of the task described below without any power allocation. They were told to compete for better performance.

In the hierarchical pairs, they were told that the winner would be able to allocate the joint rewards on a subsequent session, making him the power-holder. In the second session, they were told to co-operate, and that their added score would translate to a monetary sum (8-14 GBP). There were no constraints on how the power-holder could split the money. Because the allocation was random, the scores were not actually calculated, and the pre-assigned power-holder was told that he had won by a small percentage. This was plausible due to the large number of trials, the similar feedback probabilities and the fact that participants could not discern the reaction time of their rival accurately. This manipulation was piloted in a behavioural experiment (n = 22 pairs), and both groups rated the allocation as legitimate (unpublished data).

In the neutral pairs, the scores of the competition session reflected actual performance, but were only announced at the end of the experimental session to avoid a power manipulation. In the competition session, the better player received 5 GBP. In the cooperation session, the pair’s joint winnings were split in half (2-14 GBP).

The task

In the classic Eriksen flanker paradigm (Eriksen and Eriksen, 1974), five arrows are presented (>>>>>) or <<<<<<), in which a central arrow is surrounded by distractor arrows. Participants are required to respond by pressing either a ‘left’ or ‘right’ button according to the direction of the central arrow, while ignoring the distractors. Thus, within this paradigm, there are congruent trials (>>>>>) or <<<<<<) where all arrows are pointing in the same direction, and incongruent trials (<<<<<< or >>>>>>) where the central arrow points in the opposite direction to the distractors. Incongruent trials require the inhibition of the response triggered by the distractors, and are associated with longer reaction times and more errors (Eriksen and Eriksen, 1974). In the current adaptation, three different shapes of arrows were introduced (Figure 1a). One shape was assigned to each participant and the third was assigned to neither participant. All assignments were counterbalanced. Arrows within each trial were of the same shape, but own vs other’s shapes were different to allow participants to distinguish their own vs the other’s turn. Participants were seated in separate booths and were required to respond to targets that consisted of their shape, and to refrain from responding during the other’s turn.

Participants were told that the time window in which they were allowed to respond was constantly adjusting to keep the task challenging and that, provided they pressed the correct button, they would receive positive feedback, indicating an incremental monetary increase, for trials on which they were on time, and negative feedback, indicating monetary loss, when they were late. On the other’s trial, they could also see what feedback the other player received. As the time window was variable, participants had an incentive to be fast and accurate. If they were faster, they believed they had an increased chance of receiving positive feedback. In reality, positive feedback was provided on 75% of trials, and negative feedback on 25% of trials for both participants, regardless of their actual performance.

Participants believed they were performing the same task in an interactive way, though in reality they were performing equivalent but separate tasks in parallel. Each participant interacted with an automated version of the program. Figure 1b depicts one player’s trial and what he perceived to be the other player’s trial. The feedback stimuli were presented so that they appeared to occur at the same time during one’s own and the other’s trials. Feedback of one’s own trial was delivered 450-550 ms after response. For the other’s, it appeared to come at a similar time, but because other responses were not available to the program, a 550-900 ms time window after stimulus was used.

Participants were debriefed in a group email after the data collection was completed.
This was done because the literature suggests that the oFRN is very frontal in distribution and was analysed between 370 and 410 ms at FCz. Lysed between 230 and 250 ms at Cz. The feedback P3 followed a more post-stimulus at Cz and CPz. Feedback potentials were analysed for centroparietal distribution and was analysed between 410 and 450 ms between 280 and 300 ms post-stimulus at FCz. The five arrows array subtended a visual angle of 2.58° horizontally and 0.52° vertically, whereas feedback stimuli subtended a visual angle of 0.86° horizontally and vertically. The two sessions contained three blocks of 240 trials each.

ERP recording and pre-processing

The EEG was recorded continuously with electrodes mounted on an elastic cap from 33 standard locations according to the 10–20 electrode system. Scalp electrodes were F1/2, Fz, F3/4, FC1/2, FCz, FC3/4, C1/2, Cz, C3/4, CP1/2, CPz, CP3/4, P1/2, Pz, P3/4, PO3/4, POz, PO7/8, O1/2 and Oz. Two electrodes were placed on the right and left mastoids, and the right mastoid was used as the active reference site. An electrode placed in front of Fz served as the ground. Eye movements were monitored by deriving bipolar recordings from electrodes placed to the left and right of the right eye (HEOG); blinks were monitored by deriving bipolar recordings from electrodes placed under the right eye and FP2 (VEOG). The EEG and EOG signals were amplified with a low-pass filter 200 Hz by Neuroscan amplifier and digitized at a sampling rate of 1000 Hz.

Data were re-referenced to the average of the two mastoids and re-filtered digitally with a low-pass of 40 Hz. Target- and feedback-related epochs started 200 ms before and ended 1000 ms after stimulus presentation. All amplitude values were referred to the 200-ms pre-cue baseline. Trials were automatically eliminated if the voltage exceeded ±50 μV at either the vertical or horizontal (Electro-Oculogram) EOG channels, or if it exceeded ±100 μV at any other channel. Separate averages were computed for each type of target based on their congruency (congruent or incongruent) and ownership (own or other’s), and for feedback based on its valence (positive or negative). Topographical analysis and the previous literature were used to determine the time windows and electrodes for analysis.

Target N2 followed a frontocentral distribution and was analysed between 280 and 300 ms post-stimulus at FCz. Target P3 followed a centroparietal distribution and was analysed between 410 and 450 ms post-stimulus at Cz and CPz. Feedback potentials were analysed for own feedback only. FRN followed a central distribution and was analysed between 230 and 250 ms at Cz. The feedback P3 followed a more frontal distribution and was analysed between 370 and 410 ms at FCz and Cz. oFRN analysis was limited to the second hierarchical session. This was done because the literature suggests that the oFRN is very sensitive to whether the other is a competitor or a co-operator (Itagaki and Katayama, 2008). By analysing oFRN change across session, it would be impossible to disentangle the relative contribution of competition/co-operation and the power manipulation. By restricting the analysis to the hierarchical session, where participants were cooperating, it was possible to single out the effect of the power manipulation. The same analysis parameters were used for the FRN.

The current paradigm

For the purpose of this study, this particular choice of task and setup provided a simple and effective method to explore the experimental questions that motivated us. In terms of the effect of power on cognition, the flanker paradigm allowed the investigation of executive attention and early conflict detection, which have been proposed to vary with power. Later potentials like the P3b allowed us to investigate variations in top-down processing resources devoted to targets. Feedback stimuli allowed the investigation of self-evaluation processes, from early markers of expectancy violation, to later markers of motivational significance. Having own and other’s targets allowed a simple and effective measure of sensitivity to the other in information processing, even when not explicitly instructed, which is highly relevant for a construct like power. Finally, a design with outcome dependence provided an interesting social setting for investigating these processes. This was specifically true in the context of feedback, as the feedback stimuli coded incremental gains and losses. The addition of a control group provided a measure of co-operation (outcome dependence) that was not shifted from equilibrium by a power hierarchy.

RESULTS

The participants will be referred to as power-holders, subordinates and neutrals, although it should be kept in mind that in Session 1, all participants were hierarchically equal.

Behavioural results

Accuracy (calculated as proportion of correct trials) and reaction time (RT) were analysed for own trials only because participants were instructed to refrain from responding during the other’s trials. Accuracy and RT were submitted to separate 3 × 2 × 2 mixed-effects analyses of variance (ANOVA) with a between-subject variable of ‘group’ (power-holder, subordinate and neutral), and within-subject variables of ‘congruency’ between central and distractor arrows (congruent and incongruent) and ‘session’ (Session 1 and hierarchical Session 2).

Accuracy results yielded the expected flanker effect of congruency, \( F(2,25) = 77.92, P < 0.001, \eta^2_p = 0.76 \), with lower accuracy for incongruent (\( \text{mean} = 0.92, \text{SE} = 0.007 \)) compared with congruent trials (mean = 0.99, SE = 0.002). We found a three-way interaction between group, session and congruency, \( F(2,25) = 4.30, P = 0.025, \eta^2_p = 0.20 \), indicating that the manipulation of group had an effect on performance. To simplify the analysis, we calculated the change in accuracy (AcChange) across sessions by subtracting accuracy in Session 1 from accuracy in Session 2. We looked at AcChange for congruent and incongruent trials separately, and submitted them to a separate one-way ANOVA with a between-subject variable of ‘group’. For AcChange on congruent trials, ‘group’ did not emerge as significant (\( P = 0.35 \)), indicating that the manipulation had no effect on performance on the congruent trials (which was almost at ceiling). For AcChange on incongruent trials, however, ‘group’ emerged as significant, \( F(2,25) = 4.45, P < 0.05, \eta^2_p = 0.26 \). Post hoc analyses (corrected for multiple comparisons) showed that power-holders differed significantly from subordinates (\( P < 0.001 \)) and marginally significantly from neutrals (\( P = 0.08 \)) (Figure 2). Subordinates and neutrals did not differ.

Power-holders showed a significantly greater decrease in
Participants, in both own and other’s targets and was statistically reliable, have more negative N2s than congruent trials, was visible for all par-
mixed ANOVA, with the added within-subject variable of electrode
between 410 and 450 ms at Cz and CPz) was submitted to a five-factor
relationship (own or other’s). Amplitude of target P3s (mean amplitude be-
and within-subject variables of session, congruency and target owner-
mixed-effects ANOVA with a between-subject variable of ‘group’
whether our manipulation of group had an impact on the N2, which
mean ± SE, P < 0.05).
For RT, there was only a significant main effect of congruency,
(mean = 511.61 ms, SE = 6.66) compared with congruent
(mean = 480.42 ms, SE = 6.14) trials. There was no interaction with
‘group’.

Target-related potentials
The amplitude of N2s elicited by targets (mean amplitude between 280
and 300 ms at electrode FCz) was submitted to a 3 \times 2 \times 2 \times 2
mixed-effects ANOVA with a between-subject variable of ‘group’
and within-subject variables of session, congruency and target owner-
ship (own or other’s). Amplitude of target P3s (mean amplitude be-
between 410 and 450 ms at Cz and CPz) was submitted to a five-factor
mixed ANOVA, with the added within-subject variable of electrode
(Cz and CPz).

The typical effect of congruency on N2, where incongruent trials
have more negative N2s than congruent trials, was visible for all partic-
pants, in both own and other’s targets and was statistically reliable,
\( F(2,25) = 3.99, P = 0.05, \eta^2_p = 0.14 \). The question of interest was
whether our manipulation of group had an impact on the N2, which
would be characterized by an interaction between group, session and
congruency. This interaction was not found, neither was any inter-
action with ownership, indicating that there was no difference between
the two groups in conflict detection pertaining to own or the other’s
trials.

P3b analyses showed a significant main effect of ownership,
\( F(2,25) = 49.95, P < 0.001, \eta^2_p = 0.66 \), revealing higher P3b amplitudes
for own than for other’s targets. There was also a significant main effect
of session, \( F(2,25) = 8.64, P < 0.001, \xi^2 = 0.66 \), revealing higher P3b amplitudes for targets in Session 2 compared with Session 1. A main
question of interest was whether the manipulation had an effect on the
target P3b, which would emerge as an interaction between group and
session. We found a significant three-way interaction between ‘group’,
‘ownership’ and ‘session’, \( F(2,25) = 6.75, P < 0.01, \eta^2_p = 0.35 \). To sim-
plify the analysis, we subtracted the Session 1 values from the Session 2
values, to provide an index of change across sessions (P3bChange). We
submitted P3bChange for own vs other’s targets to two separate 2-way
ANOVAS with a between-subject variable of ‘group’. For own targets,
there was a main effect of group, \( F(2,25) = 39.70, P < 0.05, \eta^2_p = 0.22 \).
Post hoc analyses revealed that subordinates (mean = 4.40 \mu V, SE = 3.15) and neutrals (mean = 4.39 \mu V, SE = 3.37) showed significa-
cantly higher P3change than power-holders (mean = 0.78 \mu V, SE = 3.59, P < 0.05 for both), whereas neutrals and subordinates did
not differ. For other’s targets, there was a marginally significant main
effect of ‘group’, \( F(2,25) = 2.69, P = 0.08, \eta^2_p = 0.17 \). Post hoc analyses
revealed that, for other’s targets, subordinates (mean = 3.30 \mu V,
SE = 4.13) showed significantly higher P3change than power-holders
(mean = −0.45 \mu V, SE = 2.8, P < 0.05) and marginally significantly
higher than neutrals (mean = 0.24 \mu V, SE = 3.81, P = 0.08), whereas
neutrals and power-holders did not differ (Figure 3).

Feedback-related potentials
The FRN effect is characterized by a negative potential for negative
relative to positive feedback. Amplitude of the FRN (at Cz between 230
and 250 ms) was submitted to a 3 \times 2 \times 2 mixed-effects ANOVA with
‘group’ as the between-subjects variable, and ‘session’ and ‘feedback
valence’ (positive and negative) as the within-subjects variables. The
main effect of feedback valence (FRN effect) was significant,
\( F(2,25) = 54.13, P < 0.001, \eta^2_p = 0.67 \). We were interested in whether
the power manipulation had an effect on the FRN. This analysis was
simplified by calculating a metric for the FRN effect by subtracting the
positive feedback potentials from the negative feedback potentials
(FRN差 (FRN差_1 = FRN差_2) and submitting this difference score to a 3 \times 2 mixed model
ANOVA, with ‘group’ as the between-subjects variable, and ‘session’
and ‘ownership’ (positive and negative) as the within-subjects variable. The
interaction was significant, \( F(2,25) = 4.09, P < 0.05, \eta^2_p = 0.25 \), allowing us to look at group dif-
fences on FRNeChange (FRNeSession2 − FRNeSession1). Post hoc
analyses revealed that power-holders had significantly larger
FRNeChange (more negative) (mean = −2.6 \mu V, SE = 4.2) than subor-
dinates (mean = 2.21 \mu V, SE = 4.4, P < 0.05). The mean of the neutrals
(mean = −0.55 \mu V, SE = 1.67) did not differ significantly from either
the power-holders or the subordinates (Figure 4).

oFRN (analysed in Session 2) also showed a main effect of group,
\( F(2,25) = 6.11, P < 0.01 \). Post hoc analyses revealed that power-holders

![Fig. 2](https://academic.oup.com/scan/article/9/2/218/1620750/fig2.png)

Fig. 2 Graph representing change in the proportion of accurate trials across sessions, plotted separately for congruent trials (left) and incongruent trials (right). Power-holders (black) show significant decrease in accuracy for incongruent trials compared with subordinates (shaded).

![Fig. 3](https://academic.oup.com/scan/article/9/2/218/1620750/fig3.png)

Fig. 3 Difference of grand-average waveforms across session for own targets (upper) and other’s targets (lower) at Cz. Shaded rectangle represents time window where target P3b was analysed.
DISCUSSION

In this study, we showed that power asymmetries led to asymmetries in co-operation. Behaviourally, we found that power-holders performed worse than subordinates or neutrals. The ERP results showed that, while power-holders did not differ at the level of early attentional processes, they devoted less top-down motivational resources to their task compared with subordinates or neutrals. Subordinates, on the other hand, were asymmetrically sensitive to the power-holders’ targets, although attention to the other was not particularly instructed. In terms of how they perceived feedback, power-holders expected more gains, as indexed by more pronounced reward prediction errors. Power-holders, however, attached less significance to their losses. Subordinates showed the opposite effect: expecting less, but caring more. It seems that holding power reduces the motivation to co-operate diligently with less powerful others.

Power and attention

One would expect power-holders to have faster responses on incongruent trials, due to their proposed ability to inhibit distractors (Guinote, 2007b). What we found, instead, was that they were ‘less’ accurate. The ERP data, consistent with the reaction-time data, showed no difference in the conflict-sensitive N2 potential between the groups (Folstein and Van Petten, 2008). Our results do not support a proposed effect of power on executive attention, or the ability to resolve a response-related conflict arising from distracting stimuli (Posner and Petersen, 1990), as might be inferred from the set of behavioural studies described by Guinote (2007b) and Smith et al. (2008). Our findings are, however, consistent with other literature that has not, to this point, showed a direct and simple effect of power on executive attention (e.g. Willis et al., 2011). Moreover, in a recent study investigating status, which often occurs with power (Boksem et al., 2011), the authors suggest that low status most likely does not impair executive control, but rather it is associated with a more reactive mode of behavioural control that can be adaptive. We do not think that the effect of power on subordination is simple and straightforward. In that sense, it is unlikely the case that subordination is simply detrimental for cognitive performance.

P3b, a later and multi-faceted ERP, has been linked to making an assessment of whether a response should be initiated, after a decision regarding the relevance of a stimulus (Verleger et al., 2005). Compared with the benchmark of the neutral control group, power-holders had a reduced P3b to their own targets. At the same time, power-holders were less accurate in performance. Our N2 results suggest that the behavioural effect was not due to differences between the groups at the early level of response preparation. One possibility is that, in the subsequent chain of cognitive events leading to behaviour, power-holders engaged in less corrective responses, possibly as a result of devoting less resources to their own targets (as indexed by P3b). This allowed for more errors.

Subordinates showed relatively high P3b amplitudes to the other’s targets, indicating higher sensitivity, and possibly more subjective motivational significance assigned to those stimuli (Nieuwenhuis et al., 2005). This finding supports the hypothesis that subordinates process information in a rather indiscriminate fashion (Guinote, 2007a), even when it is task-irrelevant. However, in our task, the other’s targets may have a more subjective importance. Similarly to how subordinates attend asymmetrically to power-holders in a social context (Fiske, 1993), this process may apply for sensitivity to stimuli associated with the power-holder, which are relevant in a more general sense. We acknowledge, however, that P3b is a multi-faceted potential. Better assays of attention, using stimuli in peripheral vision, are important to further explore how power-holders and subordinates differ in target processing.

Power and feedback

The findings related to feedback processing show a double dissociation between two types of feedback evaluation and power. Power-holders showed an increase in the FRN effect, whereas subordinates showed a decrease. FRN has been shown to code a rather subjective reward...

had significantly more negative oFRNs than subordinates and neutrals. Subordinates and neutrals did not differ.

Fig. 4 Difference of grand-average waveforms across session for FRN (negative feedback minus positive feedback) potentials at Cz. Shaded rectangle represents time window where feedback P3 was analysed.

Amplitude of feedback P3s (between 370 and 410 ms) was submitted to a $3 \times 2 \times 2 \times 2$ mixed-effects ANOVA with ‘group’ as the between-subjects variable and ‘session’, ‘feedback valence’ (positive and negative) and ‘electrode’ (FCz and Cz) as the within-subject variables. The analysis showed a main effect of ‘feedback valence’, $F(2,25) = 32.6$, $P < 0.001$, $\eta^2_p = 0.72$; P3s were larger after negative feedback than after positive feedback. The question of interest was whether our power manipulation affected feedback P3. A three-way interaction involving group, session and feedback valence was indeed found, $F(2,25) = 7.20$, $P < 0.01$, $\eta^2_p = 0.37$. To simplify the analysis, we subtracted the Session 1 values from the Session 2 values, to provide an index of change across sessions (P3Change). We submitted P3change for positive and negative feedback to two separate one-factor ANOVAs with ‘group’ as the between-subject variable. For positive feedback, there was no effect of group ($P = 0.77$), showing that the manipulation had no effect on the way positive feedback was processed. For negative feedback, ‘group’ emerged as significant, $F(2,25) = 8.50$, $P < 0.01$, $\eta^2_p = 0.41$. Post hoc analyses showed that subordinates (mean = $5.17 \mu$V, SE = $1.54$) had significantly higher P3change than power-holders (mean = $-3.76 \mu$V, SE = $1.54$, $P < 0.05$) and neutrals (mean = $0.88 \mu$V, SE = $1.46$, $P < 0.05$), and the difference between neutrals and power-holders was also significant ($P < 0.05$). In other words, power led to a decrease in negative feedback P3, whereas subordination led to an increase in negative feedback P3, compared with neutrals (Figure 5).

Fig. 5 Difference of grand-average waveforms across session for own negative feedback at Cz. Shaded rectangle represents time window where feedback P3 was analysed.

DISCUSSION

In this study, we showed that power asymmetries led to asymmetries in co-operation. Behaviourally, we found that power-holders performed worse than subordinates or neutrals. The ERP results showed that, while power-holders did not differ at the level of early attentional processes, they devoted less top-down motivational resources to their task compared with subordinates or neutrals. Subordinates, on the other hand, were asymmetrically sensitive to the power-holders’ targets, although attention to the other was not particularly instructed. In terms of how they perceived feedback, power-holders expected more gains, as indexed by more pronounced reward prediction errors. Power-holders, however, attached less significance to their losses. Subordinates showed the opposite effect: expecting less, but caring more. It seems that holding power reduces the motivation to co-operate diligently with less powerful others.

Power and attention

One would expect power-holders to have faster responses on incongruent trials, due to their proposed ability to inhibit distractors (Guinote, 2007b). What we found, instead, was that they were ‘less’ accurate. The ERP data, consistent with the reaction-time data, showed no difference in the conflict-sensitive N2 potential between the groups (Folstein and Van Petten, 2008). Our results do not support a proposed effect of power on executive attention, or the ability to resolve a response-related conflict arising from distracting stimuli (Posner and Petersen, 1990), as might be inferred from the set of behavioural studies described by Guinote (2007b) and Smith et al. (2008). Our findings are, however, consistent with other literature that has not, to this point, showed a direct and simple effect of power on executive attention (e.g. Willis et al., 2011). Moreover, in a recent study investigating status, which often occurs with power (Boksem et al., 2011), the authors suggest that low status most likely does not impair executive control, but rather it is associated with a more reactive mode of behavioural control that can be adaptive. We do not think that the effect of power on subordination is simple and straightforward. In that sense, it is unlikely the case that subordination is simply detrimental for cognitive performance.

P3b, a later and multi-faceted ERP, has been linked to making an assessment of whether a response should be initiated, after a decision regarding the relevance of a stimulus (Verleger et al., 2005). Compared with the benchmark of the neutral control group, power-holders had a reduced P3b to their own targets. At the same time, power-holders were less accurate in performance. Our N2 results suggest that the behavioural effect was not due to differences between the groups at the early level of response preparation. One possibility is that, in the subsequent chain of cognitive events leading to behaviour, power-holders engaged in less corrective responses, possibly as a result of devoting less resources to their own targets (as indexed by P3b). This allowed for more errors.

Subordinates showed relatively high P3b amplitudes to the other’s targets, indicating higher sensitivity, and possibly more subjective motivational significance assigned to those stimuli (Nieuwenhuis et al., 2005). This finding supports the hypothesis that subordinates process information in a rather indiscriminate fashion (Guinote, 2007a), even when it is task-irrelevant. However, in our task, the other’s targets may have a more subjective importance. Similarly to how subordinates attend asymmetrically to power-holders in a social context (Fiske, 1993), this process may apply for sensitivity to stimuli associated with the power-holder, which are relevant in a more general sense. We acknowledge, however, that P3b is a multi-faceted potential. Better assays of attention, using stimuli in peripheral vision, are important to further explore how power-holders and subordinates differ in target processing.

Power and feedback

The findings related to feedback processing show a double dissociation between two types of feedback evaluation and power. Power-holders showed an increase in the FRN effect, whereas subordinates showed a decrease. FRN has been shown to code a rather subjective reward...
prediction error (Bellebaum et al., 2010). According to this interpretation, subordinates were less satisfied with their losses, possibly reflecting a belief that they were indeed worse at this task. Feedback P3 indexes another aspect of feedback, and it has been shown to be sensitive to reward magnitude, regardless of valence (Yeung and Sanfey, 2004). Feedback P3 is interpreted as a top-down controlled process of outcome evaluation, into which allocation of attentional and motivational significance may come into play (Wu and Zhou, 2009). Compared with individuals performing the task under neutral power allocation, power-holders showed smaller, whereas subordinates showed larger feedback P3. Thus, the same feedback was interpreted as having larger subjective magnitude, or importance in subordinates. Power-holders, on the contrary, did not ‘care’ as much. This is an avenue that deserves further research. It is possible that subordinates attribute negative feedback to the self, whereas, in the power-holders’ case, feedback draws attention to the task only, which has important effects on self-esteem and performance (Kluger and DeNisi, 1996).

As for the FRN elicited by the other’s feedback (oFRN), power-holders showed more negative potentials than subordinates or neutrals for the other’s feedback, who hardly showed a clear oFRN. This result has to be interpreted with caution, because it does not reflect change across session. However, given the interpretations provided by past studies (Itagaki and Katayama, 2008), it is possible that power-holders processed subordinates’ negative feedback more as ‘losses’ than the inverse relationship. This may reflect the fact that they monopolized the resource, which they had a vested interest in increasing. Another explanation, which we find unlikely, is that they are more ‘empathic’ to subordinates. This would, however, contradict the literature suggesting that power reduces perspective taking (Galinsky et al., 2006).

To contextualize our findings in the light of the dominant theories of power, we find that our results are consistent, both with Fiske’s (1993) ‘Power as Control’ model and older literature on cognitive and social processes that result from control deprivation (Berscheid et al., 1976; Pittman and Agostino, 1989). These theories state that subordination upregulates vigilance and provokes cognitive activity in an attempt to restore predictability and control. In the default state, attention travels up the power hierarchy. Along the same lines, our results show that subordinates are careful task performers and asymmetrically sensitive to power-holders’ targets.

We also found support for Keltner et al.’s (2003) theory of approach and inhibition, one of the dominant modern theories of power. According to this theory, power activates an approach motivation, whereas subordination activates an inhibition motivation. In subordinates, we found high sensitivity to negative feedback, which is consistent with the theory’s prediction that subordinates are sensitive to punishment signals in their environment.

Our results do not support a common view that subordination is necessarily detrimental for cognitive performance, which may be inferred from recent studies on the effect of power on executive functions and focused attention (Guinote, 2007b; Smith et al., 2008). Although subordinates may sometimes process information rather indiscriminately, which is suggested by Guinote’s (2007a) situated focus theory of power, this is a mechanism that can be adaptive (Boksem et al., 2011).

We recognize that, in the manipulation employed here, it is difficult to determine if it is the recent ‘loss’ incurred by the subordinates or the outcome dependency that alters how targets and feedback are processed. It is possible that the participants who lost in the first session were motivated to perform better in the second task. However, we think it unlikely that this factor could independently drive the various effects, especially the different pattern in responding to own vs other’s targets, which is consistent with the power literature (Fiske, 1993). In defence of the manipulation used, we argue that a random assignment to power (without the staged loss) might have been perceived as illegitimate, and perceived illegitimacy has been found to moderate the effects of power (Lammers et al., 2008). Future experiments should compare both types of manipulation within the same design.

Another concern is that, in this study, power may be conflated with incentive. It is possible that the high-power condition comes with greater incentive to perform well, due to the ability to assign the final monetary outcomes. Alternatively, it may be the subordinates who feel greater incentive to perform well, given their lack of resources. Power is a multi-faceted construct, and the way it affects individuals’ affordances and constraints is likely to affect their level of incentive in goal-directed behaviour. It may be useful for future studies to try to dissociate these constructs by using a careful manipulation of incentive across different levels of power.

To conclude, our findings have interesting implications for work settings where power hierarchies exist, and may seem consistent with the classic social psychological literature that tends to cast power as corruptive for harmonious social interactions (Kipnis, 1972). We do not, however, imply that power has magical or transformative effects. Our short-term manipulation suggests that situational affordance and constraints can affect cognition in remarkable ways. Although one may assume that people reach positions of power because of underlying abilities and personality traits, the data suggest that power and subordination allow for cognitive and affective changes that may reinforce these roles (Smith et al., 2008). Moreover, both power-holders and subordinates become convinced by their assigned status in the hierarchy, and subsequently interpret feedback in quite different ways.

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**Conflict of Interest**

None declared.

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