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Smartly following others: Majority influence depends on how the majority behavior is formed☆

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ABSTRACT

Individuals tend to follow choices and behaviors that are common among others, indicating majority influence. Nevertheless, majority behaviors that appear to be consistent can be generated by different factors during the decision-making process; hence, the current study addressed whether people consider the source of majority behavior and follow the majority differently when that behavior is formed under different choice conditions. The participants were asked to select a safe exit after observing others' choices in simulated fire escape scenes, and their probability of adopting the majority choice was tested when all or some of the other persons were free or constrained to choose an exit for escaping under different sizes of majority. The results showed that people are more likely to follow the majority's choice when faced with available options than when constrained to make a common choice, and an increase in majority size leads to an increase in majority influence only when the majority behavior is formed under free choice. Importantly, when the majority behavior is generated by a computer algorithm, the majority influence is not affected by the availability of options, ruling out nonsocial differences as contributors to source-dependent majority influence. These findings indicate that people do not simply engage in any form of majority behavior at face value but rather distinguish between different types of majority behavior while following the majority. This finding highlights the fact that people account for rational factors and seek to maximize information gains when following the majority.

1. Introduction

Humans are social animals and are continuously engaged in real or imagined social contexts with other people. In social environments, people not only rely on personal preferences but also refer to the behaviors of others when choosing how to act (Kim & Hommel, 2015; Kraft-Todd, Bollinger, Gillingham, Lamp, & Rand, 2018). Individuals tend to follow opinions and behaviors that are common among other people, indicating majority influence[1] (i.e., following majority rules; Cialdini & Goldstein, 2004; Toelch & Dolan, 2015; Mercier & Morin, 2019). This tendency to follow the majority emerges in the very early stages of human development (Evans, Laland, Carpenter, & Kendal, 2018; Haun, Rekers, & Tomasello, 2012) and is widespread across situations and societies (Kees, Lindenberg, & Steg, 2008; Kim & Hommel, 2015; Park, Goïame, O'Connor, & Dreher, 2017; Vollmer, Read, Trippas, & Belpaeme, 2018). Previous work on majority influence has focused primarily on apparent majority behavior, which is demonstrated by a large proportion of people. However, does every majority behavior have equal social influence? There are often situations in which a lack of available options or people being forced to select an option can lead to majority behavior. This raises the question of whether people only attend to surface-level indications of majority behavior while following the majority or whether they also probe deeper and consider why the majority behaves in a particular way (i.e., how majority behavior is formed).

Since the work of Asch (1956) on conformity, the majority influence has been demonstrated across a wide range of domains (Cialdini & Goldstein, 2004; Kees et al., 2008; Kim & Hommel, 2015; Park et al.,

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[1] We use majority influence as a general term to refer to the ways in which individuals are influenced by the opinions and behaviors of the majority. Conformity, on the other hand, refers specifically to the phenomenon where individuals relinquish their personal beliefs or preferences to adopt the behavior of the majority.

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2017; Vollmer et al., 2018), even in virtual environments (Brady, McLoughlin, Doan, & Crockett, 2021; Moussaïd et al., 2016). For instance, Klucharev, Hytönen, Rijpkema, Smidts, and Fernández (2009) revealed that participants were found to change their attractiveness ratings to align with the group rating. Chung, Orloff, Lauharatanahirun, Chiu, and King-Casas (2020) presented two peers' choices, one safe and one risky, and reported that participants (i.e., adolescents) followed the choices more readily when they were consistent, especially for selecting the safer gamble. Even after a period when the majority behavior was removed, the majority influence still lasted (Sun & Yu, 2016). Two-year-old children were more likely to copy majority behavior than either minority behavior or an option that had not been demonstrated (Haun et al., 2012). Furthermore, it appears that majority influence can operate at the perceptual level, as participants are more likely to follow the group's gaze when the majority are looking at something (Cracco et al., 2022). Research has suggested that majority influence can affect not only behaviors but also attitudes and memory. For example, participants may be more likely to follow the majority opinion regarding controversial topics such as the legalization of voluntary euthanasia (Gardikiotis, Martin, & Hewstone, 2005; Martin, Gardikiotis, & Hewstone, 2002). Edelson, Sharot, Dolan, and Dudai (2011) reported that participants followed the memory feedback of the majority in both immediate and long-lasting tests. These findings demonstrate the powerful impact of majority influence on individual behavior and cognition.

Most researchers agree that people follow the majority because they have developed a tendency to observe the behavior of others to acquire knowledge about appropriate actions, and the behavior of the majority serves as useful information (i.e., informational influence). Furthermore, people sometimes want to be accepted by and to belong to the group (i.e., normative influence) (Cialdini & Goldstein, 2004; Toelch & Dolan, 2015). At first glance, it seems that following the majority is just a simple heuristic, similar to an associative rule, as the majority choice can provide a reliable cue for a relatively accurate answer in uncertain and complex situations (Mercier & Miton, 2019). Additionally, the majority of rules have been found to perform well in simulations, and their application has comparable levels of accuracy to that of more resource-intensive rules such as the individual judgment averaging rule (Hastie & Kameda, 2005). Nevertheless, further experiments have shown that people do not simply and blindly follow the majority but rather take into account relevant factors to determine the degree to which reliance on majority rules is suitable (for review, see Mercier & Morin, 2019). Such factors include, for instance, the relative and absolute size of the majority (McDavid Jr, 1959; Moussaïd et al., 2016; Reno, Cialdini, & Kallgren, 1993) and task features (Gergen & Bauer, 1967; Rosander & Eriksson, 2012). It has been argued that the larger a group is, the greater its impact (Latané, 1981), which was confirmed in a meta-analysis study (Bond, 2005). When the majority group was larger in either absolute or relative terms (i.e., closer to a consensus), the participants were more inclined to follow it (Morgan, Rendell, Ehn, Hoppitt, & Laland, 2012; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Moreover, the difficulty, uncertainty, and other factors of the participants' task greatly contribute to the majority influence (Gergen & Bauer, 1967; Moussaïd et al., 2016; Rosander & Eriksson, 2012). Individuals conformed more frequently when the task was considered difficult (e.g., How far above sea level is Mount Everest? Rosander & Eriksson, 2012), and in an immersive virtual fire environment with high stress (e.g., time pressure and high penalties), participants were more likely to follow the escape behaviors of the majority (Moussaïd et al., 2016).

The evidence presented implies that people tend to follow the majority by accounting for a variety of factors in a broadly rational fashion, optimizing information gains.[2] However, these studies have primarily focused on the surface level of apparent majority behavior and have not directly manipulated the potential information gains transmitted by consistent majority behavior. Thus, more evidence is needed to support this conclusion. The consistent majority behaviors observed can stem from various reasons due to different situational constraints when making choices. For example, the referenced majority selects one of two options simply because they do not have another option to act differently, such as when one of the exits is closed. The question remains as to whether we optimally account for information on how the majority was formed when deciding to what degree to follow the majority behavior. It has been reported that people adopt arbitrary majority behavior when the majority has been randomly allocated to have a common decision (Pryor, Perfors, & Howe, 2019), although this effect was not compared with the same majority behavior caused by other reasons. In contrast, many studies show that people spontaneously consider the reasons underlying behaviors when copying others (Cracco et al., 2018; Cracco, Genschow, Radkova, & Brass, 2018). Therefore, it remains unclear whether we take any form of majority behavior at face value while following them. The current study explored whether people only attend to surface-level indications of majority behavior or whether they also consider the source (i.e., reason) of majority behavior. A positive answer to this question would serve as direct evidence that people do not blindly follow the majority but rather follow the majority in a generally rational manner.

From an evolutionary point of view, humans must possess cognitive mechanisms of epistemic vigilance that are designed to assess and evaluate the information communicated to them, as individuals receiving information can be deceived or manipulated (Mercier & Miton, 2019; Sperber et al., 2010). Such mechanisms are suggested to also apply to majority rules, enabling humans to take some rational factors into account in a way that optimizes information gains and remains sensitive to evolutionarily valid cues, such as the competence of the majority. Under this framework, people should be sensitive to the way in which majority behavior is formed because for majority behavior to be reliable and informative, members of the majority must make decisions largely in accordance with their free choices (Toelch & Dolan, 2015). Indeed, although the illusion of consensus, in which people express equal confidence in opinions derived from independent primary sources (i.e., true consensus) and those derived from only a single primary source (i.e., false consensus) (Sulik, Bahrami, & Deroy, 2020; Yousif, Aboody, & Keil, 2019), is prevalent, recent studies have shown that participants do have the capacity to consider the manner in which the majority opinion is formed (e.g., information dependency) when assessing the trustworthiness of majority decisions (Desai, Xie, & Hayes, 2022; Richardson & Keil, 2022; Xie & Hayes, 2022). The observed differences in results can be explained by varying levels of epistemic vigilance toward evolutionarily relevant cues regarding hearsay and perception (Mercier & Miton, 2019). For instance, when adding an explicit statement about causal dependence, the weight given to true consensus becomes greater than that given to false consensus (Desai et al., 2022). This source-sensitive social influence may be applicable to following majority behavior due to the epistemic vigilance involved. Therefore, we hypothesized that even if majority behaviors have the same apparent outcome, if they are formed for different reasons, people should follow the majority differently, showing source-dependent

[2] The term "rational" does not strictly correspond to deliberate or controlled thinking but rather to the outcome that is a rational choice optimizing gains. The process to produce such a rational choice could be automatic or unconscious, similar to the unconscious inference proposed by Hermann von Helmholtz or the Bayesian rationality in our cognition, as well through rational deliberation.

majority influence. Specifically, people are more likely to follow the decision of the majority when members of the majority are free to make a choice, as this social information reflects the actual "choice" of other people and is more reliable than when they are not.

To address the above question in this study, we created scenes to simulate fire escape with emergency exits and asked the participants to navigate avatars and select a safe exit after observing the choices of four confederates. The majority behavior of other people selecting the same exit arose under situations with different choices, such as how many options whether they had alternatives (i.e., emergency exits) to freely choose or had only one option to constrainedly choose. The majority size was changed (i.e., the proportion of four confederates selecting the same exit) to confirm that what we found was truly attributed to the majority influence. In Experiment 1, we distinguished whether the majority behavior formed under constrained choice exerts the same social influence as that formed under free choice by presenting one of two emergency exits, open or closed. According to our hypothesis on source-dependent majority influence, participants should tend to follow the majority behavior arising from free choice to a greater degree than that arising from constrained choice, and importantly, this effect would disappear in the absence of majority behavior, that is, when the number of individuals choosing different options is equal. Moreover, we predicted that when the choice of the majority is constrained, people are unlikely to follow the majority rules, as the resulting common behavior does not necessarily reflect reliable social information about the world. To investigate whether the source-dependent majority influence is a social effect, primarily driven by the confederate's constraint during decision-making and not solely by nonsocial factors, such as the implementation of distinct choices (i.e., constrained vs. free) in light of the different physical changes to the exits, we informed participants that the confederate's choice was not determined by a real human but instead controlled by a computer algorithm in Experiment 2. The disappearance of source-dependent majority influence would exclude the nonsocial explanation. To replicate the results of Experiments 1 and 2 using a between-subjects design, Experiment 3 was preregistered with minor adjustments, for instance, increasing the overall sample size while reducing the number of trials.

2. Experiment 1a

We first gauged the participants' sensitivity to the source of majority influence by showing them that all or some of four confederates were free or constrained to select an exit for escaping under different sizes of majority in simulated fire escape scenes and measured the probability of participants adopting the majority behavior.

2.1. Methods

2.1.1. Participants

Thirty adult volunteers (8 men and 22 women, mean age = 20.47 years, $SE = 0.33$) recruited from the campus were paid 40 RMB each for participating in this experiment. Three additional participants were tested but excluded because they doubted that the avatars in the fire escape game were manipulated by real humans. The sample size was determined for the following reasons. Considering that the main question of interest was whether the conformity difference between situations changed with the majority size, we conducted a power analysis using G*Power software (version 3.1; Faul, Erdfelder, Buchner, & Lang, 2009) to determine the minimum required sample size to detect a significant effect assuming a conventional medium effect size of $\eta 2\, p = 0.06$ with 3 repeated measures of majority size (an alpha level of 0.05 and a power of 0.80). The minimum sample size was determined to be 28. To detect a conventionally suggested effect size, 30 valid individuals were ultimately included. Considering that we also focused on the critical difference across majority sizes in Experiments 1b and 2, we adopted the same effect size for each as for Experiment 1a and recruited 30 valid participants. A sensitivity power analysis indicated that this sample size provided 80% power to detect an effect Cohen's $d \geq 0.53$ in different majority influence effects between two types of confederate's choice.

All of the participants 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 the authors' university and was performed in accordance with the relevant guidelines and regulations. In all of the experiments, we reported all measures, manipulations, and exclusions. No study designs were preregistered. All data, analysis codes and videos showing example trials for each condition have been made publicly available at the OSF and can be accessed at https://osf.io/7xk4d/?view_only=db4130c8e5a3429ead1217b0da8a0f17. The data were analyzed using R, version 4.1.2, with the library bruceR, version 0.8.9 and the package ggplot2, version 3.1–3.

2.1.2. Apparatus and stimuli

All stimuli were presented on the 15.6-in. LED monitor (1920 × 1080-pixel resolution; 120 Hz refresh rate) of a laptop computer at a 60-cm viewing distance. We employed custom software written in JavaScript to present the stimuli.

The experimental stimuli consisted of 2D simulated scenes of fire escape in 2D (see Fig. 1). Each of the five avatars with human silhouettes had an identifying number on their body, and these numbers indicated who navigated each avatar. Each room had two emergency exits, and the avatars were supposed to successively leave the room with fire through an exit. Whether an emergency exit was open or closed was indicated by a door. When the door was closed and the exit was accordingly blocked, no one could go through that exit; otherwise, it could be used to escape.

2.1.3. Procedure and design

In a fire escape simulation game, five persons participated, but only one was a real participant, while the other four were experimentally designated to portray the role of confederates (i.e., pretend to be confederates in order to create a particular experimental context).[3] To create the belief that participants were playing the fire escape simulation game with confederates, a randomized number of confederates entered the experimental room after the real participant. When five individuals arrived, they together saw that a computer randomly assigned each of them a number ranging from 1 to 5. This number served as the identity for each person during the game, and they only controlled their avatar corresponding to that number. Subsequently, the five individuals were led to separate compartments within the larger room, each equipped with a computer. The compartments were divided using partitions, allowing participants to hear each other (see Fig. S1 for the environmental layout). An experimenter then entered each compartment to provide instructions on how to play the fire escape simulation game online. During this game, participants had to select an exit to escape from a fire room one by one and were told that each exit had enough space to allow all five to escape. Participants were informed that the openness of each exit was regulated by the automatic device. However, due to a fire incident, the circuit controlling the automated device has been affected, resulting in intermittent openings and closings of the exit. If the door was closed, it prevented anyone from using that route for escape purposes. The real participant always navigated their avatar first or last to see which exits the other participants (i.e., the four confederates) selected. The order in which the other four avatars escaped was random. In reality, only the real participant was playing the fire escape simulation game, and the avatars shown on the real

[3] Four individuals were assigned roles to create the illusion that they were confederates to the true participant, but did not actually make any choices. Importantly, they are not real "confederates" in the conventional sense. Despite this distinction, acknowledging that they were assigned the role of confederates and treated as such within the experiment, we continued to use this term.

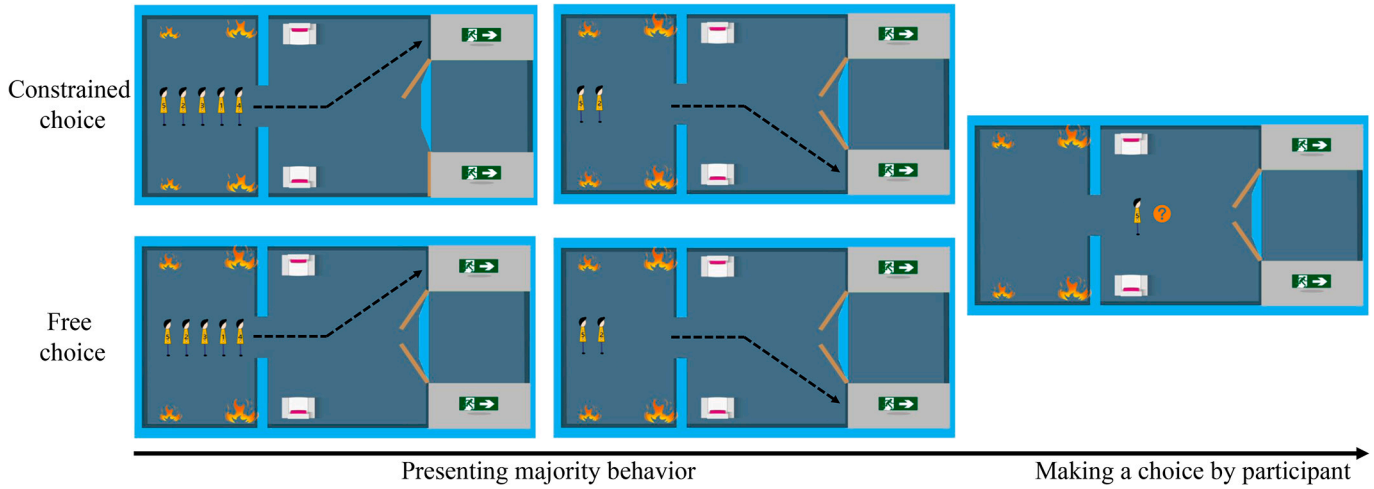

Fig. 1. An example of the trial sequence for the confederate's constrained choice and confederate's free choice situations in Experiment 1a. The dashed line indicates which exit the current avatar has selected and is not displayed in the experiment.

participant's screen were automatically controlled by the program scripts according to different conditions. The other four confederates stayed in the experimental compartments by placing their hands on the keyboard and watched the recorded gameplay videos from other participants, pretending to actively participate in the game. The real participants did not know this and were excluded from the analysis if they doubted the authenticity of the other four confederates.

At the start of each trial, the text "preparing…" appeared, signaling that a new trial was about to start. Each participant was required to press the space key after preparation and was told that when all participants pressed the space key, the text "preparing…" would disappear and a new trial would begin. The text display duration was set to last between 0 ms and 1000 ms after the participants pressed the space key. Participants could observe the exit choices of the four confederates by noting the disappearance of their respective avatars when entering an exit. Participants were informed that each confederate would make a choice while moving from the burning room to the room with exits. If participants did not respond, their controlled avatars would remain in the center of the room, equidistant from each exit, waiting for their responses. To simulate confederates making decisions with variations, a delay ranging from 0 ms to 200 ms was introduced. Following this, the participant's avatar moved to the center of the room equidistant to each exit for 400 milliseconds. The participant reported his or her between the upper or lower exit by pressing the "F" or "J" keys on a standard keyboard, and the avatar would proceed to the selected exit. The program automatically moved to the next trial after the participant made their selection.

To ensure that the participants were involved and immersed in the game of escaping from a burning building, they were instructed that one emergency exit had a fire inside and that they had to select the safe exit without any fire to earn 1 point. They would lose 1 point if they chose the exit that was on fire. To avoid social learning (which confederates have a good sense for the right door) and environmental learning (which door tends to be right), feedback regarding total points was not given during the game, but participants were told that they would see their total points after completing the game and could exchange them for money at the rate of 1 RMB per 20 points. Each participant earned some points randomly sampled from 90 to 110 and an additional 5 RMB regardless of their performance. Participants engaged in approximately 10 practice trials before the experiment (but no waiting time was set at the onset of each trial and when the other four avatars remained at the center of the room), and their earned points for these trials were not added to the final pool. After the experiment, participants were asked questions to confirm that they understood the game's mechanics (please see the debriefing questionnaire in the Supplementary Materials), and if they answered incorrectly or doubted the authenticity of their confederates, they were excluded. All included participants reported that the experiment focused on examining individuals making choices based on the decisions of others without realizing that the level of constraint in the confederates' choices would impact their own decision-making.

To create different scenarios in which the confederates formed majority behavior, the two emergency exits were assigned different statuses to operationalize the situation (i.e., confederate's choice as constrained vs. free). Notably, when the real participant made a choice, the two exits were always open. Specifically, in the condition of the confederate's constrained choice, one of the exits was initially closed, leaving the avatar with only a single escape option. As more avatars escaped (1, 2, 3 or 4), the previously closed exit was opened and selected by the remaining avatars controlled by the confederates (excluding the real participant) to escape. This allowed for the formation of different majority sizes with common behaviors, including small (2/4 confederates selecting the same exit; technically speaking, there was no majority behavior in this instance, but to be consistent, this behavior was randomly determined before each trial, and the term "small majority size" was used), medium (3/4 confederates selecting the same exit, with two types of settings), and large (4/4 confederates selecting the same exit) majority sizes. However, for the medium majority size, two types were included to counterbalance conditions: one with 1 confederate who had only one option and 3 confederates who had two options and another with 3 confederates who had only one option and 1 confederate who had two options. As both settings showed the same majority, they were combined in the following analysis. In the confederate's free choice condition, the settings were almost identical to those in the confederate's constrained choice condition, except that both exits were always open in each trial. Therefore, the experimental design was a 2 (confederate's choice: constrained vs. free) × 3 (majority size: small vs. medium vs. large) repeated-measures design. Furthermore, the medium majority size in which 3 confederates had only one option but 1 confederate had two options provided a better manipulation for the confederate's constrained choice condition, as it displayed the majority behavior formed under constrained choice. Even when only this type of medium majority size was included, similar results were found, as reported in the main text (see Supplementary Materials). Videos showing an example trial of each condition for all experiments can be accessed at https://osf.io/7xk4d/?view_only=db4130c8e5a3429ead1217b0da8a0f17.

Each condition had 20 trials, resulting in a total of 120 trials, since there were two types of medium majority size. To make the participants

believe that all of the avatars were controlled by real humans and help them be immersed in this game, 20 trials as the baseline condition and 40 filling trials were included. In the baseline condition, the participants were always the first to select an exit. In 12 of the filling trials, the remaining confederates did not always select the just opened exit in the condition of the confederate's constrained choice, and the designs of these 12 trials were also applied to the condition of the confederate's free choice, although both exits were always open. Additionally, in 16 trials, only one exit was available for escape when the real participant (i.e., the last avatar) made a choice. Hence, each participant completed 220 trials in total. The trials were divided into 4 blocks, each followed by a 2-min break, and were presented in random order. Each participant finished the entire experiment within 40 min. The design of each condition can be found in the Supplementary Materials.

2.1.4. Analysis

To examine how the confederate's choice affected the majority influence under different majority sizes, we measured the dependent variable by calculating the probability of adopting the majority choice as follows: the number of trials in which the participants selected the same exit as the majority's choice divided by the total number of trials in the corresponding condition (20). In the condition of a small majority size, the majority's choice was determined randomly.

Although the small majority size condition did not have a real majority, it was included in the analysis to determine whether participants showed a consistent preference for a particular choice and whether majority influence was dependent on the presence of majority behavior. It was expected that the probability of adopting the majority choice would be at the level of chance (i.e., 50%). Hence, the data used to demonstrate the probability of adopting the majority choice were subjected to a repeated-measures 2 (confederate's choice: constrained vs. free) × 3 (majority size: small vs. medium vs. large) ANOVA. The Greenhouse–Geisser Epsilon was used to adjust the degrees of freedom if needed (the uncorrected degrees of freedom were presented for simplicity), and post hoc contrasts were corrected with the Bonferroni method.

2.2. Results and discussion

As shown in Fig. 2, only when the participants were free to make a choice and real majority behavior (i.e., medium and large majority size) was at play was the probability of adopting the majority behavior above the level of chance (for statistics of all conditions, please see Table S1).

The ANOVA revealed that the main effect of the confederate's choice was significant ($F(1, 29) = 23.93$, $p < 0.001$, $\eta_p^2 = 0.45$), showing that the participants adopted the majority choice more frequently in the confederate's free choice condition ($M = 60.8\%$, $SE = 3.0\%$) than in the confederate's constrained choice condition ($M = 52.1\%$, $SE = 2.8\%$; $t(29) = 4.89$, $p < 0.001$, Cohen's $d = 0.30$, 95% CI of Cohen's $d = [0.17, 0.42]$). The main effect of majority size was significant ($F(2, 58) = 6.37$, $p = 0.003$, $\eta_p^2 = 0.18$). Post hoc comparisons showed that the probability of adopting the majority choice was higher in the large majority size condition ($M = 66.0\%$, $SE = 5.3\%$) than in both the medium ($M = 56.4\%$, $SE = 4.1\%$; $t(29) = 2.88$, $p = 0.022$, Cohen's $d = 0.65$, 95% CI of Cohen's $d = [0.08, 1.22]$) and small majority size conditions ($M = 47.1\%$, $SE = 2.5\%$; $t(29) = 3.17$, $p = 0.011$, Cohen's $d = 0.33$, 95% CI of Cohen's $d = [0.07, 0.59]$), but there was not a significant difference between the latter two conditions ($t(29) = 1.65$, $p = 0.331$, Cohen's $d = 0.32$, 95% CI of Cohen's $d = [-0.17, 0.81]$), suggesting that an increasing majority size increases the participants' propensity to adopt the majority choice.

The interaction effect between the two factors was significant ($F(2, 58) = 9.04$, $p < 0.001$, $\eta_p^2 = 0.24$). The simple effects analysis revealed that in the small majority size condition, the participants showed no difference in the tendency to adopt the majority choice between the confederate's free ($M = 47.5\%$, $SE = 2.9\%$) and constrained ($M = 46.7\%$, $SE = 2.9\%$) choice conditions ($t(29) = 0.30$, $p = 0.768$, Cohen's $d = 0.03$, 95% CI of Cohen's $d = [-0.17, 0.22]$). In the medium majority size condition, the participants were more likely to adopt the majority choice in the confederate's free choice condition ($M = 59.3\%$, $SE = 4.4\%$) than in the confederate's constrained choice condition ($M = 53.4\%$, $SE = 4.1\%$; $t(29) = 2.73$, $p = 0.011$, Cohen's $d = 0.20$, 95% CI of Cohen's $d = [0.05, 0.36]$), as well as in the large majority size condition (confederate's free choice: $M = 75.7\%$, $SE = 5.3\%$; confederate's constrained choice: $M = 56.3\%$, $SE = 6.0\%$; $t(29) = 4.67$, $p < 0.001$, Cohen's $d = 0.66$, 95% CI of Cohen's $d = [0.37, 0.95]$), but this difference was greater in the confederate's free choice than in the confederate's constrained choice condition ($t(29) = 2.81$, $p = 0.009$, Cohen's $d = 0.51$, 95% CI of Cohen's $d = [0.13, 0.89]$). Importantly, in the confederate's constrained choice condition, there was no significant difference between any of the paired conditions ($ts < 1.28$, $ps > 0.630$, Cohen's $d < 0.34$), but in the confederate's free choice condition, the participants were more likely to adopt the majority choice under the large majority size condition than under both the medium ($t(29) = 4.82$, $p < 0.001$, Cohen's $d = 0.56$, 95% CI of Cohen's $d = [0.26, 0.86]$) and small ($t(29) = 4.34$, $p < 0.001$, Cohen's $d = 0.97$, 95% CI of Cohen's $d = [0.40, 1.53]$)

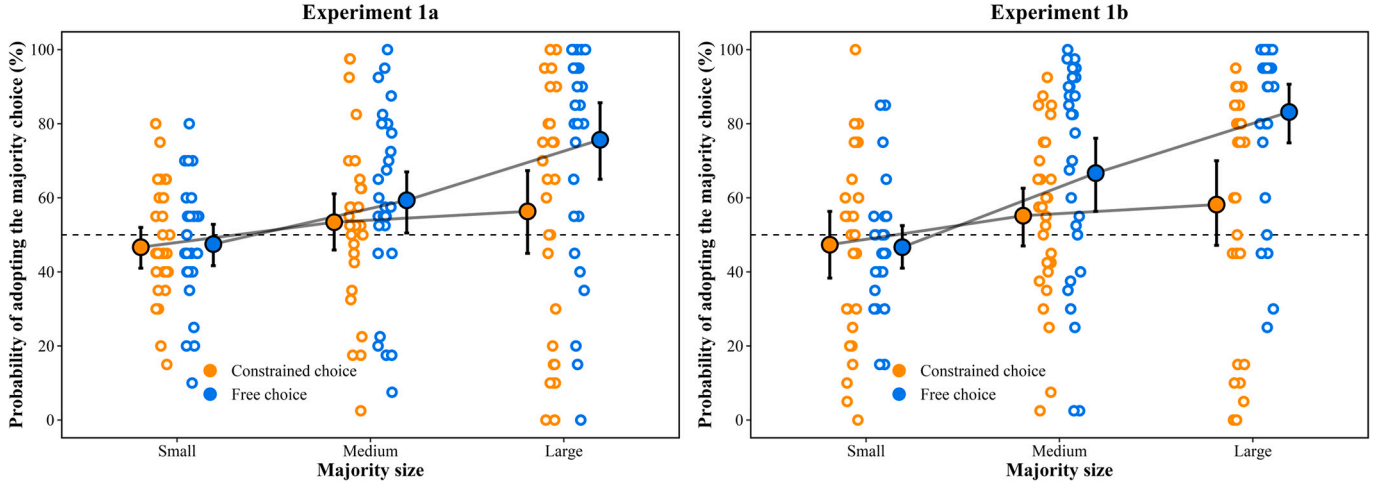

Fig. 2. Mean probability of adopting the majority choice in Experiment 1a and Experiment 1b as a function of the confederate's choice and majority size. The dots indicate the probability of adopting the majority choice for each participant in each condition. The large circles denote the means, and the black vertical lines indicate the confidence intervals (CIs) of the means. Notably, there is no majority behavior in the condition of small majority size, but for the sake of consistency in describing the level of majority size, we used the term "small majority size" to refer to this condition (similarly hereinafter).

majority size conditions.

This experiment showed that majority influence depends on how majority behavior is formed; people are more likely to adopt the majority choice when the majority have available alternatives than when they are constrained from making a common choice, which shows source-dependent majority influence. Importantly, only when people are free to make a choice does majority size exert an effect on majority influence.

3. Experiment 1b

Experiment 1a provided initial evidence that people follow the majority by probing the reason for majority behavior instead of purely attending to the apparent prevalent behavior. In the condition of the confederate's constrained choice, to ensure that the remaining confederates selected another option, two emergency exits were open. Namely, only the majority were constrained to make a choice, but the minority had available options to freely select. Hence, the size of the majority depended on how many made an unconstrained choice, resulting in a lack of complete orthogonality between the majority and constraint manipulations in Experiment 1a. This design aspect could introduce a confounding factor in the results. To address this issue and provide further replication of the findings from Experiment 1a, we also gave the minority in this experiment only one option in the constrained choice condition by opening an exit and closing another exit at the same time.

3.1. Methods

Thirty new adult volunteers (10 men and 20 women, mean age = 20.00 years, $SE = 0.39$) were paid 40 RMB each for participating in this experiment. Three additional participants were tested but excluded because they did not believe that the choices of the avatars in the fire escape game were manipulated by real humans. The procedure and design were almost the same as those in Experiment 1a, except as noted below. In the condition of the confederate's constrained choice (Fig. 3), when one exit was opened, another exit was closed. In this case, for all four confederates, even for the minority, they made a choice under the situation with choice constraints. Notably, when the real participant selected an exit, both exits were open, as in Experiment 1a.

3.2. Results and discussion

As depicted in Fig. 2, similar to Experiment 1a, it was only when participants were free to make a choice and real majority behavior (i.e., medium and large majority size) was in play that the probability of adopting the majority behavior surpassed chance levels (please refer to Table S2).

The ANOVA revealed that the main effect of the confederate's choice was significant ($F(1, 29) = 26.42$, $p < 0.001$, $\eta_p^2 = 0.48$), showing that the participants had a higher probability of adopting the majority choice in the confederate's free choice condition ($M = 65.5\%$, $SE = 2.5\%$) than in the confederate's constrained choice condition ($M = 53.6\%$, $SE = 2.6\%$; $t(29) = 5.14$, $p < 0.001$, Cohen's $d = 0.36$, 95% CI of Cohen's $d =$ [0.22, 0.50]). The main effect of majority size reached significance ($F(2, 58) = 8.86$, $p < 0.001$, $\eta_p^2 = 0.23$). Post hoc comparisons revealed that the probability of adopting the majority choice was higher in the large ($M = 70.7\%$, $SE = 4.2\%$) majority size condition than in both the medium ($M = 60.9\%$, $SE = 4.5\%$; $t(29) = 2.73$, $p = 0.032$, Cohen's $d = 0.29$, 95% CI of Cohen's $d =$ [0.02, 0.56]) and small ($M = 47.0\%$, $SE = 3.1\%$; $t(29) = 3.77$, $p = 0.002$, Cohen's $d = 0.71$, 95% CI of Cohen's $d =$ [0.23, 1.18]) majority size conditions, and the latter two conditions also did not have a significant difference ($t(29) = 2.11$, $p = 0.131$, Cohen's $d =$ 0.42, 95% CI of Cohen's $d =$ [−0.09, 0.92]). Hence, the greater that the majority size is, the more likely the participants are to adopt the majority behavior.

The interaction effect between the two factors was significant ($F(2, 58) = 7.68$, $p = 0.001$, $\eta_p^2 = 0.21$). The simple effect analysis revealed that in the large majority size, the participants were more likely to follow the majority's choice in the confederate's free choice condition ($M = 83.2\%$, $SE = 4.1\%$) than in the confederate's constrained choice condition ($M = 58.2\%$, $SE = 5.9\%$; $t(29) = 4.51$, $p < 0.001$, Cohen's $d =$ 0.75, 95% CI of Cohen's $d =$ [0.41, 1.09]). Similar results were found for the medium majority size (confederate's free choice: $M = 66.7\%$, $SE =$ 5.2%; confederate's constrained choice: $M = 55.2\%$, $SE = 4.1\%$; $t(29) =$ 4.02, $p < 0.001$, Cohen's $d = 0.34$, 95% CI of Cohen's $d =$ [0.17, 0.52]), but this difference was greater in the confederate's free choice condition than in the confederate's constrained choice condition ($t(29) = 2.15$, p = 0.040, Cohen's $d = 0.39$, 95% CI of Cohen's $d =$ [0.02, 0.76]). For the low majority size, there was no difference between the two choice conditions (confederate's free choice: $M = 46.7\%$, $SE = 3.0\%$; confederate's constrained choice: $M = 47.3\%$, $SE = 4.5\%$; $t(29) = -0.15$, $p =$ 0.883, Cohen's $d = -0.02$, 95% CI of Cohen's $d =$ [−0.30, 0.26]). As with Experiment 1a, in the condition of confederate's constrained choice, there was no significant difference between any paired condition ($ts < 1.26$, $ps > 0.650$, Cohen's $d < 0.33$), but in the confederate's free choice condition, the participants were more likely to adopt the majority choice under the large majority size condition than under both the medium ($t(29) = 3.63$, $p = 0.003$, Cohen's $d = 0.49$, 95% CI of Cohen's d = [0.15, 0.84]) and small ($t(29) = 6.42$, $p < 0.001$, Cohen's $d = 1.09$, 95% CI of Cohen's $d =$ [0.66, 1.52]) majority size conditions, and the latter two conditions had a significant difference as well ($t(29) = 2.78$, p = 0.028, Cohen's $d = 0.60$, 95% CI of Cohen's $d =$ [0.05, 1.14]).

Similar to Experiment 1a, this experiment revealed that when there was a majority behavior (i.e., medium and large majority sizes), the participants were more likely to follow this behavior when the majority was free to choose than when the majority was constrained to choose a particular option. Moreover, only when people are free to make a choice does increasing the majority size increase the propensity of people to adopt the majority behavior. Hence, people treat majority behavior from distinct sources differently, and majority behavior that largely reflects others' free choice exerts more social influence.

4. Experiment 2

Thus far, we have demonstrated that the source of majority influence affects the degree of influence on participant decisions. However, it is

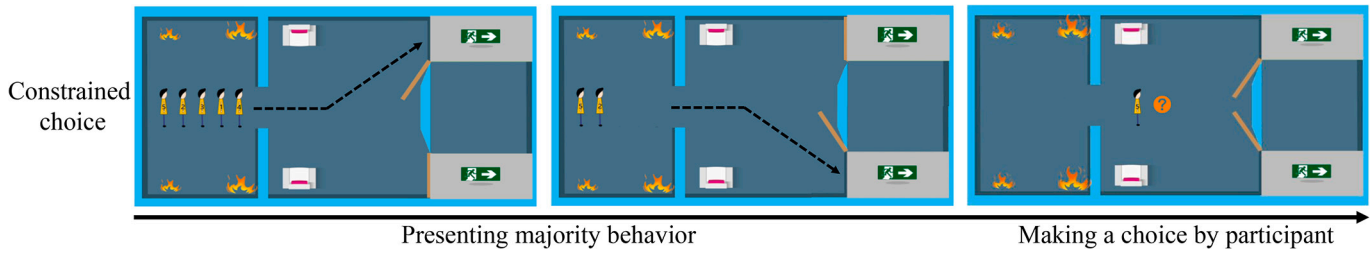

Fig. 3. An example of a trial sequence for the confederate's constrained choice condition in Experiment 1b. The dashed line indicates which exit the current avatar selects and is not presented in the experiment.

possible that the observed differences in participants' choices across different confederate's choice conditions can be attributed to nonsocial factors rather than social influence itself. This is because the physical environments (i.e., the doors' openness) were manipulated in the constrained choice conditions but not in the free choice condition, leading to distinct situational differences. Meanwhile, participants may have engaged in different forms of situational reasoning related to the functioning of the doors' openness in these distinct conditions. Furthermore, despite providing extensive instructions and creating a simulated procedure to convince participants that they were interacting with real individuals during the game, the social nature of majority influence observed in Experiment 1b requires further evidence, particularly when participants were aware that the other avatars were not controlled by real humans. In the current experiment, we maintained the same settings as in Experiment 1b but explicitly disclosed that the choices were determined by a computer algorithm (i.e., predetermined decision rules). While the situational features were still present, the social component of the confederates' decision-making process was removed. This methodology has been commonly employed in decision-making research to examine the social effects arising from human influence (Lamba, Frank, & FeldmanHall, 2020; Mahmoodi, Bahrami, & Mehring, 2018; Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). If the source-dependent majority influence is truly a social effect, it should not be observed in the current experiment.

4.1. Methods

Thirty new adult volunteers (16 men and 14 women, mean age = 21.73 years, $SE = 0.40$) were paid 40 RMB each for participating in this experiment. The procedure and design were the same as those in Experiment 1b, except as noted below. The four confederates remained in the experimental room, awaiting the arrival of the real participant. Once the real participant arrived, all five individuals were promptly escorted to separate compartments. Each participant was assigned an identification number by the experimenter to ensure an independent testing environment. The participants were told that the four avatars were controlled by the computer algorithm, not by a real human, and that they and the four persons would play the fire escape game independently in separate rooms at the same time. After they had completed the entire experiment, the participants had to answer the debriefing questionnaire, which asked whether they thought the choices of the other four avatars were controlled by a real human. All answered "No".

4.2. Results and discussion

As shown in Fig. 4, the probability of adopting the majority choice was above the level of chance only when the majority size was large (for statistics on all conditions, please see Table S3). The main effect of the confederate's choice was not significant ($F(1, 29) < 0.01$, $p = 0.980$, $\eta_p^2 < 0.01$), and the main effect of majority size did not reach significance ($F(2, 58) = 2.99$, $p = 0.058$, $\eta_p^2 = 0.09$). Unlike in Experiment 1b, the interaction effect of the two factors did not reach significance ($F(2, 58) = 0.04$, $p = 0.962$, $\eta_p^2 < 0.01$). To further examine whether the difference in following the majority between the confederate's choice conditions was due to social influence, we performed a between-experiment comparison with a 2 (confederate's type as a between-subjects factor: human vs. computer) × 2 (confederate's choice as a within-subject factor: constrained vs. free) × 3 (majority size as a within-subject factor: small vs. medium vs. large) ANOVA for the probability of adopting the majority choice, and a three-way interaction effect was found ($F(2, 116) = 3.29$, $p = 0.041$, $\eta_p^2 = 0.05$). This interaction occurred due to the probability of adopting the majority choice being modulated by the constraints faced by the majority when interacting with real humans in Experiment 2 but not being similarly modulated when the majority disclosed to be controlled by computers in Experiment 1b, as described above. Importantly, when the majority size was large, the difference in the likelihood of following the majority between the constrained and free choice conditions was larger when the confederates were real humans ($M = 25.0\%$; $SE = 5.5\%$) than when they were computers ($M = -0.2\%$; $SE = 5.3\%$; $t(58) = 3.29$, $p = 0.002$, Cohen's $d = 0.85$, 95% CI of Cohen's $d = [0.29, 1.39]$), and this was also the case when the majority size was medium ($M = 11.5\%$; $SE = 2.9\%$; $M = 1.0\%$; $SE = 4.3\%$; $t(58) = 2.04$, $p = 0.045$, Cohen's $d = 0.53$, 95% CI of Cohen's $d = [0.01, 1.05]$). Hence, the source-dependent majority influence is specific to situations in which humans are making choices, thus excluding the physical explanation and supporting the social influence explanation.

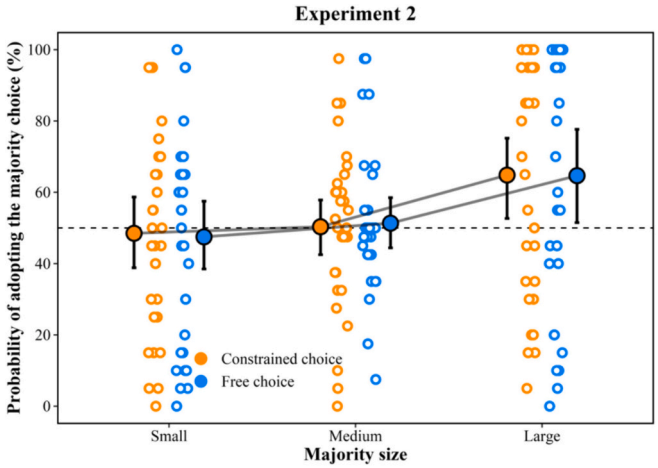

Fig. 4. Mean probability of adopting the majority choice in Experiment 2 as a function of the confederate's choice and majority size. The dots indicate the probability of adopting the majority choice for each participant in each condition. The large circles denote the means, and the black vertical lines indicate the confidence intervals (CIs) of the means.

5. Experiment 3

Previous experiments have provided evidence supporting the source-dependent majority influence and its social nature. This experiment aimed to replicate the results of Experiments 1b and 2 using a between-subjects design, which was preregistered for transparency. This design incorporated the confederate's type (human vs. computer) as a between-subjects factor. We also made modifications to enhance the credibility of the confederates' presence and the total sample size while reducing the task duration. If the source-dependent majority influence is indeed a social influence effect, we would expect to observe a pattern in which the influence of the majority depends on how the majority behavior is formed in the human condition. Conversely, we would anticipate the disappearance of this effect or weaker effect in the computer condition.

5.1. Methods

One hundred and two new adult volunteers were paid 20 RMB each for participating in this experiment, and each between-subjects condition had fifty-one participants (human condition: 22 men and 29 women, mean age = 20.59 years, $SE = 0.33$; computer condition: 23 men and 28 women, mean age = 20.71 years, $SE = 0.32$). Four additional participants were tested but excluded since in the human condition, they did not believe that the confederates were real humans, and one additional participant was tested but excluded in the computer condition because the experimental program crashed midway. The primary focus of the current experiment was to investigate whether the influence of the majority is dependent on how the majority behavior is formed. Specifically, we were interested in examining the interaction effect between the confederate's choice and the majority size, with a particular emphasis on the human condition. In the previous experiment

focusing on the source-dependent majority influence in the human condition, we collected data from 30 participants in Experiment 1b. We observed an F-value of 7.68 for the interaction effect. To determine the appropriate sample size for the planned study, we performed a power analysis using BUCSS (Anderson, Kelley, & Maxwell, 2017) for within-subjects ANOVA. We set the observed F-value at 7.68 and focused on the 2 × 3 interaction effect between the confederate's choice and majority size. The alpha level was set at 0.05 for both the previous and planned study, and the desired statistical power was set at 0.8 with a level of assurance of 0.8. Based on the power analysis, the calculated sample size was 51. Therefore, we aimed to collect 51 valid participants for each condition of the between-subjects variable. Additionally, as we reduced the number of trials of focused conditions by 40% compared to the previous experiment, if we maintained a similar number of testing trials, the sample size would need to increase to 50 in each between-subjects condition. A total of 51 valid participants would sufficiently meet these criteria. A sensitivity power analysis indicated that this sample size provided 80% power to detect an effect Cohen's $d \geq 0.40$ in different majority influence effects between two types of confederate's choice.

Participants were randomly assigned to one of two conditions: the human condition, where the avatars' choices were determined by real human confederates, and the computer condition, where the avatars' choices were determined by a computer algorithm using predetermined decision rules. The procedure and design for each condition were the same as in Experiment 1b and Experiment 2, with minor modifications. To create the illusion of genuine decision-making by the confederates, the waiting period for their decisions varied between 500 ms and 700 ms (this range was determined based on pilot experiments, which indicated that the average decision time for such a setting was approximately 600 ms). The number of trials was reduced to 12 in each within-subject condition to shorten the task duration, resulting in a total of 72 trials. The position of the majority was counterbalanced in both small and medium majority size conditions. The baseline condition with 20 trials was removed, as previous experiments have shown no evidence of participants exhibiting a preference for the position of the exit in this condition (see Supplementary Materials), but 40 filler trials were still included, resulting in a total of 112 trials per participant. The trials were presented in random order across two blocks with a 2-min break between blocks. The distribution of trials for each condition can be found in the Supplementary Materials. Following the reduction in the number of trials, each participant received a random allocation of points ranging from 45 to 55, which could be exchanged for 2.5 RMB, regardless of their performance.

In summary, the experimental design was a 2 (confederate's type as a between-subjects factor: human vs. computer) × 2 (confederate's choice as a within-subject factor: constrained vs. free) × 3 (majority size as a within-subject factor: small vs. medium vs. large). This experiment was preregistered and can be accessed at https://doi.org/10.17605/OSF.IO/FU8EN. Minorly different from the preregistered content, the reaction time was recorded starting from the onset of a question mark's presentation (i.e., when the participant's avatar arrived at the center of the room for making a choice). The reaction time was analyzed in an explorative manner, and no significant effect was found (see the Supplementary Materials).

5.2. Results and discussion

As depicted in Fig. 5, the probability of adopting the majority choice in each condition yielded similar results to the previous experiment when compared with chance levels (for detailed statistics, please refer to Table S4).

The 2 (confederate's type as a between-subjects factor: human vs. computer) × 2 (confederate's choice as a within-subject factor: constrained vs. free) × 3 (majority size as a within-subject factor: small vs. medium vs. large) ANOVA for the probability of adopting the majority choice revealed a three-way interaction effect ($F(2,200) = 3.79$, $p = 0.024$, $\eta_p^2 = 0.04$). We conducted a repeated-measures ANOVA with the factors of confederate's choice and majority size for each confederate's type to explore this effect further.

When the confederates were real humans, all effects were statistically significant (confederate's choice: $F(1, 50) = 30.28$, $p < 0.001$, $\eta_p^2 = 0.38$; majority size: $F(2,100) = 17.85$, $p < 0.001$, $\eta_p^2 = 0.26$; interaction: $F(2, 100) = 7.18$, $p = 0.001$, $\eta_p^2 = 0.13$). The results showed that the participants followed the majority choice more strongly in the confederate's free choice condition ($M = 61.1\%$, $SE = 1.8\%$) than in the confederate's constrained choice condition ($M = 51.6\%$, $SE = 1.3\%$; $t(50) = 5.50$, $p < 0.001$, Cohen's $d = 0.32$, 95% CI of Cohen's $d = [0.21, 0.44]$). Post hoc comparisons across majority sizes showed that the probability of adopting the majority choice was higher in the large majority size condition ($M = 67.0\%$, $SE = 3.0\%$) than in both the medium ($M = 53.9\%$, $SE = 2.3\%$; $t(50) = 3.57$, $p = 0.002$, Cohen's $d = 0.44$, 95% CI of Cohen's $d = [0.14, 0.75]$) and small majority size conditions ($M = 48.1\%$, $SE = 1.3\%$; $t(50) = 5.44$, $p < 0.001$, Cohen's $d = 0.64$, 95% CI of Cohen's $d = [0.35, 0.93]$). However, the difference between the latter two conditions did not reach significance ($t(50) = 2.39$, $p = 0.063$,

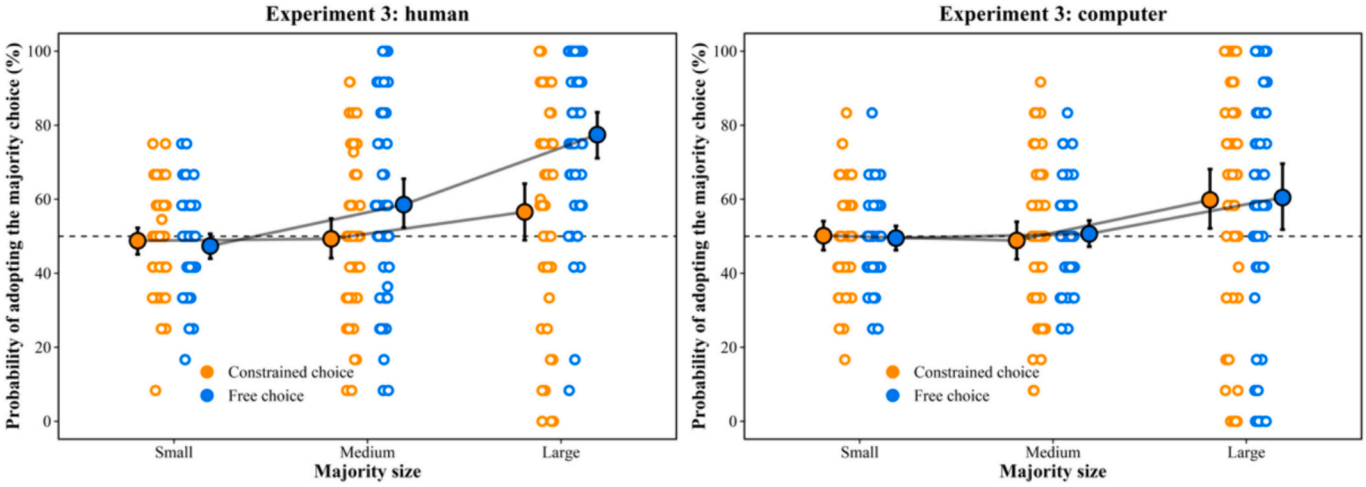

Fig. 5. Mean probability of adopting the majority choice in Experiment 3 as a function of the confederate's choice and majority size for each confederate's type. The dots indicate the probability of adopting the majority choice for each participant in each condition. The large circles denote the means, and the black vertical lines indicate the confidence intervals (CIs) of the means.

Cohen's $d = 0.20$, 95% CI of Cohen's $d = [-0.01, 0.40]$). These replicated previous findings, suggesting that an increasing majority size enhances the participants' tendency to follow the majority choice.

Concerning the interaction effect in the human condition, the simple effect analysis revealed that in the large majority size, participants were more likely to follow the majority's choice in the confederate's free choice condition ($M = 77.5\%$, $SE = 3.2\%$) than in the confederate's constrained choice condition ($M = 56.6\%$, $SE = 4.0\%$; $t(50) = 5.20$, $p < 0.001$, Cohen's $d = 0.71$, 95% CI of Cohen's $d = [0.43, 0.98]$), as well as in the medium majority size condition (confederate's free choice: $M = 58.6\%$, $SE = 3.5\%$; confederate's constrained choice: $M = 49.3\%$, $SE = 2.8\%$; $t(50) = 2.05$, $p = 0.045$, Cohen's $d = 0.31$, 95% CI of Cohen's $d = [0.01, 0.62]$). For the low majority size, there was no difference between the two choice conditions (confederate's free choice: $M = 47.4\%$, $SE = 1.8\%$; confederate's constrained choice: $M = 48.8\%$, $SE = 1.9\%$; $t(50) = -0.52$, $p = 0.606$, Cohen's $d = -0.05$, 95% CI of Cohen's $d = [-0.23, 0.14]$). Similar to Experiment 1, in the condition of the confederate's constrained choice, there was no significant difference between any paired condition ($ts < 1.61$, $ps > 0.340$, Cohen's $d < 0.27$). However, in the confederate's free choice condition, participants followed the majority choice more frequently under the large majority size condition than under both the medium ($t(50) = 4.82$, $p < 0.001$, Cohen's $d = 0.64$, 95% CI of Cohen's $d = [0.31, 0.97]$) and small ($t(50) = 8.26$, $p < 0.001$, Cohen's $d = 1.02$, 95% CI of Cohen's $d = [0.71, 1.32]$) majority size conditions. Furthermore, the latter two conditions had a significant difference as well ($t(50) = 2.67$, $p = 0.030$, Cohen's $d = 0.38$, 95% CI of Cohen's $d = [0.03, 0.73]$). Again, when the human acts as the confederate, the source-dependent majority influence is evident.

When the confederates were computers, unlike in the human condition, only the main effect of majority size was significant ($F(2, 100) = 4.07$, $p = 0.020$, $\eta_p^2 = 0.08$), and the main effect of the confederate's choice ($F(1, 50) = 0.15$, $p = 0.702$, $\eta_p^2 < 0.01$) and the interaction effect of the two factors ($F(2, 100) = 0.12$, $p = 0.884$, $\eta_p^2 < 0.01$) did not reach significance. Post hoc comparisons across majority sizes showed that no significant difference was found ($ts < 2.42$, $ps > 0.0.058$, Cohen's $d < 0.33$). Hence, when the confederate is a nonsocial entity of a computer, source-dependent majority influence becomes absent.

Similar to Experiment 2, we computed the difference in the likelihood of following the majority between the constrained and free choice conditions. It was found that when the majority size was large, this difference was more pronounced when the confederates were humans ($M = 20.9\%$; $SE = 4.0\%$) than when they were computers ($M = 0.7\%$; $SE = 3.9\%$; $t(100) = 3.62$, $p < 0.001$, Cohen's $d = 0.72$, 95% CI of Cohen's $d = [0.30, 1.13]$).

In summary, even by enhancing the credibility of the confederates' presence through minor modifications and reducing the total trials, the current experiment replicates almost all results from Experiments 1 and 2.

6. General discussion

The present study examined whether people consider the source of majority behavior in social influence and similarly follow the majority when their common behavior is formed under different choice situations. Experiment 1 showed that people are more likely to adopt the majority's choice when the majority has available alternatives than when they are constrained to make a common choice, and the pattern through which increasing the majority size increases the majority influence is only observed when the majority behavior is formed under the free choice condition. Importantly, when the majority behavior was featured as being created by a nonsocial entity—a computer algorithm—the source-dependent majority influence disappeared in Experiment 2, ruling out the possibility of influence by physical differences between the constrained and free choice situations. In Experiment 3, we employed a between-subjects design, incorporating the confederate's type (human vs. computer) as a between-subjects factor. We also extended the time duration for displaying the confederates' decision-making, increased the total sample size, and reduced the number of trials. Despite these adjustments, Experiment 3 successfully replicated the results observed in the previous two experiments. Taken together, these results show that people do not simply treat any form of majority behavior at face value but consider why the majority show consistent behavior, suggesting that people maximize information gains during their following of the majority behavior.

6.1. Alternatives for current findings

It can be argued that the current findings might be caused by the exploration of the newly opened exit (i.e., forced choice), hence showing a decreased rate of following the majority relative to all exits opening (i.e., free choice). If this is the case, regardless of the majority size, the participants should show a lower probability of adopting the majority choice when others are forced to make a choice than when they are free. However, this is not what we found, as there was no significant difference detected in this probability between the confederate's choice situations when the majority size was low, and even in the confederate's constrained choice condition, the probability of adopting the majority choice never fell below the chance level of 50%.

However, it is still possible for someone to argue that participants may have realized that they were not playing the game with real humans and that their behavior was primarily influenced by demand effects. Nonetheless, we implemented a range of instructions, simulated procedures, and debriefing measures to ensure that participants genuinely believed they were interacting with real individuals during the game. It is important to highlight that in a similar experimental setup, where the trial and environmental structures were identical but participants were explicitly informed that the choices of other avatars were determined by a computer algorithm, the source-dependent majority influence vanished. Furthermore, each condition, including filler trials, was repeated multiple times, and the order of trial presentation was randomized. This randomization of presentation made it challenging for participants to discern the specific aims of each condition and adopt a consistent strategy for each one.

Last, participants may be less motivated in scenarios where a computer algorithm is determining outcomes than in scenarios where real human agents determine the outcomes, which might account for the observed differences. However, the engagement and motivation reported by participants were similar between the human and computer conditions (please see the results in the Supplementary Materials). Hence, source-dependent majority influence is truly attributed to the social influence of majority behavior.

6.2. Contributions to situation-specific social influence

The current findings are in accordance with previous literature showing that the tendency to follow the majority increases with majority size (or the descriptive norm; Bond, 2005; Jachimowicz, Hauser, O'Brien, Sherman, & Galinsky, 2018; Schultz et al., 2007). Moreover, this paper demonstrates that when the human majority is free to make a common choice, the majority size impacts the majority influence, but when they are constrained or framed as a computer function rather than a true choice function, this effect is absent. Importantly, participants did not show majority bias (i.e., the probability of adopting the majority choice did not differ from 50%) when majority behavior was formed under constraints. Hence, people are sensitive to majority behavior in an informative rather than superficial manner. This source-dependent majority influence was supported by a situation-specific influence in which when the participant saw a confederate throw a bag in the trash in the same environment as he faced, he littered less than when a confederate threw a bag in the trash in a different environment (Reno et al., 1993). While the results of Reno et al. (1993) can be explained by the decay from memorizing the confederate's behaviors, the current study,

in any situation, gave the participants equal time to watch others' behaviors, thereby providing robust evidence of situation-specific social influence. This finding is also consistent with the fact that people consider how the majority opinion is formed when deciding whether to trust it (Desai et al., 2022; Richardson & Keil, 2022; Xie & Hayes, 2022). Hence, the source-dependent social influence is conclusive.

In our study, we found that whether the choice is free or constrained, which are specific to the experimental context, play a significant role in shaping majority behavior. This influence is primarily exerted through the constraints imposed by the physical environment, which provide cues that guide participants' behaviors. However, individuals may have different levels of knowledge about the same physical environment, which can also drive their behaviors (De Freitas, Thomas, DeScioli, & Pinker, 2019; Jara-Ettinger, Schulz, & Tenenbaum, 2020). For instance, in a scenario with two exits, one person might have a better understanding of the fire's location or the feasibility of each exit. This varying knowledge could affect how individuals perceive majority behavior. Specifically, the majority behavior of knowledgeable individuals within a group tends to have greater social influence, as their behaviors are perceived as more informative. Additionally, if a few knowledgeable individuals make different choices from the majority, who are less informed about the fire or exits, participants may be more inclined to follow the knowledgeable individuals. This is because while following the majority is a common strategy for maximizing gains, individuals also consider the knowledge level of group members in their decision-making processes. However, these speculations require further investigation to fully understand the dynamics of majority behavior in different situational contexts.

6.3. Cognitive mechanisms underlying majority influence

The convergence of following the majority dependent upon how the common behavior is shaped has noteworthy implications for the cognitive mechanisms underlying majority influence. It has been suggested that humans have evolved epistemic vigilance mechanisms to evaluate the reliability of communicated information and respond to cues that are accessible and deemed reliable in the environment, i.e., evolutionarily valid cues (Mercier & Morin, 2019; Sperber et al., 2010). The epistemic vigilance mechanisms could be used to evaluate the reliability of information transmitted by the majority in our experiments so that the majority choice formed under constraint could be given less weight, as it fails to provide reliable social information about which exit is safe. Similarly, in Experiment 2, when the majority choice is not driven by an informative human actor, it is also given less weight. Therefore, the way in which majority behavior is formed serves as a crucial evolutionarily valid cue for evaluating the reliability of social information. Therefore, our study provides solid evidence that rather than being a simple heuristic, following the majority accounts for rational factors to optimize information gains. However, it is not to say that only the main effect of majority size—i.e., following the majority regardless of how the majority behavior is formed—can be purely explained by being driven by a simple heuristic, as a larger majority can also lead to greater information gain. However, it is crucial to acknowledge that such information gain covaries with the size of the majority because altering the size of the majority can contribute to the cumulative effect of each confederate's influence (MacCoun, 2012). In our study, we manipulated the potential information gains transmitted by consistent majority behavior under different situational constraints. This manipulation provided a clear test of the rational component of majority influence, suggesting that individuals rationally account for, at least to some degree, how majority behavior is formed while following the majority.

The conclusion that people exhibit rational choice when following the majority does not imply that this process is necessarily deliberate. According to rational choice theory, choices are considered "rational" if they meet certain consistency criteria defined by decision theory and are appropriate for achieving specific goals within the constraints of the situation (Hechter & Kanazawa, 1997). The process of making such a rational choice can be automatic or unconscious, similar to the concept of unconscious inference proposed by Hermann von Helmholtz (for a review, see Turner, 1977) or Bayesian rationality in our cognition (Oaksford & Chater, 2009), as well as through deliberate rational deliberation. Alternatively, both automatic and defibrate processes may be involved in arriving at our rational choice, following a Gilbert-like process (Gilbert & Malone, 1995). Specifically, participants might initially process the majority influence automatically and then, through a more deliberate and controlled (correction phase) process, decide whether or not to follow it based on a careful consideration of their options. However, the exploratory analysis of reaction times in Experiment 3 does not seem to support such speculation, as the observed majority choice, whether made freely or under constraint, did not significantly influence decision time. This finding is not conclusive, as recorded reaction times may not strictly reflect decision times. Future studies could investigate how the two pathways in the dual-process model contribute to source-dependent majority influence.

Our findings are important for constructing computational models, especially for reinforcement learning, in which people update their beliefs about their surroundings by integrating social information according to its reliability. Previous studies have mainly emphasized majority size and general subjective confidence as signals to compute reliability (De Martino, Bobadilla-Suarez, Nouguchi, Sharot, & Love, 2017; Park et al., 2017). We found that the situational constraints for forming majority behavior should be considered, as situations in which the majority are free to make a common choice have greater reliability than situations in which they are constrained to make a common choice.

6.4. Limitations and future studies

Admittedly, this study has some limitations. First, considering that the participants may question the existence of confederates if their number is truly large, the majority size is set at a small number—four. It is important to increase the majority size to examine the generalizability of our findings with new methods, such as by designing an online web game. Second, the participants were required to avoid dangerous outcomes and may have been more cautious when taking other persons' behaviors into account; therefore, they were highly sensitive to the source of majority behavior. Our research raises the intriguing question of whether a similar effect can be observed in approach motivation, specifically when seeking out a location for rewards. We hypothesize that source-dependent majority influence may also manifest in approach behavior. This is because the informative value of the majority's actions depends on their knowledge and experience. While exploration might be beneficial for finding rewards in an unknown environment (Deffner et al., 2024), avoiding danger often prioritizes exploiting existing information, such as following the majority (Moussaïd et al., 2016). This asymmetry between exploration and exploitation could lead to different levels of source-dependent majority influence. For instance, when seeking rewards in a novel environment, individuals might be more inclined to explore a new location or exit even if they choose differently from the majority. However, when facing a potential threat, such as a fire, individuals might prioritize exploiting the knowledge of the majority, even if it means sacrificing some exploration. Third, while we have taken great care in providing instructions, designing procedures, and debriefing measures to enhance participants' beliefs in the authenticity of the confederates' presence, we acknowledge that the confederates' presence is ultimately fictitious.

To further increase the ecological validity of our findings, future studies could explore alternative methods. For instance, one possibility is to include a group of participants who make their choices online in a real-time scenario rather than relying on the illusion created by confederates. Additionally, virtual reality technology could be used to create highly immersive fire escape environments, allowing for a more

realistic and interactive experience. These approaches would contribute to maximizing the authenticity and ecological validity of the research. Finally, our study focused on a two-alternative choice setting where the majority's option was determined by >50% of participants. We believe that the findings from this setting can be generalized to contexts beyond two options. Our results suggest that individuals consider rational factors and aim to maximize information gains when following others. Even in situations without an absolute majority, the relative majority, defined as the option chosen by a larger proportion of individuals, has a stronger influence on herding behavior than the relative minority. This is because the former is socially valued and provides more information. Participants' preferences may exhibit a gradual increase from the most chosen option to the least chosen option, although the option chosen by the largest proportion of individuals may become the prevailing choice due to its perceived correctness or optimality. Further research is needed to explore the extension of source-dependent majority influence to scenarios with more than two options and to investigate participants' preferences between the second and third most chosen options.

7. Conclusion

To conclude, people do not simply treat any form of majority behavior at face value but distinguish between different sources of majority behavior and follow the majority according to how majority behavior is formed. This source-dependent majority influence highlights the fact that people account for rational factors when opting to follow the majority and that following the majority is a rational way to maximize information gains.

Author note

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The study titled "majority influence" 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. All data, analysis codes and videos showing different conditions have been made publicly available via the Open Science Framework and can be accessed at https://osf.io/7xk4d/?view_only=db4130c8e5a3429ead1217b0da8a0f17. Experiments 1 and 2 were conducted without preregistration, but Experiment 3 was preregistered and can be accessed at https://doi.org/10.17605/OSF.IO/FU8EN.

CRediT authorship contribution statement

Jun Yin: Conceptualization, Formal analysis, Funding acquisition, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Zikai Xu:** Conceptualization, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Jing Lin:** Conceptualization, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Wenying Zhou:** Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Xiuyan Guo:** Conceptualization, Supervision, Validation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesp.2024.104644.

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