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Action Generalization Across Group Members: Action Efficiency Matters

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Abstract

Actions are usually generalized among social group members. Importantly, the efficiency of an action with respect to achieving an external target determines action understanding, and it may have different degrees of social relevance to social groups. Thus, this study explored the role of action efficiency in action generalization. We used computer animations to simulate actions in social groups initiated by visual action cues or category labels, and we measured differences in response times between identifying actions that were and were not consistent with group members, without explicit requirements regarding generalization. It was found that in both visually introduced and explicitly labeled social groups, when the group members acted inefficiently toward the external object, perceivers identified group-consistent actions faster than group-inconsistent actions, indicating that the exemplars' common inefficient actions are generalized to the unknown ingroup member, accordingly facilitating the identification of expected consistent inefficient action (Experiment 1). As this effect was not present when removing social group cues, it was determined to be specific to social groups (Experiment 2). Importantly, such generalization was not observed when the identical action was deemed efficient toward the external object (Experiment 3) and was specific to the demonstration of the action being completed by multiple group members rather than being repeated twice by one group member, supporting the group-based inference and ruling out the possibility of the increased memorability of inefficient actions leading to more generalization relative to efficient actions (Experiment 4). Therefore, the efficiency of an action bounds the generalization of the action across social group members through a process that is spontaneous and implicit. This constrained action generalization may be due to inefficient actions being represented as culture-specific conventional forms.

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1. Introduction

"No man is an island." Though human beings are diverse and are often treated as independent social thinkers, they are also often tied to their affiliations with social groups and conceived of as belonging to social groups (Liberman, Woodward, & Kinzler, 2017). Further, as human social groups are central to social structure, they substantially impact how individuals behave (Hamilton & Sherman, 1996; Rhodes & Chalik, 2013). This influence is evident in the fact that individuals conform to the norms of their social groups and coordinate their actions with those of other group members, that is, conformity behavior (Mehrabian & Ksionzky, 1970; Sherif, 1937), even without any previous contact with group members (Klucharev, Hytönen, Rijpkema, Smidts, & Fernández, 2009; Shestakova et al., 2012). In addition to shaping how we act, social groups penetrate our cognitive system and guide our interpretations and expectations of others' actions (Hamilton & Sherman, 1996; Lickel, Hamilton, & Sherman, 2001). The most notable demonstration of the role social groups play with respect to cognition is that they provide boundaries. More specifically, perceivers believe that individuals within these boundaries share behavioral tendencies, and thus, they (the perceivers) generalize actions of individuals in the group to all group members (Bodenhausen, Kang, & Peery, 2012; Liberman et al., 2017; Tajfel, Billig, Bundy, & Flament, 1971). However, as group members are diverse and have their own reasons for executing actions, it is sometimes considered unacceptable to judge people on the basis of the actions of group members with whom they are associated (Banaji & Bhaskar, 2000; Ranganath & Nosek, 2008). Hence, there is interest in exploring the boundary conditions that determine action generalization. Given that the action can be deemed as efficient or inefficient to the external target, the current study asks whether actions with different degrees of efficiency, for example, efficient versus inefficient, are similarly generalized across members of the same group.

1.1. Common actions expected of group members

Social groups can activate categorical thinking (Bodenhausen et al., 2012; Macrae & Bodenhausen, 2000). In other words, rather than treating a collection of individuals as separate pieces, we organize the individuals into categories according to their commonalities. Specifically, individuals in a social group are not perceived as solitary but are automatically identified as belonging to a category comprised of other group members. This process is both implicit and automatic (Liberman et al., 2017; Macrae & Bodenhausen, 2000). In this sense, social categories mark individuals as fundamentally similar to each other (Billig & Tajfel, 1973; Macrae & Bodenhausen, 2000). Hence, theoretically, when making inferences about unknown members of social groups, people implicitly generalize the features of known members to unknown members and thereby expect group members to behave consistently and engage in common actions.

The expectation that group members act alike has been evidenced empirically, as well. For instance, it was reported that when the group was perceived as a real social group, in which a crowd of individuals is perceived as a unified entity, participants automatically generalized the behavioral tendencies of a group member, that is, the trait underlying actions, to other group members; however, when the group was diverse and loosely formed, participants resisted generalizing their behavioral tendencies from one person to another person in the same group (Crawford, Sherman, & Hamilton, 2002). More direct evidence to support the group-based expectation of actions was obtained from a pioneer study of infants (Powell & Spelke, 2013). In their study, infants first watched an operationalized animated display of two social groups whereby three actors in each group had identical appearances, were near each other, and moved synchronously. Then, two figures from the same group performed a similar action, that is, jumping or sliding on a platform, while the remaining figure of this group behaved either consistently or inconsistently with the others. Infants looked significantly longer at the inconsistent action trials than at the consistent action trials, indicating that the infants expected members of the same social group to act alike. Xu et al. (2019) modified the above methods for adults by showing two agents from a group performing the same action without external effects, that is, going straight or jumping, and then measured the generalization of actions across social groups by asking participants to identify an unknown agent's action. It was found that not only was the group-consistent action identified faster than the group-inconsistent action, but this effect was only observed for the ingroup member (results for the English version are reported in Appendix S1). Thus, it is concluded that social group members are expected to engage in common actions; otherwise, the identification of the unknown agent's actions is irrelevant with respect to the actions of the other group members. Put simply, people generalize actions for all group members.

The above efforts notwithstanding, the authors primarily investigated whether action generalization among group members exists. The actions are usually interpreted differently when relevant to external targets, that is, efficient and inefficient actions, and have different social relevance to different groups, for example, instrumental or ritualized actions (Kapitány & Nielsen, 2015; Legare & Souza, 2012). However, the degree to which action generalization is constrained by how the action is performed and is dependent on action efficiency with respect to an external target remains unknown.

1.2. Efficiency as a principle for interpreting actions

Humans always interact with external objects and environments, for example, by approaching an apple or a location. With respect to observed actions, such as reaching for an apple, infants and adults often interpret such actions as being driven by goals and intentions to achieve external results rather than perceiving them as simple movements (Baker, Saxe, & Tenenbaum, 2009; Csibra, 2003). This inference has been suggested to follow the principle of rationality. That is, in a given situation, agents are assumed to take the most efficient actions to achieve their goals, and an action's efficiency determines how this action is interpreted (Gergely & Csibra, 2003; Ongchoco & Jara-Ettinger, 2020; Schachner & Carey, 2013).

Specifically, when actions are efficient, they are treated as a means to obtain a desired goal (i.e., goal-based interpretation). This notion of efficiency is agent invariant; that is, agents will take the shortest possible path given environmental constraints to approach the same goal, and it has been widely documented (Jastorff, Clavagnier, Gergely, & Orban, 2011; Ongchoco & Jara-Ettinger, 2020; Schachner & Carey, 2013; Southgate & Csibra, 2009; for a review, see Gergely & Csibra, 2003). Moreover, the computational model based on Bayesian inverse planning has also been found to support the goal-based interpretation of efficient action, according to which the goals or mental states of agents have been inferred by inverting the forward model of a goal, thus spurring an action with rational planning (Baker et al., 2009; Jara-Ettinger, Gweon, Schulz, & Tenenbaum, 2016). Hence, concerning the efficient action, the external object is the intended outcome, and as the action is a means to realize the end state, it can be adjusted to achieve the same goal/object.

In contrast, if an action is inefficient for achieving a possible goal, its interpretation is fundamentally different from an efficient action, for example, for its own sake and for a culturally related routine. For instance, Schachner and Carey (2013) observed that when an agent's actions were not an efficient means of achieving a plausible external goal (i.e., placing a star in a box), almost half the participants concluded that the movements of the actions were the intended outcome and not just a means to an end. Importantly, the repetition of movements that are manifested by moving toward and away from an external target did not modulate the rate of movement-based interpretations. Novack, Wakefield, and Goldin-Meadow (2016) further found that observers predominately interpret inefficient actions for their own sake when external objects are present but not acted on (i.e., empty-handed movements not involving approaching the target directly). Moreover, when the actions deviated from efficiency, such as using the head to turn on a lamp without any use of the hands, preschool children exhibited a high degree of fidelity to imitate and over imitate the actions regardless of the causally irrelevant actions to achieve the goal (Evans, Laland, Carpenter, & Kendal, 2018; Gergely, Bekkering, & Király, 2002; Király, Csibra, & Gergely, 2013). It was claimed that inefficient actions are often construed as culturally relevant routines to be acquired and, accordingly, are imitated with fidelity (Altınok, Hernik, Király, & Gergely, 2020; Csibra & Gergely, 2009). As inefficient actions violate the rationale to discriminate the start–end state, they cannot be meaningfully interpreted as having caused physical outcomes but rather as showing causal opacity, and thus, they are usually regarded as ritualistic (Kapitány & Nielsen, 2015; Legare & Souza, 2012). Furthermore, ritualized actions cannot be interpreted as serving exclusively instrumental purposes but are instead interpreted as motivated by social concerns, such as group-relevant norms (Nielsen, 2018). However, this group-based inference has not been directly explored.

Hence, while the efficiency of an action with respect to achieving an external target determines action understanding for individuals, can this boundary condition be extended to social groups? Further, does an action's efficiency moderate action generalization?

1.3. Overview and hypotheses

Regarding the above questions, we expect action generalization to depend on action efficiency and that only when the observed exemplars act inefficiently with respect to the target is action generalization among group members present. As an efficient action is interpreted as a means to realize a goal in a given situation, each individual may adopt specific, albeit different, actions to realize this specific goal, and accordingly efficient actions can vary across individuals. Hence, the generalization of an efficient action would not be expected. In addition, given that cognitive resources are limited (Lavie, 2005), efficient actions can be easily explained in terms of their external goals by the fundamental principle of rationality (Schachner & Carey, 2013), and thus, it is not necessary to search for social explanations of a group's behavior (Spelke, 2016). Accordingly, generalization regarding group members' efficient actions is not required. However, when the sampled exemplars perform the same inefficient action, these inefficient actions may come to represent culture-specific rituals shared by a social group, and accordingly, they are more likely to be group-based and be generalized among group members.

To test the above hypothesis, four experiments were conducted. First, we assessed whether participants generalized inefficient actions among group members (Experiment 1) by showing that the action was completed by multiple group members. To further examine whether the generalization was specific to group membership rather than making inferences about shapes that merely share visual similarities, we conducted Experiment 2 in which we removed group action cues but retained the same visual shapes as those used in Experiment 1. Later, the determinative role of efficiency regarding action generalization among group members was explored by presenting a new action that efficiently achieves an external target in a given situation in Experiment 3. If action generalization is dependent upon action efficiency and only the inefficient action is generalized in a social group, Experiments 1 and 3 should exhibit different patterns of action generalization, and no generalization effect would be observed in Experiment 3. Finally, to address whether the generalization phenomenon relies on group-based inference rather than on individual-based inference and whether the greater generalization of inefficient actions relative to efficient actions is due to the increased memorability, in Experiment 4 the action was repeatedly performed by a single group member. Accordingly, the evidence for no action generalization among group members when the action is demonstrated by a single group member would support a group-based inference and also rule out the memorability explanation, as this possibility only concerns inefficient action regardless of who performs the inefficient action.

1.4. General methods

This study adopted methods similar to those used by Powell and Spelke (2013). Specifically, cartoon animation was used to simulate social groups and different types of actions. The social group was operationalized as follows: Two groups of three animated agents appeared near one another and moved synchronously, and two visual cues, namely, spatial proximity and synchronous movement, were considered key characteristics governing group entitativity (Campbell, 1958). The visual action cues to manipulate social groups may prompt participants to learn that group members tend to perform inefficient actions from the start, that is, the synchronous dance-like movements, thus indicating the effect of generalizing actions among group members. Hence, referring to previous studies (Lupyan, Rakison, & McClelland, 2007; Ting, He, & Baillargeon, 2019), Experiments 1 and 3 also use a nonvisual-based set-up with category labels to explicitly inform participants as to how the observed individuals were grouped to test the generalization of the conclusion. After watching two agents from the same social group perform a consistent action, the generalization of the action across social groups was measured by asking participants to judge a new agent's action rather than asking them to verbally report their expectations about the agent's actions. This agent was either an ingroup member or an outgroup member and performed either a group-consistent or group-inconsistent action. If action generalization occurs, in other words, the group members are expected to act alike, participants should identify the group-consistent action faster than they do the group-inconsistent action, as the group-consistent action fits with the participants' expectations about group members' actions. Importantly, this effect should be observed only for the ingroup member when different group members performed the same action, rather than when a group member repeated the same action, as the expectation of inefficient action shared among group members is group-based. This indirect (implicit) measurement of action generalization reveals participant's spontaneous expectations with respect to group members' actions, as they are encouraged to respond quickly to generalization unrelated tasks.

2. Experiment 1a: Generalization of inefficient action

This experiment tested whether perceivers generalized an inefficient action of the known group members to the unknown member. In this experiment, two groups of agents were presented, and the members of each group were spatially close to one other and moved synchronously. Two members from a social group then performed a consistent action directed toward the same object on one side of the screen; however, there was another object on the other side of the screen. Later, the remaining agent, an ingroup or outgroup member, performed an action consistent or inconsistent with the action of the two exemplars. The participants were asked to judge whether the action was going straight or jumping. The hypothesis that inefficient action is generalized predicts that when the last agent performs an action consistent with that of the exemplars, the agent's action will be judged to be faster than when the agent's action is inconsistent with the exemplars', that is, the facilitation effect. However, we posit that this effect should only be found among ingroup members.

2.1. Methods

2.1.1. Participants

Of the 20 participants in the study, there were six men and 14 women aged between 17 and 24 years (M_{age} = 19 years). The participants received approximately $3 to participate in the study. Using G*Power 3 (Faul, Erdfelder, Buchner, & Lang, 2009), the sample size was determined by (a) referring to previous research to obtain a medium effect size (f^2 = ~0.2; Xu, Duan, Chen, & Yin, 2019), which did not consider the efficiency of action and (b) using a power analysis where the alpha level was set at 0.01 and the suggested sample size to reach a medium effect size ($f^2 = 0.15$) was approximately 20 individuals (Cohen, 1988). For consistency, all experiments used 20 valid participants, all of whom had normal or corrected-to-normal vision and no history of neurological disorders. The study was approved by the Research Ethics Board of the Department of Psychology at Ningbo University and was performed in accordance with relevant guidelines and regulations. Information sheets were distributed to all participants prior to the experiment, and, after learning the purpose and procedures of the experiment, written informed consent was obtained from all participants.

2.1.2. Apparatus and stimuli

The stimuli were presented on a gray background using a 19-inch cathode ray tube monitor (1,024 × 768 pixel resolution; 120 Hz refresh rate) positioned at a 60 cm viewing distance, and the custom software used was written in MATLAB with the Psychophysics Toolbox Libraries (Brainard, 1997).

The visual stimuli were computer-animated events that simulated group behaviors. Each event involved two kinds of agents with different appearances who were randomly selected from six cartoon figures of distinct colors and shapes (see Fig. 1a). Each agent was given two eyes as facial features and subtended at 1.5° × 1.5°.

2.1.3. Procedure and design

Each trial started with the presentation of a fixation cross (1.5° × 1.5°) in the center of the screen for 500 ms, which was then replaced by a blank background for 200–300 ms. Thereafter, two groups of agents were presented. The agents composing each group initially appeared near one another in the top two corners of the screen, and then, immediately, the agents in each group made a series of synchronized movements along a circular path (see Fig. 1b and the link: https://osf.io/zs2tf/?view_only=a07651ad562047c193375fa6c627f98c; "introducing social groups") for 3,600 ms.

Following this introductory sequence, the agents were distributed across the top of the platforms, and two agent exemplars from the same group successively performed the same action. This step lasted 14,600 ms (see Fig. 1b; "group members' action"). Specifically, each exemplar initially moved downward to the bottom of the screen, turned to the left or right (balanced within subjects) to approach one of two objects with an inefficient action (i.e., jumping), and then returned to its starting point by going straight. The two

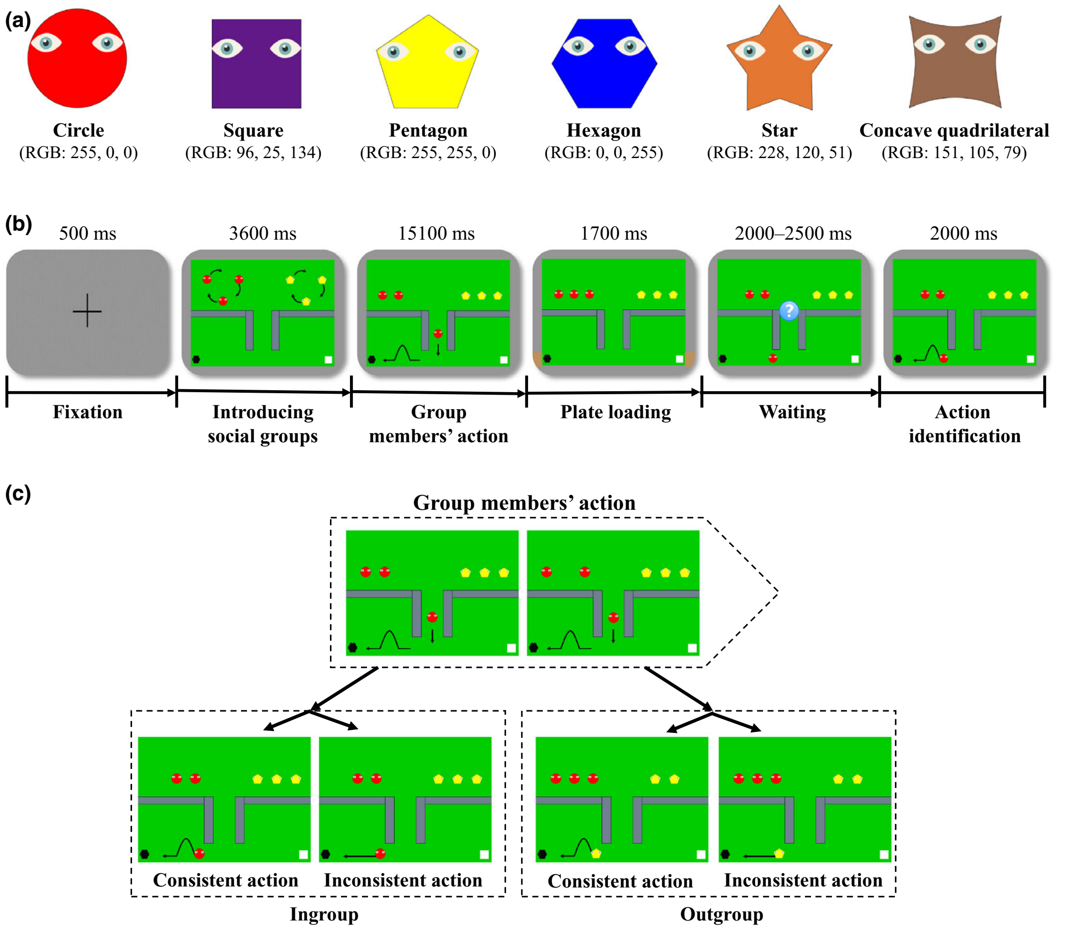

Fig. 1. Overview of the experimental materials, procedure, and conditions where (a) depicts six figures used in all the experiments; (b) represents an example trial sequence from Experiment 1a; and (c) shows how each condition was conceptualized in Experiment 1a. In the depiction of (b), the trial begins with a fixation and displays the movements to introduce social groups ("introducing social groups" phase); then, in the "group members' action" phase, two agents from the social group successively perform the same action. Next, a plate is presented to cover the two external targets, thus making it convenient to swap them in Experiment 1b ("plate loading" phase). Finally, after waiting a few seconds, an agent approaches a target with a going straight or jumping action, and participants are asked to judge whether this agent's action is going straight or jumping by pressing the appropriate button ("action identification" phase). The measurement logic is that if participants use social groups to anticipate actions, when the display in the phase of "action identification" matches the expectation (i.e., ingroup consistent action in (c)), the response should be facilitated.

objects were a white square and a black club, which were placed in the left and right bottom corners, respectively, of the screen. The objects approached were counterbalanced across participants, and different sounds were played when each was approached.

Next, a plate was presented to cover the two objects. This phase was added so the same procedure could be used in Experiments 1a and 1b, while allowing the two objects to be swapped. This phase is labeled in Fig. 1b as “plate loading” and lasted 1,700 ms. Then, the remaining agent from either the ingroup or the outgroup moved. This agent imitated the action of the two exemplars by moving downward to the bottom of the screen where it then stopped, and a question mark symbol was presented above this agent for 2,000–2,500 ms (see Fig. 1b; “waiting”). Finally, the last agent started to move again in the same direction as the two exemplars by going straight or jumping. Participants were required to judge whether this agent was going straight or jumping by pressing the “F” or “J” button, respectively, on a standard keyboard (see Fig. 1b; “action identification”). If the participant did not respond within 2,000 ms, the program automatically proceeded to the next trial.

The participants completed 96 trials, which followed a 2 (group condition: ingroup vs. outgroup) × 2 (action consistency: consistent vs. inconsistent) within-subject design (see Fig. 1c). The group condition was defined by whether the judged (i.e., last) agent belonged to the same group as the two exemplars (i.e., ingroup) or a different group (i.e., outgroup). Action consistency was defined as whether the action of the judged agent was the same as that of the previous two agents, namely, consistent (i.e., jumping) or inconsistent (i.e., going straight). Before the formal experiment, participants had 2 min to practice. Each participant was given a short break after completing 24 trials and then completed the experiment within 55 min.

Since the participant’s reaction time (RT) was emphasized and was closely related to our hypothesis, the analyses in all experiments focused primarily on the RT data, although the accuracy data were also reported. A two-way repeated measures analysis of variance (ANOVA) was conducted on the RT and accuracy data. As RT distributions are usually positively skewed and always have a lower bound at zero, we also analyzed RT data using log transformations with a base of 10 before conducting the ANOVA and found the same results as when analyzing raw RT data (please see Appendix S1). Moreover, given that trials were nested within participants, the mixed-effects models that included trial-level data rather than ANOVAS on summary scores were used and revealed results similar to those reported by the ANOVAS (please see Appendix S1). The descriptive results of all of the experiments are listed in Table S1, and the raw data can be accessed at the following link: https://osf.io/zs2tf/?view_only=a07651ad562047c193375fa6c627f98c.

2.2. Results and discussion

The mean RT of each participant for each condition (Fig. 2a) was computed after excluding trials with incorrect responses and response times greater than three standard deviations (*SD*s) from the mean (exclusion rate = 9.06%). Fig. 2a presents the mean RTs for trials in all conditions. A 2 (group condition: ingroup vs. outgroup) × 2 (action consistency: consistent vs. inconsistent) ANOVA of the RT data was conducted and revealed that neither the main effect of group condition ($F(1, 19) = 0.53$, $p = .477$, $\eta_p^2 = 0.03$) nor the main effect of action consistency ($F(1, 19) = 2.66$, $p = .120$, $\eta_p^2 = 0.12$) was

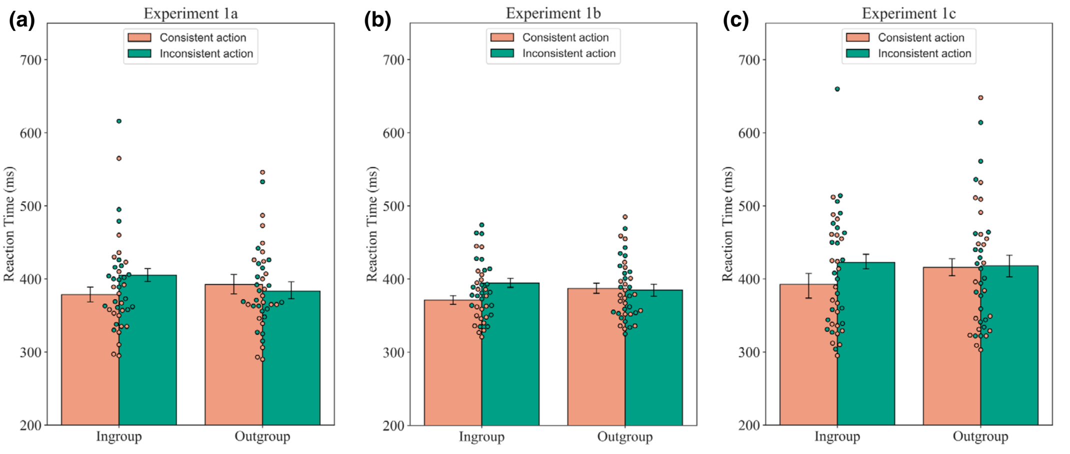

Fig. 2. Reaction times (RTs) in (a) Experiment 1a, (b) Experiment 1b, and (c) Experiment 1c as a function of group condition and action consistency. All experiments presented inefficient actions. Experiments 1a and 1b used visual action cues, whereas Experiment 1c adopted category labels to introduce social groups. Bars represent the mean RT for each condition. Dots indicate the mean RT for each participant in each condition. Error bars indicate the within-subject 95% confidential intervals.

significant, but the interaction effect between the group condition and action consistently reached significance ($F(1, 19) = 7.31$, $p = .014$, $\eta_p^2 = 0.28$). The simple effects analysis determined that when the judged agent belonged to the same group as the two exemplars (i.e., an ingroup member), participants judged faster when the action was consistent ($M = 378$ ms) than when it was inconsistent ($M = 405$ ms; $F(1, 19) = 15.46$, $p = .001$, $\eta_p^2 = 0.45$, 95% CI of mean difference = [−41, −13]). When the judged agent belonged to a different group than the two exemplars (i.e., an outgroup member), this effect was absent (consistent action: $M = 392$ ms; inconsistent action: $M = 384$ ms; $F(1, 19) = 0.79$, $p = .386$, $\eta_p^2 = 0.04$, 95% CI = [−12, 30]). Thus, the perceivers generalized the inefficient action to group members.

All the same analyses were conducted for the accuracy data. However, none of the effects, that is, the main effect of group condition ($F(1, 19) < 0.01$, $p = .949$, $\eta_p^2 < 0.01$), the main effect of action consistency ($F(1, 19) = 0.06$, $p = .813$, $\eta_p^2 < 0.01$), or the interaction effect ($F(1, 19) = 0.28$ $p = .603$, $\eta_p^2 = 0.01$), reached significance.

3. Experiment 1b: Replication with swapping targets

As the generalized context was the agent's action, the approached goal should not matter. Hence, to verify the findings of Experiment 1a, we conducted Experiment 1b, which swapped the two targets after plate loading; that is, their locations changed. The remaining details of the experiment were identical to those in Experiment 1a.

3.1. Methods

Twenty new students (8 men, 12 women) aged 18–21 years (M_{age} = 19 years) were paid approximately \$3 to participate in this experiment. The stimuli and procedures were the same as in Experiment 1a, except that the positions of the two targets were swapped after plate loading.

3.2. Results and discussion

The exclusion rate was 7.45% after employing the same exclusion methods used in Experiment 1a. Fig. 2b presents the mean RTs for trials in all conditions. A 2 (group condition: ingroup vs. outgroup) × 2 (action consistency: consistent vs. inconsistent) repeated measures ANOVA was conducted using the RT data. The ANOVA revealed that the main effect of group condition ($F(1, 19) = 1.12$, $p = .303$, $\eta_p^2 = 0.06$) was not significant; however, the main effect of action consistency ($F(1, 19) = 5.17$, $p = .035$, $\eta_p^2 = 0.21$) and the interaction effect between group condition and action consistency reached significance ($F(1, 19) = 15.40$, $p = .001$, $\eta_p^2 = 0.45$). The simple effects analysis indicated that when the judged agent belonged to the same group as the two exemplars (i.e., an ingroup member), participants judged consistent actions ($M = 372$ ms) faster than they judged inconsistent actions ($M = 395$ ms; $F(1, 19) = 22.75$, $p < .001$, $\eta_p^2 = 0.55$, 95% CI of mean difference = [−33, −13]). When the judged agent belonged to a different group than the two exemplars (i.e., an outgroup member), this effect was absent (consistent action: $M = 387$ ms; inconsistent action: $M = 385$ ms; $F(1, 19) = 0.13$, $p = .725$, $\eta_p^2 = 0.01$, 95% CI of mean difference = [−11, 15]). Again, the hypothesis that the inefficient action was generalized to group members was supported.

All the same analyses were conducted with the accuracy data. None of the effects, that is, the main effect of group condition ($F(1, 19) = 0.09$, $p = .770$, $\eta_p^2 = 0.01$), the main effect of action consistency ($F(1, 19) = 2.14$, $p = .160$, $\eta_p^2 = 0.10$), or the interaction effect ($F(1, 19) = 0.45$ $p = .512$, $\eta_p^2 = 0.02$), reached significance.

4. Experiment 1c: Replication with category labeled social groups

The previous two experiments used visual action cues to manipulate social groups, a factor that may result in participants learning that group members tend to perform inefficient actions based on the set-up (i.e., the synchronous dance-like movements), and thus demonstrating the effect of generalizing actions within group members. Hence, this experiment aimed to replicate the results of Experiment 1a with a nonvisual-based set-up by using the category labels to explicitly tell participants how the observed individuals were grouped. Accordingly, the replication of the results of Experiment 1a would much more strongly support the conclusion of generalizing inefficient actions within social groups.

4.1. Methods

Twenty new students (7 men, 13 women) aged 18–27 years (M_{age} = 22 years) were paid approximately $3 to participate in this experiment. The procedures and design were the same as in Experiment 1a, with the exception of the settings in the "introducing social groups" phase. Specifically, all six agents remained still. Three agents on one side of the screen were marked within a rectangle and explicitly labeled Group A. The participants then heard a voice say, "These are members of Group A." This was accompanied by a downward-pointing hand that moved up and down above these three agents. The other three agents appeared on the other side of the screen and were explicitly labeled Group B. The participants then heard a voice say, "These are members of Group A," and this was accompanied by a downward-pointing hand that moved up and down above these three agents (please see Fig. 3 and the following link: https://osf.io/zs2tf/?view_only=a07651ad562047c193375fa6c627f98c).

4.2. Results and discussion

The exclusion rate was 6.09% after employing the same exclusion methods used in Experiment 1a. Fig. 2c presents the mean RTs for trials in all conditions. The 2 (group condition: ingroup vs. outgroup) × 2 (action consistency: consistent vs. inconsistent) repeated measures ANOVA conducted with the RT data revealed that neither the main effect of group condition ($F(1, 19) = 3.09$, $p = .095$, $\eta_p^2 = 0.14$) nor the main effect of action consistency ($F(1, 19) = 3.15$, $p = .092$, $\eta_p^2 = 0.14$) was significant; however, the interaction effect between the group condition and action consistency reached significance ($F(1, 19) = 4.76$, $p = .042$, $\eta_p^2 = 0.20$). The simple effects analysis indicated that when the judged agent belonged to the same group as the two exemplars (i.e., an ingroup member), participants identified consistent actions ($M = 392$ ms) faster than they judged inconsistent actions ($M = 423$ ms; $F(1, 19) = 6.81$, $p = .017$, $\eta_p^2 = 0.26$, 95% CI of mean difference = [−55, −6]). When the judged agent belonged to a different group than the two exemplars (i.e., an outgroup member), this effect was absent (consistent action: $M = 416$ ms; inconsistent action: $M = 418$ ms; $F(1, 19) = 0.04$, $p = .854$, $\eta_p^2 < 0.01$, 95% CI of mean difference = [−24, 20]). Again, the conclusion that the inefficient action was generalized to group members was supported when the social groups were introduced with category labels. Hence, this generalization effect was not specific to visual-action displays for social groups and was robust.

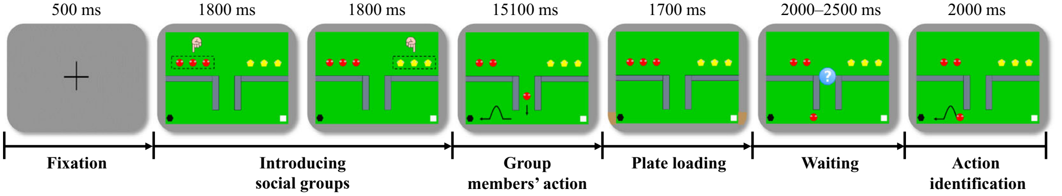

Fig. 3. An example trial sequence in Experiment 1c by using category labels to introduce social groups.

All the same analyses were conducted with the accuracy data. Although none of the main effects, that is, the main effect of group condition ($F(1, 19) = 0.20$, $p = .661$, $\eta_p^2 = 0.01$) or the main effect of action consistency ($F(1, 19) = 2.50$, $p = .131$, $\eta_p^2 = 0.12$), reached significance, the interaction effect ($F(1, 19) = 5.75$, $p = .027$, $\eta_p^2 = 0.23$) was significant. The simple effects analysis revealed that in the ingroup condition, participants identified consistent actions ($M = 0.97$) more accurately than they judged inconsistent actions ($M = 0.93$; $F(1, 19) = 8.05$, $p = .011$, $\eta_p^2 = 0.30$, 95% CI of mean difference = [0.01, 0.07]), but this effect was absent in the outgroup condition (consistent action: $M = 0.95$; inconsistent action: $M = 0.95$; $F(1, 19) = 0.29$, $p = .594$, $\eta_p^2 = 0.02$, 95% CI of mean difference = [−0.04, 0.02]). Hence, based on the accuracy data, the ingroup members are expected to act in a common inefficient manner, and accordingly, identifying this shared action is facilitated.

5. Experiment 2: Specific to social groups

To some extent, the finding that perceivers do not generalize the shared action to the outgroup members supports the generalization that actions are specific to social groups, a finding that may be explained by the perceptual similarity of shared shapes. To examine this possibility, this experiment reduced social group information by presenting agents as spatially separated and independent in terms of movement. The same visual shapes as used in Experiment 1a are used in this experiment. If group membership is the determinative factor for generalization, no difference should be observed between conditions when group information is reduced.

5.1. Methods

Twenty new students (8 men, 12 women) aged 17–20 years ($M_{age} = 18$ years) were paid approximately \$3 to participate in this experiment. The stimuli and procedures applied were the same as those used in Experiment 1a, except that the social group cues were removed. Specifically, six cartoon agents moved independently rather than synchronously and then spread out into an ABABAB arrangement instead of the AAABBB arrangement used in Experiment 1a. Consequently, there were no social groups, but two assemblies could be defined based on their distinct appearance (i.e., three agents had the same identity). To keep terms consistent and facilitate the comparison of results across experiments, the concepts of ingroup and outgroup were still used. Accordingly, ingroup meant that the judged agent had the same appearance as the two exemplars, and outgroup meant that the judged agent had a different appearance.

To test whether the operation in this experiment could reduce social group information, 44 new adults were recruited to watch the video in the “social group manipulation” phase of either Experiment 1a or Experiment 2 (i.e., 22 participants for each video) and evaluate the degree to which the agents with the same appearance looked like a unified group, that is, group entitativity (Campbell, 1958) based on seven items that were established according to the definition and characteristics of a social group (Aronson, Wilson, Akert, & Sommers, 2015). Generally, a social group consists of at least three persons who have a common goal and collective interest, and the members depend on and influence each other. A social group also includes social norms and the members connect with and embrace each other. According to this concept of a group, the participants were asked to evaluate group entitativity based on whether the three agents with the same appearance (a) have a common goal, (b) have a collective interest, (c) depend on each other, (d) influence each other, (e) have social norms, (f) connect with each other, and (g) embrace each other.

Each item was rated from 1 (*completely disagree*) to 7 (*completely agree*). The video with social group cues from Experiment 1a and the video without social group cues from Experiment 2 were counterbalanced across participants. The internal consistency ratings for the video with social group cues and without social group cues were 0.60 and 0.61, respectively. Independent t tests revealed that group entitativity was judged stronger for the video with social group cues from Experiment 1a ($M = 4.90$) than for the video without social group cues from this experiment ($M = 3.69$; $t(42) = 4.74$, $p < .001$, Cohen's $d = 3.83$, 95% CI of mean difference = [0.69, 1.72]). Further, the ratings in the former condition significantly differed from the mid-value (i.e., 3.5; $t(21) = 8.77$, $p < .001$, Cohen's $d = 3.83$, 95% CI of mean difference = [1.07, 1.74]); however, the ratings in the latter condition were not statistically different from the mid-value ($t(21) = 0.98$, $p = .338$, Cohen's $d = 0.42$, 95% CI of mean difference = [−0.23, 0.61]). These results suggest that the operation in this experiment is valid and can reduce social group information.

5.2. Results and discussion

5.2.1. Within-experiment tests

Fig. 4a presents the mean RTs for trials in all conditions. The exclusion rate was 7.19% after employing the same exclusion methods as used in Experiment 1a. To examine the effect of social group information on the expectations of group members' actions, we conducted a 2 (group condition: ingroup vs. outgroup) × 2 (action consistency: consistent vs. inconsistent) repeated measures ANOVA with the RT data and found that the main effect of group condition ($F(1, 19) = 0.22$, $p = .646$, $\eta_p^2 = 0.01$), the main effect of action consistency ($F(1, 19) = 0.15$, $p = .705$, $\eta_p^2 = 0.01$), and the interaction effect between group condition and action consistency ($F(1, 19) = 2.31$, $p = .145$, $\eta_p^2 = 0.11$) were not significant.

With respect to accuracy, the 2 (group condition: ingroup vs. outgroup) × 2 (action consistency: consistent vs. inconsistent) repeated measures ANOVA revealed that none of the effects, that is, the main effect of group condition ($F(1, 19) = 0.68$, $p = .420$, $\eta_p^2 = 0.03$), the main effect of action consistency ($F(1, 19) = 0.18$, $p = .679$, $\eta_p^2 = 0.01$), or the interaction effect ($F(1, 19) = 0.18$, $p = .676$, $\eta_p^2 = 0.01$), reached significance.

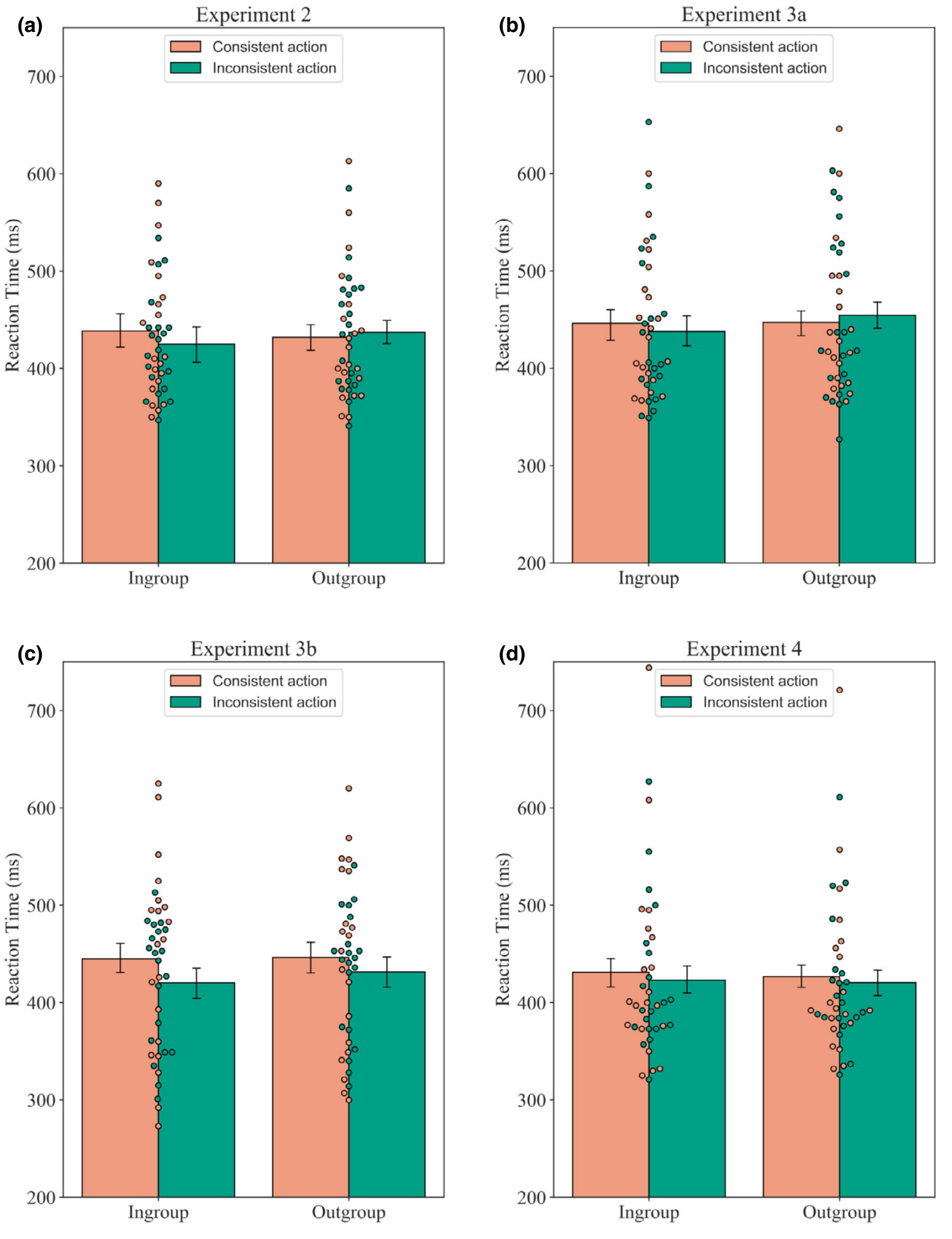

Fig. 4. Reaction times (RTs) as a function of group conditions and action consistency. (a) Experiment 2 removed group cues. (b) Experiment 3a displayed efficient actions and used visual action cues to manipulate social groups. (c) Experiment 3b displayed efficient actions and used category labels to manipulate social groups. (d) Experiment 4 presented a single agent demonstrating actions twice. Bars represent the mean RT for each condition. Dots indicate the mean RT for each participant in each condition. Error bars indicate the within-subject 95% confidential intervals.

5.2.2. Between-experiment tests

To further test the role of social group information on action generalization, a 2 (social group information as a between-subjects factor: present in Experiment 1a vs. absent in Experiment 2) × 2 (group condition as a within-subject factor: ingroup vs. outgroup) × 2 (action consistency as a within-subject factor: consistent vs. inconsistent) ANOVA was conducted for the RT data, and a three-way interaction was found ($F(1, 38) = 9.11$, $p = .005$, $\eta_p^2 = 0.19$). This interaction was due to a two-way interaction between group condition and action consistency when the social group information was present in Experiment 1a, but not when the social group information was absent in Experiment 2, as described above. In addition, we analyzed the three-way interaction by fixing the variable for group conditions and found that the interaction between social group information and action consistency was significant ($F(1, 38) = 5.84$, $p = .021$, $\eta_p^2 = 0.13$) when the judged agent was an ingroup member but not when this agent was an outgroup member ($F(1, 38) = 0.97$, $p = .330$, $\eta_p^2 = 0.03$). Hence, the social group information modulates the expectations of actions.

Further, according to our hypothesis, for the judged agent from the same group as the exemplars, the crucial difference in RTs between the consistent action condition and the inconsistent action condition (i.e., H1) should be favored when the social group is present in Experiment 1a and Experiment 1b, but H0, that is, no significant difference between the consistent action condition and the inconsistent action condition, should be favored when the social group is absent in Experiment 2. To address this prediction, we ran a Bayesian paired samples t test in each experiment to compute the ratio of the likelihood probability of two competing hypotheses (BF_{10}, H1/H0; $BF_{10} < 0.33$ suggests substantial evidence supporting H0 and $BF_{10} > 3.00$ suggests substantial evidence supporting H1) using JASP software (JASP Team, 2018). In Experiments 1a and 1b, the two computed values for BF_{10} were 40.26 and 215.03, respectively, and the computed BF_{10} value in Experiment 2 was 0.33. Hence, the Bayesian factors indicate that the difference in RTs between action consistency conditions for group members relied on the existence of the social group, thus supporting that the generalization of inefficient action is specific to group membership.

6. Experiment 3a: No generalization for efficient action

The above experiments demonstrate that perceivers generalize inefficient actions across group members. To investigate whether an inefficient action is necessary for this generalization, the action in this experiment was operationalized as being efficiently related to the external objects by adding an obstacle to the path by which the agent approached the external object. If our hypothesis is correct, the facilitation effect observed in Experiment 1 should be absent.

6.1. Methods

Twenty new students (9 men, 11 women) aged 17–19 years ($M_{age} = 19$ years) were paid approximately $3 to participate in this experiment. The stimuli and procedures were the same as those in Experiment 1a, except that the two exemplars acted efficiently when approaching the target because an obstacle was added at the jumping position (i.e., action efficiency differed between experiments with an inefficient action in Experiment 1a and an efficient action in this experiment). The obstacle became invisible when the judged agent implemented its actions after the plate was removed to allow for the possibility of performing a different action (see Fig. 5).

6.2. Results and discussion

6.2.1. Within-experiment tests

Fig. 4b presents the mean RTs for trials in all conditions. The exclusion method used in Experiment 1 was adopted to exclude trials, and 7.86% of the trials were ultimately excluded. A 2 (group condition: ingroup vs. outgroup) × 2 (action consistency: consistent vs. inconsistent) repeated measures ANOVA was employed using the RT data. None of the effects, that is, the main effect of group condition ($F(1, 19) = 2.97$, $p = .101$, $\eta_p^2 = 0.14$), the main effect of action consistency ($F(1, 19) < 0.01$, $p = .955$, $\eta_p^2 < 0.01$), or the interaction effect ($F(1, 19) = 0.63$, $p = .437$, $\eta_p^2 = 0.03$), were significant. Hence, this experiment provided evidence that group members are expected to perform common actions when exemplar members behave inefficiently with respect to their goals.

All the same analyses were conducted with the accuracy data, and the results indicated that none of the effects, that is, the main effect of group condition ($F(1, 19) = 0.59$, $p = .452$, $\eta_p^2 = 0.03$), the main effect of action consistency ($F(1, 19) = 0.17$, $p = .684$, $\eta_p^2 = 0.01$), or the interaction effect ($F(1, 19) = 1.70$, $p = .208$, $\eta_p^2 = 0.08$), reached significance.

6.2.2. Between-experiment tests

Similar to Experiment 2, a 2 (action efficiency as a between-subjects factor: inefficient in Experiment 1a vs. efficient in Experiment 3a) × 2 (group condition as a within-subject factor: ingroup vs. outgroup) × 2 (action consistency as a within-subject factor: consistent vs. inconsistent) ANOVA was conducted using the RT data, and a three-way interaction was found ($F(1, 38) = 4.71$, $p = .036$, $\eta_p^2 = 0.11$). This interaction was due to a two-way interaction between group condition and action consistency when the action was

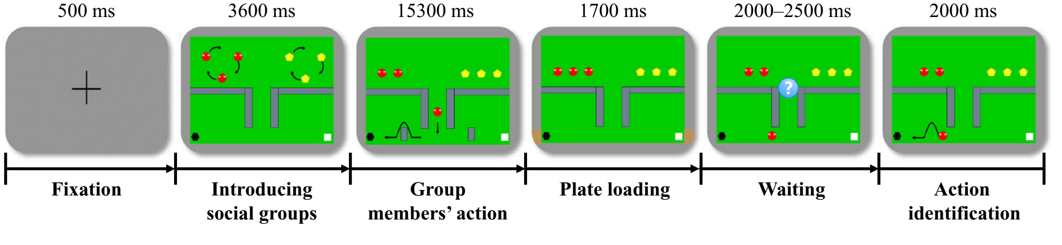

Fig. 5. An example trial sequence with efficient actions presented in Experiment 3a.

inefficient in approaching the external target in Experiment 1a, but not when the action was efficient in approaching the external target in Experiment 3a, as previously described. In addition, we analyzed the three-way interaction by fixing the variable of group condition and determined that the interaction between action efficiency and action consistency was significant ($F(1, 38) = 5.48$, $p = .025$, $\eta_p^2 = 0.13$) when the judged agent was an ingroup member, but not when this agent was an outgroup member ($F(1, 38) = 1.25$, $p = .271$, $\eta_p^2 = 0.03$).

Further, according to our hypothesis, regarding the judged agent from the same group as the exemplars, the crucial difference in RTs between the consistent action condition and the inconsistent action condition (i.e., H1) should favor the inefficient action in Experiment 1a ($BF_{10} = 40.26$) and Experiment 1b ($BF_{10} = 215.03$), and this finding is evidenced in the between-experiment tests conducted in Experiment 1. On the other hand, H0, that is, no significant difference between the consistent action condition and the inconsistent action condition, should be favored due to the efficient action in Experiment 3a, and the computed BF_{10} of 0.28 for Experiment 3a serves as substantial evidence supporting H0. Hence, the RT difference between the consistent action and inconsistent action conditions for ingroup members was modulated by action efficiency, thus indicating that the inefficient action is necessary for action generalization to group members.

7. Experiment 3b: Replication

As Experiment 3a used visual cues of synchronous dance-like movements to manipulate social groups, these inefficient movements may result in participants learning that group members tend to perform inefficient actions, and thus, it is not expected that the efficient action would be generalized within social groups in such settings. Hence, this experiment aimed to replicate the results of Experiment 3a by using the category labels as used in Experiment 1c.

7.1. Methods

Twenty new students (8 men, 12 women) aged 18–22 years ($M_{age} = 20$ years) were paid approximately \$3 to participate in this experiment. The procedures and design were the same as in Experiment 3a, with the exception of the settings in the "introducing social groups" phase. Similar to Experiment 1c, three agents at one side of the screen were explicitly labeled, "These are members of Group A," while the three agents on the other side of the screen were explicitly labeled by a voice saying, "These are members of Group B."

7.2. Results and discussion

7.2.1. Within-experiment tests

Fig. 4c presents the mean RTs for trials in all conditions. The exclusion method used in Experiment 1 was adopted to exclude trials, and 7.45% of trials were ultimately excluded. A 2 (group condition: ingroup vs. outgroup) × 2 (action consistency: consistent vs. inconsistent) repeated measures ANOVA was employed using the RT data. None of the effects, that is, the main effect of group condition ($F(1, 19) = 3.02$, $p = .098$, $\eta_p^2 = 0.14$), the main effect of action consistency ($F(1, 19) = 2.38$, $p = .139$, $\eta_p^2 = 0.11$), or the interaction effect ($F(1, 19) = 0.83$, $p = .375$, $\eta_p^2 = 0.04$), were significant. Hence, this experiment replicates the results of Experiment 3a, thus further supporting that action efficiency governs action generalization within group members.

All the same analyses were conducted with the accuracy data. None of the effects, that is, the main effect of group condition ($F(1, 19) = 0.95$, $p = .343$, $\eta_p^2 = 0.05$), the main effect of action consistency ($F(1, 19) = 1.20$, $p = .287$, $\eta_p^2 = 0.06$), or the interaction effect ($F(1, 19) = 0.46$, $p = .505$, $\eta_p^2 = 0.02$), reached significance.

7.2.2. Between-experiment tests

Similar to Experiment 3a, to further test the role of action efficiency with respect to action generalization when using category labels to introduce social groups, a 2 (action efficiency as a between-subjects factor: inefficient in Experiment 1c vs. efficient in Experiment 3b) × 2 (group condition as a within-subject factor: ingroup vs. outgroup) × 2 (action consistency as a within-subject factor: consistent vs. inconsistent) ANOVA was conducted using the RT data, and a three-way interaction was found ($F(1, 38) = 5.13$, $p = .029$, $\eta_p^2 = 0.12$). This interaction was due to a two-way interaction occurring between group condition and action consistency when the action was inefficient for approaching the external target in Experiment 1c but not when the action was efficient for approaching the external target in Experiment 3b as previously described. In addition, we analyzed the three-way interaction by fixing the variable of group condition, indicating that the interaction between action efficiency and action consistency was significant ($F(1, 38) = 9.08$, $p = .005$, $\eta_p^2 = 0.19$) when the judged agent was an ingroup member, but not when this agent was an outgroup member ($F(1, 38) = 0.94$, $p = .338$, $\eta_p^2 = 0.02$).

We also computed BF_{10} for the crucial comparison of RTs between the consistent action condition and the inconsistent action condition for the ingroup condition, as in Experiment 3a. The computed BF_{10} was 3.27 in Experiment 1c where the response was faster in the consistent action condition than in the inconsistent condition, thus suggesting substantial evidence in support of H1, and the computed BF_{10} was 0.84 in Experiment 3b, thus providing additional support for H0. Accordingly, the facilitation effect was modulated by the action's efficiency, indicating that the action's efficiency plays a determinative role in action generalization to group members. Please note that Fig. 4c indicates that the identification time in the inconsistent action condition appeared faster than in the consistent condition, that is, the efficient action of moving straight was identified faster than the inefficient action of jumping. This may be caused by the expectation of rationality with respect to agents' actions.

8. Experiment 4: Individual-based or group-based inference

Previous experiments have demonstrated that people generalize inefficient actions rather than efficient actions within group members. However, it is not clear whether this generalization is based on genuine group-based inferences as participants may deem that when an individual performs an action this action should be generalized to group members (i.e., individual-based inference) without considering how the exemplars are sampled. This experiment was designed to test this by having one of the group members perform an inefficient action twice. If the individual-based inference is valid, even if this action is demonstrated twice by one group member, the same results as those of Experiment 1 should be observed; otherwise, given that the sample size is crucial to the inductive generalization of group-based inference (Hendrickson, Perfors, Navarro, & Ransom, 2019; Lawson & Fisher, 2011) and as seeing two individuals do the same thing at the same time is a strong indication that the exact inefficient action they perform is regulated by the group's convention (Haun, Rekers, & Tomasello, 2012; Herrmann, Legare, Harris, & Whitehouse, 2013), the action generalization observed in Experiment 1 should disappear or become weaker when the inefficient action is repeated by one same group member rather than being performed by two different group members as in Experiment 1.

Further, since acting inefficiently seems stranger than acting efficiently (Legare & Souza, 2012), it is possible that the oddness of the inefficient actions may result in the actions being more memorable. Therefore, the increased memorability of inefficient actions is one possible explanation as to why inefficient actions lead to greater generalization relative to efficient actions. Furthermore, the current setting of the action repeated by a single group member would rule out this possibility as well, as this possibility only concerns inefficient action regardless of who performs the inefficient action.

8.1. Methods

Twenty new students (5 men, 15 women) aged 18–24 years ($M_{\text{age}} = 20$ years) were paid approximately \$3 to participate in this experiment. The stimuli and procedures were the same as those in Experiment 1a, except that in the exemplars' demonstration the first agent remained still while the second agent completed the action twice.

8.2. Results and discussion

8.2.1. Within-experiment tests

The exclusion rate was 5.68% after employing the same exclusion methods as those used in Experiment 1. Fig. 4d presents the mean RTs for the trials in all conditions. A 2 (group condition: ingroup vs. outgroup) × 2 (action consistency: consistent vs. inconsistent) repeated measures ANOVA was conducted with the RT data. Neither the main effect of group condition ($F(1, 19) = 0.60$, $p = .449$, $\eta_p^2 = 0.03$) nor the main effect of action consistency ($F(1, 19) = 0.48$ $p = .499$, $\eta_p^2 = 0.02$) was significant, and the interaction effect between group conditions and action consistency did not reach significance (F(1,

19) = 0.06, $p = .816$, $\eta_p^2 < 0.01$). Hence, the group-based inference was supported, and the explanation of increased memorability of inefficient actions was ruled out.

When all the same analyses were conducted with the accuracy data, it was determined that none of the effects, that is, the main effect of group condition ($F(1, 19) = 0.91$, $p = .352$, $\eta_p^2 = 0.05$), the main effect of action consistency ($F(1, 19) = 0.19$, $p = .665$, $\eta_p^2 = 0.01$), or the interaction effect ($F(1, 19) = 2.69$, $p = .118$, $\eta_p^2 = 0.12$), reached significance.

8.2.2. *Between-experiment tests*

Again, a 2 (exemplar demonstration as a between-subjects factor: two group members completing the same action in Experiment 1a vs. one group member completing the action twice in Experiment 4) × 2 (group condition as a within-subject factor: ingroup vs. outgroup) × 2 (action consistency as a within-subject factor: consistent vs. inconsistent) ANOVA was conducted for the RT data, and a three-way interaction effect was found ($F(1, 38) = 5.44$, $p = .025$, $\eta_p^2 = 0.13$). This interaction was due to a two-way interaction between group condition and action consistency when two group members completed the same action in Experiment 1a, but not when a single group member completed the action twice in Experiment 4, as previously described. Additionally, we analyzed the three-way interaction by fixing the variable of group conditions and determined that the interaction between exemplar demonstration and action consistency was significant ($F(1, 38) = 6.09$, $p = .018$, $\eta_p^2 = 0.14$) when the judged agent was an ingroup member but not when this agent was an outgroup member ($F(1, 38) = 0.04$, $p = .840$, $\eta_p^2 < 0.01$).

Further, according to our hypothesis, with respect to the judged agent from the same group as the exemplars, the crucial difference in RTs between the consistent action condition and the inconsistent action condition (i.e., H1) should be favored when two group members complete the same action in Experiment 1a ($BF_{10} = 40.26$) and Experiment 1b ($BF_{10} = 215.03$). This is further evidenced in the between-experiment tests in Experiment 1. However, H0, that is, no significant difference between the consistent action condition and the inconsistent action condition, should be favored when a group member completes the action twice in Experiment 4. The computed BF_{10} was 0.28 in Experiment 4, suggesting substantial evidence in support of H0. Hence, the action generalization is specific to the demonstration of the action completed by multiple group members, thus supporting the group-based inference.

9. General discussion

Although previous research documented that generalizing actions to group members has boundary conditions (Crawford et al., 2002; Nosek, 2007), it remains unknown whether the characteristics of exemplars' actions determine this generalization. This study focused on the fundamental characteristic of actions—efficiency with respect to an external target—and explored its role in action generalization. It was found that when group members acted inefficiently toward an external object, perceivers generalized the exemplars' common actions to the unknown ingroup member with both visual and labeling presentations regarding the social groups (Experiment 1) and determined that this effect was specific to social groups (Experiment 2). Importantly, such a generalization was not observed when the common action was efficient toward an external object in both visually introduced and explicitly labeled social groups (Experiment 3), but rather, the generalization was specific to the demonstration of the action completed by multiple group members rather than to the action being repeated twice by one group member, supporting the group-based inference and ruling out the possibility that the increased memorability of inefficient actions leads to more generalization relative to efficient actions (Experiment 4). Hence, the efficiency of an action determines action generalization across social group members.

Our study indicates that knowledge about group members' actions is generalized to unknown ingroup members, which is in accordance with previous studies, while also generalizing knowledge of behaviors, such as attributes and characteristics (Crawford et al., 2002; Dunham, 2018; Ranganath & Nosek, 2008). It has been reported that the generalization of behavioral properties across group members has boundary conditions and is modulated by the sample size, typicality, and diversity of the exemplars (Hampton, 2007; Heit & Hahn, 2001; Hendrickson et al., 2019; Lawson & Fisher, 2011). Relative to this finding, the results of Experiment 4 of our study confirm the role of sample size in action generalization, indicating that when the action was sampled from one exemplar (i.e., one exemplar demonstrated the action twice), action generalization was not present. Nevertheless, the nature of an action, that is, action efficiency, works as a boundary condition for generalization. Hence, when categorizing social group members and when forming generalizations, how the action is performed by group members is also considered. This relationship cannot be explained by an immediately learned rule that group members tend to perform inefficient actions based on social group introductions, such as the synchronous dance-like movements, because, when all agents remained motionless but were socially grouped by labels, generalizing inefficient actions within social groups still occurred. Therefore, this generalization phenomenon may be rooted in our knowledge about social groups, such as culture-specific conventional forms of actions.

In the current study, visual scenes were used to simulate social groups and actions, and participants were not aware of their action generalization during the task, which is consistent with the widely accepted conclusion that generalization within social groups is implicit and spontaneous (Ranganath & Nosek, 2008; Uleman, Saribay, & Gonzalez, 2008). The present study also extended the learning context for generalization from textual descriptions to visual scenes. The textual stimuli are usually adopted to describe one person's behaviors in a given context, and accordingly, the Implicit Association Test (IAT) paradigm and similar tests with language labels are employed to test the implicit generalization about a learned attribute (Blair, 2002; Crawford et al., 2002; Nosek, Greenwald, & Banaji, 2007; Ranganath & Nosek, 2008). Nevertheless, the use of texts may drive participants to create deep and stable concepts of the described person and the categorical representation of groups. This is because the language label is, at times, supposed to refer to an internal trait of the described person and the nature of that group (Noyes &

Keil, 2019; Orvell, Kross, & Gelman, 2019), and thus, the participants easily and spontaneously generalize the corresponding attribute (e.g., action) of that trait to group members in textual descriptions. In daily life, our experience of our surroundings is primarily visual, and the information we directly obtain is of individuals' observable actions. Our results indicate that implicit action generalization occurs with visually observed actions, suggesting that the implicit generalization to group members is not specific to textual descriptions. Moreover, in our study, the perceivers immediately learned the boundaries of the social groups from the visual cues (i.e., synchronous movement) but without accumulating specific experiences of those groups. The definitive information regarding social groups is the membership of individuals. Hence, membership could be enough to induce the action generalization tendency, as suggested by Dunham (2018), who posited that because the belief in the abstract similarity of persons in social groups can stem from mere membership, it is not necessary to attribute it to a rich knowledge of social groups.

Our findings demonstrate that the generalization of actions across members of social groups relies on both agentic and social reasoning, two proposed systems for reasoning with respect to actions (Spelke, 2016). Specifically, the agentic reasoning system interprets the actions of agents who act on an object as guided by goals and intentions based on the principle of rationality (Gergely & Csibra, 2003). The social reasoning system interprets the actions of social beings as expressing shareable attributes and phenomenal states to realize the group's functions of affiliation and normative influence, that is, social reasoning (Rakoczy, 2015). In the social reasoning system, commonalities across actions are emphasized for group cohesion, such as in synchronized dance. With respect to the parameters of social reasoning, when the agent's action cannot be explained by the agentic reasoning system, that is, it violates the principle of rationality, the output of agent knowledge regarding inefficient actions may automatically feed into the module of social reasoning. In this sense, the cognitive structure constitutes the basis for thinking structurally about group actions. Accordingly, group members activate the generalization of inefficient action to an unknown member. In addition, this effect cannot be attributed to the experimental demand as participants were not asked to explicitly expect but rather to judge the agent's actions. The relationship between agentic and social reasoning has been previously discussed in terms of how to interpret rituals as ritualized actions apparently violate the efficiency expectation derived from the principle of rationality through agentic reasoning (Kapitány & Nielsen, 2015; Legare & Souza, 2012) and are perceived as being socially normative and functioning to enhance cooperation within groups. Thus, the inefficient action performed in our study is likely to be treated as a ritual. If this is the case, when this ritual action is demonstrated by multiple group members, instead of only one person, it can be treated as socially relevant and thereby be adopted by other group members. Future studies should address this issue.

However, the current research used computer animation with nonhuman agents. This method allowed for the strict control of possible confounding factors, further allowing us to effectively inspect the mechanisms of reasoning regarding the actions. Moreover, this method has been widely employed to gain an understanding of actions (Heider & Simmel, 1944; Ludwig et al., 2020; Powell & Spelke, 2013; Schachner & Carey, 2013).

However, as this method may limit the external generalizability of our findings, future studies should use recorded human actions in their experimental designs. Furthermore, the inefficient action in this study was always jumping and never moving straight to the external target, but there are many types of inefficient actions, such as approaching the target via the longest path instead of the shortest path. Therefore, whether different types of inefficient actions have the same effects on social generalization should be explored.

To conclude, action generalization is not always observed for social groups. However, the efficiency of an action creates a boundary for generalizing actions across social group members, and this process is both spontaneous and implicit. This conclusion elucidates which characteristics of actions constrain action generalization across social groups.

Acknowledgments

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Appendix S1. Additional results to address possible explanations.