Received: 25 April 2022 | Accepted: 22 February 2023

DOI: 10.1111/bjop.12643

the british psychological society
promoting excellence in psychology

ARTICLE

Event-related potential and behavioural evidence of goal-based expectations for consistent actions among group members

Jun Yin[1,2] | **Dan Zhou**[1,2] | **Danfeng Ai**[1,2] | **Hongli Sun**[1,2] | **Jipeng Duan**[1,2] | **Zhongqiang Sun**[1,2] | **Xiuyan Guo**[3]

[1]Department of Psychology, Ningbo University, Ningbo, China

[2]Center of Group Behavior and Social Psychological Service, Ningbo University, Ningbo, China

[3]Fudan Institute on Ageing, Fudan University, Shanghai, China

Correspondence

Jun Yin, Department of Psychology, Ningbo University, No. 616 Fenghua Rd., Ningbo, 315211, China.
Email: yinjun1@nbu.edu.cn

Xiuyan Guo, Fudan Institute on Ageing, Fudan University, No. 220 Handan Rd., Yangpu District, Shanghai, 200433, China.
Email: guoxiuyan@fudan.edu.cn

Funding information

Special Foundation of Philosophy and Social Science in Zhejiang Province for Young Talents (浙江省哲学社会科学领军人才培育专项课题 (青年英才培育), Grant/Award Number: 21QNYC12ZD

Abstract

Placeholder Text:

Abstract: People expect group members to act consistently. However, because actions are organized hierarchically, incorporating deep-level goals and shallow-level movements, it remains unclear what level of action is expected to be consistent among group members. We determined that these two levels of action representations can be dissociated in object-directed actions and measured the late positive potential (LPP), which indicates expectation. We found that participants identified a new agent's actions more quickly when this agent pursued a consistent goal while moving in a manner inconsistent with group members than when this agent pursued an inconsistent goal while moving in the same manner as group members. Moreover, this facilitation effect disappeared when the new agent was from a different group, revealing goal-based expectations for consistent actions among group members. The LPP amplitude during the action-expectation phase was greater for agents from the same group than for agents from a different group, suggesting that people implicitly generate clearer action expectations for group members than for other individuals. Additionally, the behavioural facilitation effect was observed when the goal of actions was clearly identifiable (i.e. performing rational actions to reach an external target) rather than when there was no clear association between actions and external targets (i.e. performing irrational actions). The LPP amplitude during the action-expectation phase was greater after observing rational actions than after observing irrational actions performed by two agents from the same group, and the expectation-related increase in LPP predicted the behavioural measurements of the facilitation effect. Hence, the behavioural and event-related potential evidence suggest that

people implicitly expect group members to behave consistently according to goals rather than movements per se.

KEYWORDS
action expectation, goal, late positive potential, movement, social group

BACKGROUND

The ability to anticipate and predict the actions of others is critical for smooth social interactions. People must acquire knowledge of an individual to generate appropriate expectations about their actions, as observed actions are usually classified according to one's knowledge of an individual's internal factors (Blakemore & Decety, 2001; Jara-Ettinger et al., 2016), including their mental state, preferences and personality. However, the actions of an individual are often constrained by the people around them; thus, their actions are the result of both internal factors and the social (group) context. We sometimes lack sufficient individual-specific knowledge to generate expectations of others' actions. Therefore, we may use knowledge of social groups to support the generation of action expectations (Bodenhausen et al., 2012; Powell & Spelke, 2013; Vijayakumar et al., 2021). Hence, it is important to determine whether and how people use social knowledge, such as the social group to which an individual belongs, to establish expectations of how that individual will act.

Social groups specify invisible boundaries for individuals and can also activate group-related knowledge (Bodenhausen et al., 2012; Rhodes & Baron, 2019). In such cases, the people in a social group are not viewed as individuals but instead are classified as belonging to the same category as other group members. This process is known as social categorization and facilitates mental organization of the complicated social world into coherent conceptual knowledge (Liberman et al., 2017). Membership in a social group can guide inferences of properties shared among group members; indeed, when making predictions about unknown members of a social group, people tend to generalize the properties of known members to unknown members and expect group members to behave consistently (Grigoryan et al., 2020; McGarty et al., 2015). Regarding stereotyping and evaluative generalizations, many studies have reported that unknown group members are generally expected to have the same behavioural tendencies, for example, traits, behaviours and preferences, as known individuals in the same social group (Crawford et al., 2002; Ranganath & Nosek, 2008; Vijayakumar et al., 2021). Recently, more direct evidence regarding group-based expectations of actions was obtained by comparing responses to actions identified as consistent or inconsistent among group members. The results indicated that members of the same social group are expected, even implicitly, to behave similarly (Duan et al., 2021; Xu et al., 2019).

Observed actions are thought to be organized in a hierarchical manner with shallow-level movements and deep-level goals or preferences (Cavallo et al., 2013; Csibra, 2007; Wurm & Caramazza, 2022). While actions can be characterized as belonging to many levels, we focus on two levels, shallow and deep, that have been widely discussed in previous studies (Cavallo et al., 2013; Fogassi et al., 2005; Grafton & Hamilton, 2007). It remains unclear whether the goal or the movement of actions is expected to be consistent among group members. Answering this question could highlight the importance of the level of action representation and prioritization in expectations of group member behaviour. Empirically, it is difficult to disentangle the effects of goals and movements on action expectations, as goals are realized by performing particular movements and individuals who perform actions with the same goals tend to have similar movements. Fortunately, Yin et al. (2022) developed a new method of distinguishing goal-based expectations and movement-based expectations; in this method, expectations regarding the actions of group members are assessed by asking participants to identify the movements of a new member. If people expect a new group member to behave consistently according to goals rather than movements, a different movement used to achieve the original goal should be identified more quickly than the original movement used to achieve a different goal; this effect, known as the facilitation effect in that the content

of the expected actions is congruent, is similar to semantic priming (Castner et al., 2007; Lorenz & Newman, 2002). These findings indicate that people implicitly rely on goals rather than movements to predict common actions across group members.

Regardless of the above findings, the measured reaction times (RTs) may not reflect action expectations because the behavioural measurement of action expectation in the study of Yin et al. (2022) is the result of multiple cognitive processes. For example, similar to repetition priming (Grill-Spector et al., 2006; Race et al., 2010), after repeated exposure to the same stimuli, that is actions of known group members, participants became habituated to these actions, refining representations of action-specific features. This refinement facilitated the response to group-consistent actions. Although this alternative is speculative and unlikely, it suggests that further evidence is needed to support goal-based expectations of commonness among group members, such as measurements of neural activity during action expectation beyond merely determining whether the expected action was observed. Such evidence can be provided by recording event-related potentials (ERPs), which have millisecond-level temporal resolution and are suitable for monitoring specific event-related activity (Luck, 2014). Late positive potential (LPP), which increases in centroparietal sites approximately 300 ms after the onset of an event, is the most appropriate ERP component for studying cognitive expectation (Brudner et al., 2018; Lin et al., 2012; Sussman et al., 2017). Furthermore, LPP is enhanced when clear expectations are formed compared to when expectations are less clear. For example, during the interval between a cue and a target, where the cue signifies whether an item should be anticipated, the LPP amplitude is greater when the expected content is held in memory than when it is not (Rutters et al., 2015).

To test whether deep-level goals or shallow-level movements are expected to be consistent among group members, the current studies used the same methods as Yin et al. (2022) to collect behavioural measurements but also examined recordings of the LPP component during the action-expectation phase. These measurements of automatic responses allow analysis of implicit expectations regarding the commonness of group member actions, in contrast to explicit reports that may lead participants to devote more attention to the goals or movements they are directly asked to recall. If people implicitly rely on goals to form expectations of commonness among group members, when a new agent belongs to the same group as the known agents and the goal of his or her action is obvious, participants should generate clear expectations regarding the agent's actions; accordingly, the LPP component, which is related to cognitive expectation, should have a greater amplitude than if the goal is not obvious or the agent belongs to a different group. In addition, we predicted that the same behavioural facilitation effect observed by Yin et al. (2022; i.e. in the identification of a new movement towards the original goal) would be observed, but, importantly, only for agents from the same group (not those from a different group). Furthermore, we predicted that the LPP evoked by group-related expectations would be correlated with the behavioural facilitation effect if both indices assessed implicit action expectations regarding group members.

Two experiments were performed. First, we assessed whether the implicit expectation of consistent actions among group members is based on the movements or goals of agent actions by comparing action expectations for agents from the same group with those for agents from a different group (Experiment 1). To further investigate whether group-related implicit expectations are formed according to the interpreted goal of actions or the association between actions and external objects, the ambiguity of the action's goal was directly manipulated (Experiment 2).

EXPERIMENT 1

In this experiment, participants were shown animated videos of two groups of agents moving synchronously. Then, two targets were placed on opposite sides of the screen, and two members of the same group performed the same action to approach the same target. Next, the two presented targets were switched, and a new agent from either the same or a different group as the original two members was shown stationary for a period, during which time the action expectation was induced. Finally, the new agent performed either a consistent movement to approach an inconsistent goal or an inconsistent

movement to approach a consistent goal, as previously demonstrated. Participants were asked to identify which of these options (i.e. which movement) the agent performed. If participants expect common goals among group members, the LPP amplitude during the action-expectation phase would be greater for the agent from the same group as two representatives (same group agent) than for the agent from a different group (different group agent), as the LPP reflects cognitive expectation. Furthermore, an inconsistent movement towards a consistent goal should be identified faster than a consistent movement towards an inconsistent goal, as the former would match the content of the expected actions; importantly, such an effect would be expected only for the agent from the same group as two representatives.

Methods

Participants

In all, 30 paid volunteers (16 males and 14 females; mean age: 20 years, age range: 18–26 years) participated in the experiment. All participants had normal or corrected-to-normal vision and no history of neurological disorders. Four participants were excluded for the following reasons: two had excessive movement artefacts, and the other two did not complete the test due to discomfort. The sample size was determined based on a previous study (Yin et al., 2022) that adopted methods very similar to the present experiment but included only behavioural comparisons between conditions, that is the facilitation effect, with a medium effect size (Cohen's $d \approx 0.6$), an alpha level of 0.05 and a power of 0.80. The estimated minimum sample size for the experiment was 24 individuals. Because electroencephalography (EEG) measurements are usually highly variable, 30 valid individuals were included to be conservative. This sample size was comparable to that of a previous study that used similar EEG measurements to evaluate expectations (Brudner et al., 2018). This research was approved by the Research Ethics Board of the Department of Psychology at the authors' university and was performed in accordance with the relevant guidelines and regulations. All participants received written information about the research and provided informed consent.

Apparatus and stimuli

The stimuli were presented on a grey background using a 24-inch LCD monitor (BenQ, XL2430; 1024 × 768 pixel resolution; 120-Hz refresh rate) at a 100-cm viewing distance using custom software written in MATLAB using the Psychophysics Toolbox library (Brainard & Vision, 1997).

The visual stimuli included computer-animated events of group behaviours developed with Adobe Animate software. Each event included two agents with different appearances that were randomly selected from six animated figures with distinct colours and shapes (see Figure 1). Each agent was rendered with two eyes as facial features that subtended approximately 1.5° × 1.5°.

Procedure and design

At the beginning of each trial, a fixation cross (1.5° × 1.5°) was presented in the centre of the screen for 400–500 ms, after which two groups of agents were presented. The agents in each group (three per group) initially appeared close to one another in the top two corners of the screen with an AAABBB arrangement. The agents in each group then performed a series of synchronized movements around a circular path. This introductory phase for the social group was 1800 ms in duration.

Following this introductory sequence, all agents moved to the top of the platforms, and two agents, who served as representatives of their respective groups, successively performed the same goal-directed action. This phase was 7400 ms in duration (see Figure 1 – group members' actions). Specifically, each

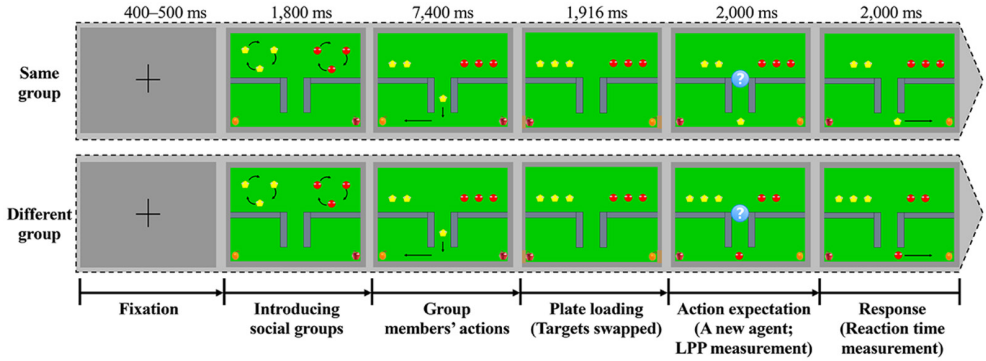

FIGURE 1 Representative trial sequences from Experiment 1. The LPP and RT were measured in the action-expectation phase and the response phase, respectively.

agent initially moved to the bottom of the screen. The agent then turned left or right, with the direction balanced among each participant, to approach one of two objects as its target and then returned to the starting point. The two objects, a yellow orange and a red apple, were placed in the lower left-hand and right-hand corners of the screen, respectively; the goal objects were counterbalanced across participants. Next, a yellow plate appeared and covered the two objects, during which time the positions of the objects were switched. This phase is depicted in Figure 1 as the object-switch phase and lasted 1916 ms. A new agent from either the same or different group then moved to the bottom of the screen and paused, at which time a question mark was presented above this agent for a period of 2000 ms (see Figure 1, action-expectation phase). During this phase, participants were asked to freely anticipate the action that the paused agent would perform in the future; no behavioural response was needed. The aim of this phase was to induce expectations regarding the subsequent action of the unknown group member and evoke an expectation-related LPP component. Next, the paused agent moved towards the left or right object on the screen; participants were asked to identify whether the agent moved to the left or right object as quickly as possible by pressing 'F' or 'J', respectively, on a standard keyboard (see Figure 1 – response phase, during which RTs were measured). When the participant's judgement matched the agent's movement, the trial was recorded as correct; otherwise, it was recorded as incorrect. If a participant did not respond within 2000 ms, the programme automatically proceeded to the next trial, and the trial was recorded as incorrect.

In the response phase, a 2 (agent group: same vs. different) × 2 (goal consistency: consistent vs. inconsistent) within-subject design was used. Each condition had 32 trials, resulting in a total of 128 trials. The trials were presented in pseudorandom order, in that the same condition was not repeated for more than three consecutive trials. The agent group was defined by whether the identified (i.e. new/last) agent belonged to the same group as the two representatives or a different group. Goal consistency was defined by whether the identified agent approached the same target as the two representatives, that is whether the target was consistent or inconsistent. Thus, a consistent goal was accompanied by an inconsistent movement (e.g. right vs. left movement) relative to the movement of the representatives, and an inconsistent goal was accompanied by a consistent movement. Before the formal experiment, the participants were allowed 2 min to practice. Each participant finished the entire experiment within 50 min. The videos showing the design of each condition in both experiments can be accessed at https://osf.io/g4v7p/?view_only=4f621ed9a6374612ab0635aefeba0fc1. Since goal consistency was manipulated after the action-expectation phase and in the response phase, the trials in the consistent goal and inconsistent goal conditions were actually not different, the action-expectation phase had a single-factor (agent group: same vs. different) within-subject design, and each condition had 64 trials.

To test whether the manipulation of social group in this experiment was valid, we recruited 50 new participants, that is individuals who did not participate in the main study (mean age = 20 years, 22 males and 28 females), to watch the video in which the two social groups were introduced. The participants

were then asked to indicate whether the agents from the groups were associated with each other and embraced each other (from 1 = completely disagree to 7 = completely agree), according to the method for evaluating groupness as described in Duan et al. (2021). The difference in the ratings of the social group presented on the left ($M = 5.05$, $SE = 0.14$) and the social group presented on the right was not significant ($M = 4.94$, $SE = 0.13$; $t(49) = 0.99$, $p = .326$, 95% CI = [−0.11, 0.33], Cohen's $d = 0.14$), and both groups were rated as having higher groupness when the agents were presented separately than when the agents were presented without distinguishing the groups ($M = 4.20$, $SE = 0.17$; left group: $t(49) = 4.06$, $p < .001$, 95% CI = [0.43, 1.27], Cohen's $d = 0.57$; right group: $t(49) = 3.86$, $p < .001$, 95% CI = [0.36, 1.23], Cohen's $d = 0.55$). These results suggest that the manipulation of the social group in this experiment was valid.

EEG recordings and analyses

The EEGs of the participants were recorded continuously using 64 actiCAP active electrodes with an actiCHamp Plus amplifier (Brain Products GmbH) at a sampling rate of 500 Hz and a low-pass filter at 200 Hz. All recordings were initially referenced to the left mastoid (TP9) and re-referenced offline to the average of the left and right (TP10) mastoids, thus incorporating 62 electrodes referenced to the left mastoid (TP9). All interelectrode impedances were maintained below 10 kΩ.

The EEG measurements were analysed using the EEGLAB toolbox in MATLAB (Delorme & Makeig, 2004). The EEG was first bandpass filtered (fir1) offline between 0.1 and 50 Hz and segmented into epochs around each trial; epochs with correct behavioural responses were selected for the following analyses. Each epoch started 0.2 s before the onset of the action-expectation phase (i.e. the new agent had not performed the goal-directed action), which was used as the baseline for the time-domain analysis, and ended after the action-expectation phase ended, with each epoch having a total duration of 2.2 s. During this period, different expectations could evoke different LPP amplitudes. Next, an independent component analysis was performed for each participant. The eye-movement and blink artefacts were automatically detected using the ADJUST toolbox, visually confirmed and then removed from the EEG signals. Additional artefact rejection was applied to epochs with extremely large fluctuations, defined as a 1000-μV threshold limit and a 5-*SD* probability threshold. Finally, the averaged ERPs were computed for the same group and different group conditions. When computing the ERPs for the action-expectation phase, we did not introduce a goal-consistency factor; even when we included goal consistency, the amplitude of the LPP during the action-expectation phase should not have been influenced by goal consistency, as this factor was meaningful only during the response phase. In the exploratory analyses, we found that goal consistency did not influence the amplitude of LPP in either experiment (see the Supplementary Material).

The LPP has been reported to be more pronounced at the centroparietal electrodes than at other electrodes and to be most prominent in a window starting at approximately 300 ms and extending up to approximately 1700 ms after an event (MacNamara et al., 2009; Paul et al., 2013; Shafir et al., 2015; Thiruchselvam et al., 2011). Thus, the LPP was computed as the average activity across the centroparietal electrodes (C1, C2, C3, C4, C5, C6, Cz, CP1, CP2, CP3, CP4, CP5, CP6, CPz, P1, P2, P3, P4, P5, P6 and Pz) in the time window between 300 and 1700 ms for the same group condition and different group condition.

Results and discussion

Behavioural results in the response phase

Because the RT of the participants was emphasized and was closely related to our hypothesis, the analyses mainly focused on the RT data. However, the accuracy data are also reported. The mean RT of each participant in each condition (see Figure 2a) was computed after excluding trials with incorrect responses

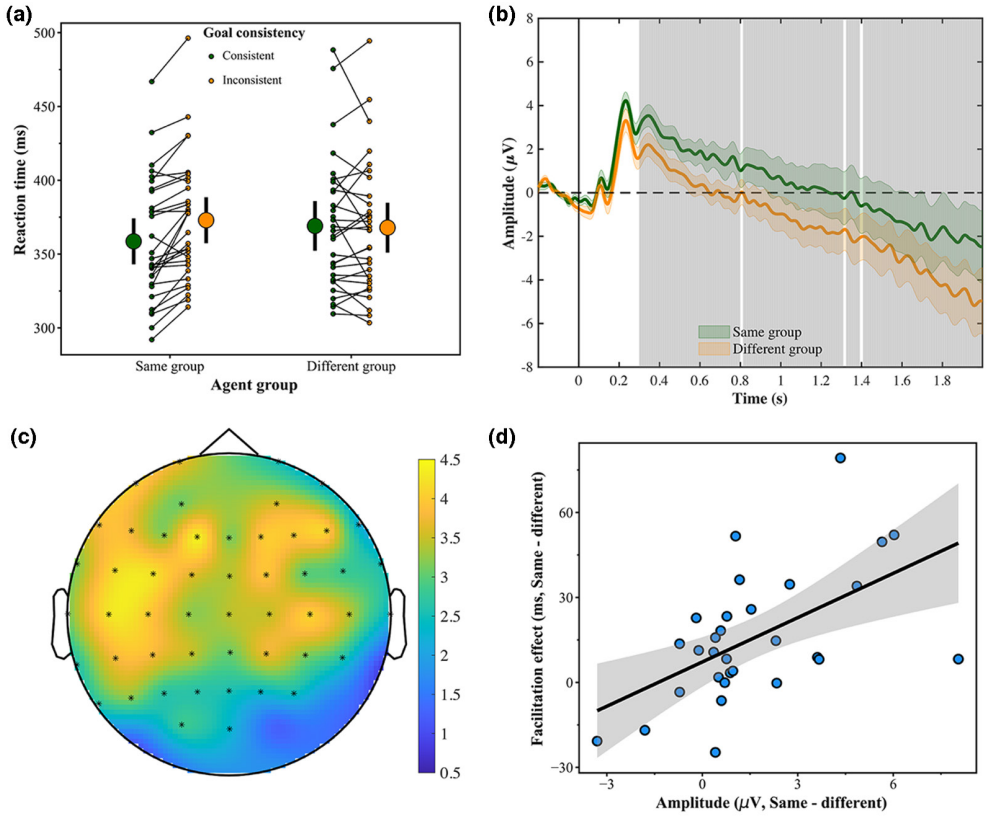

FIGURE 2 Behavioural and EEG results from Experiment 1. (a) Mean RT of correct responses as a function of agent group and goal consistency. The small dots indicate the mean RTs of each participant in each condition, and those from the same participant are connected by a line. The large circles denote the group means in each condition, and the black vertical lines indicate the 95% confidence intervals (CIs) of the means. (b) The ERPs of the same group and different group conditions were obtained by averaging the electrodes of interest. The shaded areas represent ±1 standard error (SE), and the grey-masked time windows represent significant differences in amplitude between the same group and different group conditions. (c) The distribution of *t* values in the cluster-based permutation test for the LPP amplitude between the same group and different group conditions. Asterisks (*) indicate significant channels. (d) The correlation between the magnitude of LPP modulation as a function of agent group and the expectation-related facilitation effect. The grey region represents the 95% CI of predictions from a linear model.

(exclusion rate = 2.14%). The RT data were subjected to a 2 (agent group: same vs. different) × 2 (goal consistency: consistent vs. inconsistent) repeated-measures analysis of variance (ANOVA). While the main effect of agent group was not significant ($F(1, 29) = 1.36$, $p = .253$, $\eta_p^2 = 0.05$), the main effect of goal consistency was significant ($F(1, 29) = 9.26$, $p = .005$, $\eta_p^2 = 0.24$), indicating that participants responded faster when the goal was consistent ($M = 364$ ms, $SE = 8$) than when it was inconsistent ($M = 370$ ms, $SE = 8$; 95% CI = [−11, −2]). In addition, the interaction between the two factors ($F(1, 29) = 13.64$, $p < .001$, $\eta_p^2 = 0.32$) was significant.

A simple effect analysis revealed that in the same group condition, participants responded more quickly when the agents pursued a consistent goal ($M = 359$ ms, $SE = 8$) than when they pursued an inconsistent goal ($M = 373$ ms, $SE = 8$; $t(29) = 5.67$, $p < .001$, 95% CI = [−19, −9], Cohen's $d = 1.04$). However, in the different group condition, this facilitation effect was not observed (consistent goal: $M = 369$ ms, $SE = 8$; inconsistent goal: $M = 368$ ms, $SE = 8$; $t(29) = 0.34$, $p = .739$, 95% CI = [−6, 8], Cohen's $d = 0.06$). These results suggest that group members are implicitly expected to have consistent goals of actions relative to other group members; accordingly, the identification of an action consistent with this expectation was facilitated for only group members (i.e. same group agents vs. different group agents).

TABLE 1 Accuracy across conditions for each experiment.[a]

	Experiment 1		Experiment 2	
	Same group	**Different group**	**Same group**	**Different group**
Consistent goal	0.974 (0.005)	0.984 (0.005)	0.985 (0.004)	0.988 (0.004)
Inconsistent goal	0.979 (0.005)	0.977 (0.005)	0.980 (0.006)	0.988 (0.005)

[a]Data are presented as the mean (standard error; SE).

The accuracy in each condition was computed by calculating the proportion of correct trials out of the total number of trials. A similar ANOVA was applied to the accuracy data, but none of the effects were determined to be significant (agent group: $F(1, 29) = 0.61$, $p = .442$, $\eta_p^2 = 0.02$; goal consistency: $F(1, 29) = 0.06$, $p = .807$, $\eta_p^2 < 0.01$; agent group × goal consistency: $F(1, 29) = 3.96$, $p = .056$, $\eta_p^2 = 0.12$; Table 1).

ERP results in the action-expectation phase

To examine the influence of agent group on the LPP during the expectation interval, we performed a paired-sample *t* test to compare the mean LPP amplitudes of the same group and different group conditions. We found that the same group condition ($M = 0.70\,\mu V$, $SE = 0.86$) elicited a greater LPP response than the different group condition ($M = -0.89\,\mu V$, $SE = 0.72$; $t(29) = 3.58$, $p = .001$, 95% CI = [0.68, 2.49], Cohen's $d = 0.65$) and that this difference was not due to chance. Specifically, when conducting paired-sample *t* tests (with a Bonferroni correction) at each time point from 300 ms to the end of the event but not computing the average LPP amplitude in the selected time window, we found that the LPP amplitudes of the same group and different group conditions were significantly different from 300 to 798 ms, from 814 to 1390 ms and from 1408 to 2000 ms (ps <0.050; grey-masked time window in Figure 2b). Importantly, the difference in the LPP amplitude between the same group and different group conditions was not modulated by goal consistency (please see the Supplementary Material).

The significant difference between the two group conditions could not be attributed to the predefined electrodes, as the cluster-based permutation test for the average activity in the time window from 300 to 1700 ms was conducted with all 62 electrodes (excluding the two reference electrodes) by defining a cluster as consisting of at least two adjacent electrodes reaching the predetermined significance level ($p < .05$). We found that the LPP amplitude was larger in the same group condition than in the different group condition for all included electrodes (see Figure 2c). As LPP reflects cognitive expectations, the greater LPP amplitude observed for same-group agents suggests that people automatically generate clearer action expectations for group members than for other individuals.

To further examine whether the LPP component in the action-expectation phase contributes to behavioural responses in the response phase, we computed the expectation-evoked LPP modulation by subtracting the LPP amplitude of the same group condition from that of the different group condition. We also calculated the expectation-related facilitation effect by subtracting the facilitation effect, that is the RT of the inconsistent-goal condition minus the RT of the consistent goal condition, of the same group condition from that of the different group condition. We found a significant positive correlation between the magnitude of LPP modulation as a function of agent group and the expectation-related facilitation effect, that is the difference in the facilitation effect between the same group and different group conditions ($r = .55$, $p = .002$, 95% CI = [0.24, 0.76]; Figure 2d). Hence, the prior expectation regarding a new group member's action predicts subsequent behavioural responses regarding this agent's action.

After considering both the LPP and RT effects, we concluded that action expectation in the action-expectation phase was related to goal commonness. If it was not related to goal commonness, the facilitation effect observed in the response phase should not have been correlated with the magnitude of LPP modulation. We further analysed the ERPs in the response phase according to both agent group and goal consistency, even though the number of valid trials in each condition was low (approximately 30),

and these ERPs may have been contaminated by the activity of the behavioural response, that is pressing the key. This additional analysis indicated similar effects according to the P300 amplitude as those measured by RTs (see the Supplementary Material). In summary, both ERP and RT data converge to show that people implicitly expect group members to exhibit consistent actions at the goal level.

EXPERIMENT 2

The results of Experiment 1 suggest that when possible, people form expectations of the consistent behaviour of group members according to the goals of actions rather than the movements towards the goal. However, this finding could be explained by an association between an action (i.e. moving left or right) and its outcome (i.e. reaching a particular target) rather than by the goal interpretation of the observed action. To investigate this possibility, we slightly changed the movement of agents to the left or right by adding a jumping motion when approaching the external target, as jumping is treated as an irrational action with respect to realizing a possible goal. Thus, the goal interpretation for this action is ambiguous and less likely to be available (Gergely & Csibra, 2003; Jara-Ettinger et al., 2016; Jastorff et al., 2011; Schachner & Carey, 2013). Hence, if the goal is crucial for generating expectations about group-consistent action, watching the irrational actions of two representatives would not provide an available action goal to develop action expectations regarding the consistency of group members; thus, no clear action expectation would be generated for a new group member. In contrast to these irrational actions, viewing rational actions of two representatives (the group-consistent action defined by the goal as in Experiment 1) would enable the generation of clear action expectations for a new group member. In this case, the LPP amplitude in the action-expectation phase should be greater for rational actions than for irrational actions, as this component is enhanced by clear expectations. Thus, the behavioural facilitation effect may be present only after viewing rational actions, whereas the association explanation would predict no difference in LPP amplitude or the behavioural facilitation effect between rational actions and irrational actions.

Methods

Since the current experiment had almost the same design as Experiment 1, except that the different group condition was replaced by the irrational action condition, we used the same sample size as Experiment 1. In all, 30 paid volunteers (17 males and 13 females; mean age: 21 years, age range: 17–25 years) participated in this experiment. Two adults were excluded because of excessive movement artefacts.

The stimuli and procedure were the same as those in Experiment 1. However, all trials involved the same group agent during the phase of group members' actions; in half of the trials, the agents reached the same object (consistent goal) by jumping (i.e. an irrational action; irrational action condition) instead of travelling straight (i.e. a rational action; rational action condition) towards the object (see Figure 3). Importantly, in the introductory phase (which introduced the social groups), we still presented two groups of agents to maintain similar group-related cues as those in Experiment 1 and to make group-related cues salient, as there was no comparison group in this experiment, which focused on one group of agents. Moreover, since the action expectation for the same group and different group agents was explored in Experiment 1, Experiment 2 compared the difference between action expectations for rational and irrational actions of group members. Since it was not necessary to retain different group agents, as discussed above, and the inclusion of trials with different group agents performing rational versus irrational actions would have doubled the experimental duration, we included only trials in which the identified agent was from the same group as two representatives. In this case, a 2 (action rationality: rational vs. irrational) × 2 (goal consistency: consistent vs. inconsistent) within-subject design was used, and each condition consisted of 32 trials.

The analysed electrodes and the time window were the same as those in Experiment 1.

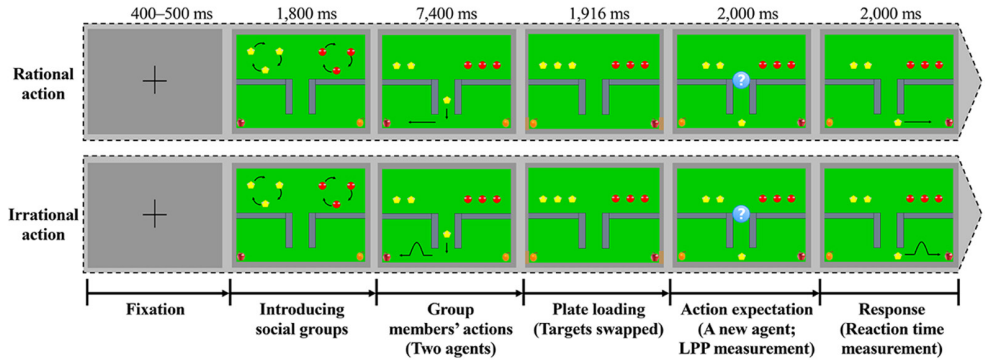

FIGURE 3 Representative trial sequences from Experiment 2.

Results and discussion

Behavioural results in the response phase

Figure 4a shows the mean RTs for all conditions after excluding trials with incorrect responses (exclusion rate = 1.48%). A 2 (action rationality: rational vs. irrational) × 2 (goal consistency: consistent vs. inconsistent) repeated-measures ANOVA revealed that while the main effect of action rationality was not significant ($F(1, 29) = 1.45$, $p = .239$, $\eta_p^2 = 0.05$), the main effect of goal consistency was significant ($F(1, 29) = 7.05$, $p = .013$, $\eta_p^2 = 0.20$), indicating that the participants responded faster when the goal was consistent ($M = 378$ ms, $SE = 11$) than when it was inconsistent ($M = 388$, $SE = 12$; 95% CI = [−18, −2]). Moreover, the interaction between the two factors ($F(1, 29) = 5.07$, $p = .032$, $\eta_p^2 = 0.15$) was also significant.

A simple effect analysis revealed that in the rational action condition, participants responded faster when the agents pursued a consistent goal ($M = 377$ ms, $SE = 10$) than when they pursued an inconsistent goal ($M = 393$ ms, $SE = 12$; $t(29) = 3.53$, $p = .001$, 95% CI = [−26, −7], Cohen's $d = 0.64$). However, in the irrational action condition, this facilitation effect was not observed (consistent goal: $M = 379$ ms, $SE = 13$; inconsistent goal: $M = 383$ ms, $SE = 13$; $t(29) = 0.88$, $p = .387$, 95% CI = [−14, 6], Cohen's $d = 0.16$). Hence, people generated expectations of group-consistent actions only when the goal was clear; accordingly, the expectations of a group-consistent action goal were facilitated.

A similar ANOVA was applied to the accuracy data, but none of the effects were significant (action rationality: $F(1, 29) = 2.42$, $p = .139$, $\eta_p^2 = 0.08$; goal consistency: $F(1, 29) = 0.33$, $p = .573$, $\eta_p^2 = 0.01$; action rationality × goal consistency: $F(1, 29) = 0.71$, $p = .407$, $\eta_p^2 = 0.02$).

ERP results in the action-expectation phase

To examine the influence of action rationality on the LPP during the action-expectation phase, we performed a paired-sample t test to compare the mean LPP amplitudes of the rational action and irrational action conditions. The results indicated that rational actions ($M = 3.26\,\mu V$, $SE = 1.88$) elicited a greater LPP than irrational actions ($M = -0.02\,\mu V$, $SE = 1.33$; $t(29) = 2.75$, $p = .010$, 95% CI = [0.84, 5.73], Cohen's $d = 0.50$) and that this difference was not due to chance. Specifically, when conducting paired-sample (Bonferroni-corrected) t tests for each time point from 300 ms to the end of the event without computing the average LPP amplitude in the selected time window, we found that the LPP amplitudes of the rational action and irrational action conditions were significantly different from 300 to 1650 ms (ps < .050; see the grey-masked time window in Figure 4b). Importantly, the difference in the LPP amplitudes of rational action and irrational action conditions was not modulated by goal consistency (for details, please see the Supplementary Material).

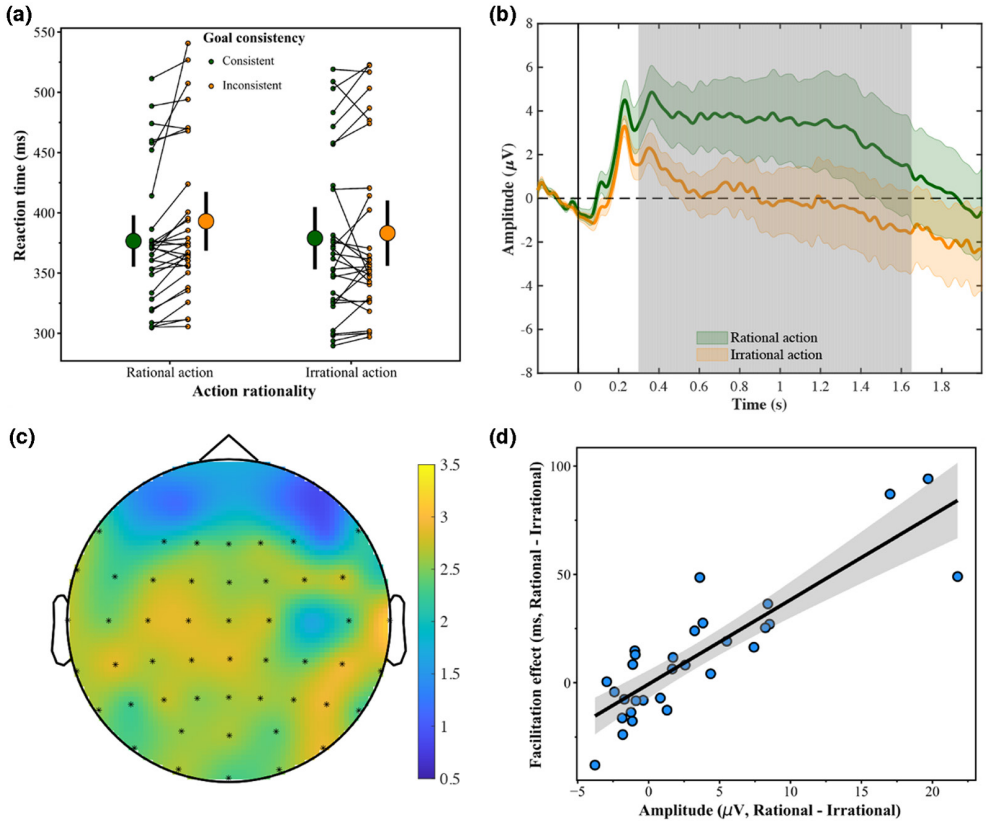

FIGURE 4 Behavioural and EEG results from Experiment 2. (a) Mean RTs of correct responses as a function of action rationality and goal consistency. The small dots indicate the mean RTs of each participant in each condition, and those from the same participant are connected by a line. The large circles denote the group means in a condition, and the black vertical lines indicate the 95% CIs of the means. (b) The ERPs of the rational action and irrational action conditions were obtained by averaging the electrodes of interest. The shaded areas represent ±1 SE, and the grey-masked time window represents significant differences in amplitude between the rational action and irrational action conditions. (c) The distribution of *t* values in the cluster-based permutation test for the LPP amplitude between the rational action and irrational action conditions are denoted. Asterisks (*) indicate significant channels. (d) Correlation between the magnitude of LPP modulation as a function of action rationality and the rationality-related facilitation effect. The grey region represents the 95% CI of predictions from a linear model.

Based on a cluster-based permutation test of the average activity in the time window from 300 to 1700 ms, which was also conducted in Experiment 1, we concluded that the significant difference between the two action-rationality conditions was not attributable to the predefined electrodes. The results of the test indicated that the LPP amplitude was greater in the rational action condition than in the irrational action condition at all selected electrodes except C4 (see Figure 4c). This finding is consistent with the prediction of goal-based consistency rather than the association explanation; accordingly, the LPP amplitude is greater when a rational action is used to reach the goal (i.e. the goal is clear) than when an irrational action is used to reach the goal (i.e. the goal is ambiguous).

Similar to Experiment 1, we computed the expectation-evoked LPP modulation by subtracting the LPP amplitude of the irrational action condition from the LPP amplitude of the rational action condition. We also calculated the expectation-related facilitation effect by subtracting the facilitation effect, that is the RT of the inconsistent goal condition minus the RT of the consistent goal condition, of the rational action condition from that of the irrational action condition to investigate whether the LPP component contributed to the behavioural responses. We found a significant positive correlation between the magnitude of LPP modulation as a function of action rationality and the expectation-related facilitation effect

(i.e. the difference in the facilitation effect between the rational action and irrational action conditions (r = .89, p < .001, 95% CI = [0.77, 0.94]; see Figure 4d). Hence, people's expectations regarding the goal-based consistency of group members accurately predicted subsequent behavioural responses to the actions of a new agent.

We also performed exploratory analyses of ERPs in the response phase and found similar effects according to the P300 amplitude as those measured by the RTs (please see the Supplementary Material).

GENERAL DISCUSSION

The present studies explored whether the goals or movements of actions contribute to expectations of common actions among group members. We determined that these two levels of representations (i.e. goals and movements) of actions can be dissociated by assessing object-directed actions and the LPP, which reflects cognitive expectations of future events, during the action-expectation phase. Our results revealed that participants identified an agent's actions more quickly when the new group member pursued a consistent goal with an inconsistent movement relative to two previous group members than when the new group member pursued an inconsistent goal with a consistent movement relative to the two previous group members. However, this facilitation effect disappeared when the agent was from a different group, thus revealing goal-based expectations of commonness among group members. Furthermore, the LPP component of agents from the same group was higher than that of agents from a different group, suggesting that people generate clearer action expectations for group members than for other individuals. Moreover, the behavioural facilitation effect was observed only when the actions had a clear goal (i.e. rational actions) rather than when the actions had an ambiguous goal (i.e. irrational actions) and yet the goal and the external target were associated. The LPP amplitude during the action-expectation phase was also greater after observing two group members perform rational actions than after observing the group members perform irrational actions, suggesting that when the goal is obvious, a clear commonness expectation is generated for group members. Importantly, the expectation-related LPP enhancement predicted the behavioural measurements of the facilitation effects. Both the behavioural and ERP evidence suggest that people implicitly expected group members to act consistently regarding goals rather than movements.

The findings of this study provide further evidence that people use group knowledge to anticipate actions and that people expect group members to behave consistently (Crawford et al., 2002; Duan et al., 2021; Powell & Spelke, 2013; Rydell et al., 2007; Spencer-Rodgers et al., 2007; Vanbergen et al., 2020; Xu et al., 2019). Moreover, this study replicated the behavioural facilitation effect reported by Yin et al. (2022), thus contributing to the literature by showing that the commonness expectations of people regarding group member actions are based on goals rather than movements. Importantly, the conclusion of goal-based commonness was supported by LPP data; LPP reflects cognitive expectations and can be used to evaluate action expectations as well as to complement behavioural judgements of outcomes (Brudner et al., 2018; Osman et al., 2016; Rutters et al., 2015; Sussman et al., 2017). Such observations cannot be attributed to a group of individuals or the association between movements and external targets, as we observed no behavioural facilitation effects for different group agents and irrational actions. More specifically, the LPP amplitudes of the different group and the irrational action conditions (which had unclear or unavailable goals) were lower than those of the same group and the rational action conditions, respectively. Hence, the behavioural and ERP data support the conclusion that expectations regarding the common actions of group members rely on the goals of the observed actions. Moreover, the commonness defined by goals can be extracted through visual observations, as group boundaries were visually presented in our experiments without linguistic labels; it has been suggested that linguistic labels encourage learners to seek deep-level concepts to understand the meaning of the labels (Burgers & Beukeboom, 2020; Orvell et al., 2019). Thus, social groups may be sufficient for generating goal-based commonness expectations.

The finding that goals (rather than movements) are prioritized when forming expectations of group members' commonness is consistent with the functional explanation for social groups, especially as social groups usually engage in collective action to achieve common goals (Stangor, 2015), at least with respect

to task groups, and that the function of a social group determines its existence (Guala, 2016; Noyes & Keil, 2019). Although it has been suggested that people are more likely to adopt the goal implied by a group member's behaviour (Loersch et al., 2008), our experiments imply that knowledge regarding the function of shared goals among group members may guide goal-based commonness expectations. Moreover, the groups in the current studies were task oriented, as the group members moved synchronously and appeared to complete a task. Task-oriented groups are different from groups based on categories (e.g. race or gender) and may be perceived as characterized by realizing a common goal to an extent that is inherent, deep and possibly essential, that is at least deeper than other action properties (Lickel et al., 2000, 2001; Rangel & Keller, 2011). Thus, based on such a view, when observing a social group, the essence of this group may be a common action goal to the extent that this property is expected to be shared by unknown group members when all representatives approach a common goal.

This study revealed higher LPP amplitudes for events with clear action expectations of a new group member than for events with ambiguous action expectations. The observation that LPP amplitude was associated with action expectations was further supported by the significant correlation between LPP enhancement and behavioural measures of expectation-related effects. This finding expands upon previous ERP research, which demonstrated the impact of expectations at the cue and target intervals (Brudner et al., 2018; Rutters et al., 2015) by revealing that expectations modulate the LPP amplitude before actions are identified. Hence, the LPP amplitude can indicate differences in action expectations in addition to emotional expectations and cue-based expectations, as previously described. Interestingly, visual inspections of the LPP patterns in the two experiments revealed a few differences; however, both patterns have been observed previously (Brudner et al., 2018; Danker et al., 2008; Turk et al., 2018). This variation may be caused by different comparisons between conditions and could be investigated further by exploring the mechanisms underlying the functional link between LPP and action expectations as well as by using neuroimaging methods to measure activity in specific regions responsible for cognitive expectations, such as the amygdala (Amir et al., 2019; Belova et al., 2007; Johansen et al., 2010). However, this question was beyond the scope of the present research and should be addressed in future work. Regardless, we demonstrated that goal-based commonness contributes to the action expectations of group members.

Any generalization of the current findings to other types of social groups should be undertaken with caution. Previous studies have claimed that meaningful social groups can be categorized into intimate groups (e.g. family and friends), task groups (e.g. coworkers and study groups) and social categories (e.g. sex and race; Johnson et al., 2006; Lickel et al., 2000). With respect to the social groups in our studies, the group members moved synchronously and seemed to create task groups. Hence, future studies should examine the generalizability of the present findings to intimate groups and other social categories. To ensure that the two groups could be presented simultaneously on a screen, each group included only three people; however, because the number of group members is a crucial factor in group-related processing (Gerard et al., 1968; Luhmann & Rajaram, 2015), it is important to utilize larger groups to explore action expectations among group members. Finally, although the different group agents and irrational action condition led to low action expectations, the content represented during the action-expectation phase of these scenarios would be interesting to explore further. More specifically, are all movements (i.e. movements to the left and right) included in the present studies indistinguishable with respect to supporting expectations, or have participants not generated any specific representation during the action-expectation?

In conclusion, members of a social group are implicitly expected to behave consistently, and these expectations are based on action goals rather than on movements. This cognitive characteristic may reflect group-related knowledge of shared goals among group members.

AUTHOR CONTRIBUTIONS

Jun Yin: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; validation; visualization; writing – original draft; writing – review and editing. **Dan Zhou:** Conceptualization; data curation; formal analysis; investigation; methodology; validation; visualization; writing – original draft; writing – review and editing. **Danfeng Ai:** Data curation; formal analysis; software; validation; writing – original draft; writing – review and editing. **Hongli Sun:** Data curation; formal analysis;

investigation; validation; visualization; writing – original draft; writing – review and editing. **Jipeng Duan:** Conceptualization; formal analysis; methodology; resources; validation; writing – original draft; writing – review and editing. **Zhongqiang Sun:** Data curation; validation; writing – review and editing. **Xiuyan Guo:** Conceptualization; methodology; supervision; writing – original draft; writing – review and editing.

FUNDING INFORMATION

This research was supported by the Special Foundation of Philosophy and Social Science in Zhejiang Province for Young Talents (浙江省哲学社会科学领军人才培育专项课题 (青年英才培育); Grant no. 21QNYC12ZD). The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript.

CONFLICT OF INTEREST STATEMENT

All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

All data, analysis code and supplemental videos have been made publicly available via the Open Science Framework and can be accessed at https://osf.io/g4v7p/?view_only=4f621ed9a6374612ab0635aefeba0fc1. None of experiments was preregistered.

ETHICAL APPROVAL

The research titled 'knowledge about social groups' was approved by the Research Ethics Board of the Department of Psychology at Ningbo University and was performed in accordance with the relevant guidelines and regulations.

ORCID

Jun Yin https://orcid.org/0000-0002-2009-6068

REFERENCES

Amir, A., Kyriazi, P., Lee, S. C., Headley, D. B., & Paré, D. (2019). Basolateral amygdala neurons are activated during threat expectation. *Journal of Neurophysiology*, *121*(5), 1761–1777.

Belova, M. A., Paton, J. J., Morrison, S. E., & Salzman, C. D. (2007). Expectation modulates neural responses to pleasant and aversive stimuli in primate amygdala. *Neuron*, *55*(6), 970–984.

Blakemore, S. J., & Decety, J. (2001). From the perception of action to the understanding of intention. *Nature Reviews Neuroscience*, *2*(8), 561–567.

Bodenhausen, G. V., Kang, S. K., & Peery, D. (2012). Social categorization and the perception of social groups. In I. S. T. Fiske & C. N. Macrae (Eds.), *The Sage handbook of social cognition* (pp. 311–329). SAGE.

Brainard, D. H., & Vision, S. (1997). The psychophysics toolbox. *Spatial Vision*, *10*(4), 433–436.

Brudner, E. G., Denkova, E., Paczynski, M., & Jha, A. P. (2018). The role of expectations and habitual emotion regulation in emotional processing: An ERP investigation. *Emotion*, *18*(2), 171–180.

Burgers, C., & Beukeboom, C. J. (2020). How language contributes to stereotype formation: Combined effects of label types and negation use in behavior descriptions. *Journal of Language and Social Psychology*, *39*(4), 438–456.

Castner, J. E., Chenery, H. J., Copland, D. A., Coyne, T. J., Sinclair, F., & Silburn, A. P. A. (2007). Semantic and affective priming as a function of stimulation of the subthalamic nucleus in Parkinson's disease. *Brain*, *130*(5), 1395–1407.

Cavallo, A., Bucchioni, G., Castiello, U., & Becchio, C. (2013). Goal or movement? Action representation within the primary motor cortex. *The European Journal of Neuroscience*, *38*(10), 3507–3512.

Crawford, M. T., Sherman, S. J., & Hamilton, D. L. (2002). Perceived entitativity, stereotype formation, and the interchangeability of group members. *Journal of Personality and Social Psychology*, *83*(5), 1076–1094.

Csibra, G. (2007). Action mirroring and action understanding: An alternative account. In P. Haggard, Y. Rosetti, & M. Kawato (Eds.), *Sensorimotor foundations of higher cognition (attention and performance XXII)* (pp. 435–459). Oxford University Press.

Danker, J. F., Hwang, G. M., Gauthier, L., Geller, A., Kahana, M. J., & Sekuler, R. (2008). Characterizing the ERP old–new effect in a short-term memory task. *Psychophysiology*, *45*(5), 784–793.

Delorme, A., & Makeig, S. (2004). EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods*, *134*(1), 9–21.

Duan, J., Jiang, Y., He, Y., Zhang, F., Shen, M., & Yin, J. (2021). Action generalization across group members: Action efficiency matters. *Cognitive Science*, *45*(4), 1–27.

Fogassi, L., Ferrari, P. F., Gesierich, B., Rozzi, S., Chersi, F., & Rizzolatti, G. (2005). Parietal lobe: From action organization to intention understanding. *Science*, *308*(5722), 662–667.

Gerard, H. B., Wilhelmy, R. A., & Conolley, E. S. (1968). Conformity and group size. *Journal of Personality and Social Psychology*, *8*(1), 79–82.

Gergely, G., & Csibra, G. (2003). Teleological reasoning in infancy: The naïve theory of rational action. *Trends in Cognitive Sciences*, *7*(7), 287–292.

Grafton, S. T., & Hamilton, A. (2007). Evidence for a distributed hierarchy of action representation in the brain. *Human Movement Science*, *26*(4), 590–616.

Grigoryan, L., Bai, X., Durante, F., Fiske, S. T., Fabrykant, M., Hakobjanyan, A., Javakhishvili, N., Kadirov, K., Kotova, M., Makashvili, A., Maloku, E., Morozova-Larina, O., Mullabaeva, N., Samekin, A., Verbilovich, V., & Yahiiaiev, I. (2020). Stereotypes as historical accidents: Images of social class in postcommunist versus capitalist societies. *Personality and Social Psychology Bulletin*, *46*(6), 927–943.

Grill-Spector, K., Henson, R., & Martin, A. (2006). Repetition and the brain: Neural models of stimulus-specific effects. *Trends in Cognitive Sciences*, *10*(1), 14–23.

Guala, F. (2016). *Understanding institutions*. Princeton University Press.

Jara-Ettinger, J., Gweon, H., Schulz, L. E., & Tenenbaum, J. B. (2016). The naïve utility calculus: Computational principles underlying commonsense psychology. *Trends in Cognitive Sciences*, *20*(8), 589–604.

Jastorff, J., Clavagnier, S., Gergely, G., & Orban, G. A. (2011). Neural mechanisms of understanding rational actions: Middle temporal gyrus activation by contextual violation. *Cerebral Cortex*, *21*(2), 318–329.

Johansen, J. P., Tarpley, J. W., LeDoux, J. E., & Blair, H. T. (2010). Neural substrates for expectation-modulated fear learning in the amygdala and periaqueductal gray. *Nature Neuroscience*, *13*(8), 979–986.

Johnson, A. L., Crawford, M. T., Sherman, S. J., Rutchick, A. M., Hamilton, D. L., Ferreira, M. B., & Petrocelli, J. V. (2006). A functional perspective on group memberships: Differential need fulfillment in a group typology. *Journal of Experimental Social Psychology*, *42*(6), 707–719.

Liberman, Z., Woodward, A. L., & Kinzler, K. D. (2017). The origins of social categorization. *Trends in Cognitive Sciences*, *21*(7), 556–568.

Lickel, B., Hamilton, D. L., & Sherman, S. J. (2001). Elements of a lay theory of groups: Types of groups, relational styles, and the perception of group entitativity. *Personality and Social Psychology Review*, *5*(2), 129–140.

Lickel, B., Hamilton, D. L., Wieczorkowska, G., Lewis, A., Sherman, S. J., & Uhles, A. N. (2000). Varieties of groups and the perception of group entitativity. *Journal of Personality and Social Psychology*, *78*(2), 223–246.

Lin, H., Gao, H., Wang, P., Tao, L., Ke, X., Zhou, H., & Jin, H. (2012). Expectation enhances event-related responses to affective stimuli. *Neuroscience Letters*, *522*(2), 123–127.

Loersch, C., Aarts, H., Payne, B. K., & Jefferis, V. E. (2008). The influence of social groups on goal contagion. *Journal of Experimental Social Psychology*, *44*(6), 1555–1558.

Lorenz, A. R., & Newman, J. P. (2002). Deficient response modulation and emotion processing in low-anxious Caucasian psychopathic offenders: Results from a lexical decision task. *Emotion*, *2*(2), 91–104.

Luck, S. J. (2014). *An introduction to the event-related potential technique* (2nd ed.). MIT Press.

Luhmann, C. C., & Rajaram, S. (2015). Memory transmission in small groups and large networks: An agent-based model. *Psychological Science*, *26*(12), 1909–1917.

MacNamara, A., Foti, D., & Hajcak, G. (2009). Tell me about it: Neural activity elicited by emotional pictures and preceding descriptions. *Emotion*, *9*(4), 531–541.

McGarty, C., Mavor, K. I., & Skorich, D. P. (2015). Social categorization. In J. D. Wright (Ed.), *International encyclopedia of the social and behavioral sciences* (Vol. 22, 2nd ed., pp. 186–191). Elsevier.

Noyes, A., & Keil, F. C. (2019). Collective recognition and function in concepts of institutional social groups. *Journal of Experimental Psychology: General*, *149*(7), 1344–1359.

Orvell, A., Kross, E., & Gelman, S. A. (2019). "You" and "I" in a foreign land: The persuasive force of generic-you. *Journal of Experimental Social Psychology*, *85*, 103869.

Osman, A., Paczynski, M., & Jha, A. P. (2016). Affective expectations influence neural responses to stressful images in soldiers. *Military Psychology*, *29*(1), 41–57.

Paul, S., Simon, D., Kniesche, R., Kathmann, N., & Endrass, T. (2013). Timing effects of antecedent-and response-focused emotion regulation strategies. *Biological Psychology*, *94*(1), 136–142.

Powell, L. J., & Spelke, E. S. (2013). Preverbal infants expect members of social groups to act alike. *Proceedings of the National Academy of Sciences*, *110*(41), E3965–E3972.

Race, E. A., Badre, D., & Wagner, A. D. (2010). Multiple forms of learning yield temporally distinct electrophysiological repetition effects. *Cerebral Cortex*, *20*(7), 1726–1738.

Ranganath, K. A., & Nosek, B. A. (2008). Implicit attitude generalization occurs immediately; explicit attitude generalization takes time. *Psychological Science*, *19*(3), 249–254.

Rangel, U., & Keller, J. (2011). Essentialism goes social: Belief in social determinism as a component of psychological essentialism. *Journal of Personality and Social Psychology*, *100*(6), 1056–1078.

Rhodes, M., & Baron, A. (2019). The development of social categorization. *Annual Review of Developmental Psychology*, *1*, 359–386.

Rutters, F., Kumar, S., Higgs, S., & Humphreys, G. W. (2015). Electrophysiological evidence for enhanced representation of food stimuli in working memory. *Experimental Brain Research*, *233*(2), 519–528.

Rydell, R. J., Hugenberg, K., Ray, D., & Mackie, D. M. (2007). Implicit theories about groups and stereotyping: The role of group entitativity. *Personality and Social Psychology Bulletin*, *33*(4), 549–558.

Schachner, A., & Carey, S. (2013). Reasoning about 'irrational' actions: When intentional movements cannot be explained, the movements themselves are seen as the goal. *Cognition*, *129*(2), 309–327.

Shafir, R., Schwartz, N., Blechert, J., & Sheppes, G. (2015). Emotional intensity influences pre-implementation and implementation of distraction and reappraisal. *Social Cognitive and Affective Neuroscience*, *10*(10), 1329–1337.

Spencer-Rodgers, J., Hamilton, D. L., & Sherman, S. J. (2007). The central role of entitativity in stereotypes of social categories and task groups. *Journal of Personality and Social Psychology*, *92*(3), 369–388.

Stangor, C. (2015). *Social groups in action and interaction*. Routledge.

Sussman, T. J., Weinberg, A., Szekely, A., Hajcak, G., & Mohanty, A. (2017). Here comes trouble: Prestimulus brain activity predicts enhanced perception of threat. *Cerebral Cortex*, *27*(4), 2695–2707.

Thiruchselvam, R., Blechert, J., Sheppes, G., Rydstrom, A., & Gross, J. J. (2011). The temporal dynamics of emotion regulation: An EEG study of distraction and reappraisal. *Biological Psychology*, *87*(1), 84–92.

Turk, K. W., Elshaar, A. A., Deason, R. G., Heyworth, N. C., Nagle, C., Frustace, B., Flannery, S., Zumwalt, A., & Budson, A. E. (2018). Late positive component event-related potential amplitude predicts long-term classroom-based learning. *Journal of Cognitive Neuroscience*, *30*(9), 1323–1329.

Vanbergen, N., Irmak, C., & Sevilla, J. (2020). Product entitativity: How the presence of product replicates increases perceived and actual product efficacy. *Journal of Consumer Research*, *47*(2), 192–214.

Vijayakumar, S., Hartstra, E., Mars, R. B., & Bekkering, H. (2021). Neural mechanisms of predicting individual preferences based on group membership. *Social Cognitive and Affective Neuroscience*, *16*(9), 1006–1017.

Wurm, M. F., & Caramazza, A. (2022). Two "what" pathways for action and object recognition. *Trends in Cognitive Sciences*, *26*(2), 103–116.

Xu, H., Duan, J., Chen, M., & Yin, J. (2019). The mechanisms of action prediction based on social group information. *Chinese Journal of Applied Psychology*, *25*(3), 239–252.

Yin, J., Duan, J., Huangliang, J., Hu, Y., & Zhang, F. (2022). Members of highly entitative groups are implicitly expected to behave consistently based on their deep-level goals instead of their shallow-level movements. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *48*(1), 13–28.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Yin, J., Zhou, D., Ai, D., Sun, H., Duan, J., Sun, Z., & Guo, X. (2023). Event-related potential and behavioural evidence of goal-based expectations for consistent actions among group members. *British Journal of Psychology*, *114*, 662–677. https://doi.org/10.1111/bjop.12643