Cognitive Control Strategies in Impression Formation under Perceptual Conflict: The Case of Stereotypical and Counter-stereotypical Information

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Abstract

Using stereotypical and counter-stereotypical information as examples, the semantic Stroop paradigm and a masked target-priming paradigm were employed to divide experimental tasks into high/low perceptual load or supraliminal/subliminal priming levels, examining the influence of perceptual load level and intensity of conflicting information on cognitive control strategies in impression formation of others. The results revealed: (1) The dynamic changes in conflict information priming methods and perceptual load determined individuals' cognitive control strategies for impression formation from stereotypical and counter-stereotypical information. Reactive control consumes fewer cognitive resources, processes impressions of stereotype-consistent information more quickly, but processes impressions of stereotype-conflicting information more slowly, and tends to activate counter-stereotypes; whereas proactive control consumes more cognitive resources, processes impressions of stereotype-consistent information more slowly, but processes impressions of stereotype-conflicting information more quickly, and tends to produce stereotypical bias. (2) Cognitive control adopts different processing modes for stereotypical and counter-stereotypical information. When stereotypical and counter-stereotypical information are simultaneously primed supraliminally, their processing is under the proactive control of the intentional operating system, that is, processing that is conscious and under intentional control; whereas when these two types of information are simultaneously primed subliminally, their processing is under the reactive control of the automatic monitoring system, that is, processing that is unconscious and not under intentional control. These results indicate that individuals, through perceived stereotypical and counter-stereotypical information, can flexibly trade off

between the two cognitive control systems (intentional operating system vs. automatic monitoring system), adjusting their weights (i.e., either initiating proactive control or biasing toward reactive control), thereby forming the most advantageous strategy for processing impressions of others. Even when below the perceptual threshold, individuals can still process impressions of others through unconscious cognitive control.

Full Text

Cognitive Control Strategies in Perceptual Conflict Impression Formation: An Example of Stereotyped and Counter-Stereotyped Information

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Abstract

Using stereotyped and counter-stereotyped information as examples, this study employed a semantic Stroop paradigm and a masked target-priming paradigm to manipulate experimental tasks across high/low perceptual load and supraliminal/subliminal priming conditions. We investigated how the perceptual load level and intensity of conflicting information influence cognitive control strategies in impression formation. The results revealed: (1) The interaction between conflict information priming method and dynamic changes in perceptual load determines individuals' cognitive control strategies for processing stereotyped and counter-stereotyped information. Reactive control consumes fewer cognitive resources, facilitating faster impression processing of stereotype-consistent information while slowing processing of stereotype-conflicting information and readily activating counter-stereotypes. Conversely, proactive control consumes more cognitive resources, slowing impression processing of stereotype-consistent information while accelerating processing of stereotype-conflicting information, and is prone to stereotype bias. (2) Cognitive control employs distinct processing modes for stereotyped versus counter-stereotyped information. When both types of information are primed supraliminally, their processing is governed by proactive control from the intentional operating system—that is, conscious, controlled processing. When both types of information are primed subliminally, their processing is governed by reactive control from the automatic monitoring system—that is, unconscious, uncontrollable processing. These findings demon-

strate that individuals can flexibly balance and adjust the weighting of two cognitive control systems (intentional operating system vs. automatic monitoring system) based on perceived stereotyped and counter-stereotyped information, thereby regulating whether proactive or reactive control is engaged to form the most advantageous impression processing strategy. Even below perceptual threshold, individuals can process impressions of others through unconscious cognitive control.

Keywords: stereotype activation; conflict information priming method; cognitive control strategy; proactive control; reactive control

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The question of whether stereotype activation is truly automatic has long been debated. Early research found that when presented with stereotypical information about a group member (e.g., trait constructs, behavioral characteristics), such information often receives prioritized processing, and the associated stereotype becomes activated automatically and inevitably (Banse, Seise, & Zerbes, 2001; Clow & Esses, 2007; Ito & Urland, 2003). As research has progressed, the view that "stereotype activation is a conditional automatic process influenced by multiple cognitive factors" has gained increasing attention (Posten & Mussweiler, 2013), involving category information, cue signals, directed attention (Radvansky, Copeland, & Hippel, 2010), interpersonal trust (Posten & Mussweiler, 2013), perspective-taking (Skorinko, Sinclair, & Conklin, 2012), social cognitive goals (Hoza, Bukowski, & Beery, 2000), mental imagery (Jia et al., 2012), perceiver age (Radvansky et al., 2010), and individual construal levels (Cui & Wang, 2018). Category information influences stereotype priming through a spreading activation process, wherein various conceptualized attributes form a network structure. By establishing connections between social categories and stereotypical traits, activation of a particular social group representation ultimately forms a stereotype (Quadflieg & Macrae, 2012). Specifically, when encountering a group member, the category information is rapidly activated, transmitting neural excitation from the perceiver' s group concept node to connected stereotype feature nodes, thereby facilitating rapid responses to information consistent with the primed category. If we apply schema theory (Hamilton & Trolier, 1986) to describe the semantic representation structure of social categories, these categories exhibit a typical schematic structure of stereotyped information. Correspondingly, the relationship between social categories and stereotyped information has been confirmed by subsequent experiments: social categorization is a prerequisite for stereotype formation, and activating a social category consequently increases the probability of stereotype activation (Rim, Uleman, & Trope, 2009).

Recent researchers have explained how social categories prime stereotyped information from a perceptual conflict perspective (Bartholow & Dickter, 2008; Conrey, Sherman, Gawronski, Hugenberg, & Groom, 2005). When category information (the prime) matches stereotyped information (the target stimulus), their tendencies to activate stereotypes are congruent, accelerating responses to

stereotyped information. When the primed category information mismatches stereotyped information, their activation tendencies oppose each other, thereby slowing responses to stereotyped information. This processing mode clearly operates on the basis of associations between stereotyped information and processing goals, exerting parallel facilitative or inhibitory effects (i.e., facilitating stereotype activation while inhibiting counter-stereotypes) to form relatively consistent impressions of others. However, when stereotyped information is disrupted by other information—or even influenced by counter-stereotyped information (information conflicting with stereotype-consistent information)—does the associated stereotype still become activated? Häfner and Stapel (2009) found that when stereotyped information is disrupted by counter-stereotyped information, additional cognitive resources are required to internalize the counter-stereotyped information into the cognitive schema, thereby enhancing processing of counter-stereotypical information in impression formation and reducing stereotype activation. This suggests that stereotype activation is influenced by information processing type. But when both types of conflicting information —stereotyped and counter-stereotyped—are subliminally primed, how do these processing types affect stereotype activation?

Researchers have compared the mechanisms of supraliminal versus subliminal cues on cognitive control by manipulating the presentation duration of cue stimuli and masking stimuli (Aarts, Custers, & Marien, 2008; Jimura, Locke, & Braver, 2010; Savine & Braver, 2010). Studies show that after being primed by relevant cues, perceivers retrieve attributes about a social group from long-term memory. This information processing constitutes a rapid, implicit perceptual readiness process comprising two stages: social categorization based on stereotyped information and stereotype activation based on extracted social categories (perceptual readiness processing; Rüsch & Corrigan, 2011). These two stages belong to two parallel processing systems: the former involves the intentional operating system, while the latter involves the automatic monitoring system. Unlike the intentional operating system, the automatic monitoring system does not require conscious processing and accompanies the entire impression formation process. In contrast, the intentional operating system requires active effort to draw cognitive resources into consciousness and fails to function when cognitive resources are depleted. When achieving a specific goal, these two systems flexibly and optimally coordinate multiple impression processing operations, with enhancement of one system necessarily diminishing the role of the other (Evans & Coventry, 2006; McCulloch, Ferguson, Kawada, & Bargh, 2008). Consequently, these dual cognitive systems enable individuals to regulate themselves based on perceptual selection, response bias, and real-time situational updates to adaptively process impressions of current perceptual objects (Custers & Aarts, 2010). According to the dual mechanisms of cognitive control (DMC) account, people flexibly employ proactive or reactive control across different contexts, thereby influencing stereotype activation and its intensity (Braver, 2012; Savine & Braver, 2010).

Robertson and Weiss (2017) further noted that supraliminal and subliminal

priming produce distinct effects: individuals exhibit more strategic control under supraliminal priming, whereas subliminal priming leads to more automatic responses. That is, supraliminally presented information enables conscious action—participants can respond using anticipatory strategies based on instructions or stimulus relationships. In contrast, subliminally presented information produces more automatic, uncontrollable responses. Previous research found that, like supraliminal priming, subliminal priming also facilitates sustained processing of goal-relevant information during impression formation and enhances executive control (Capa, Bustin, Cleeremans, & Hansenne, 2011). Other studies indicate subtle differences between supraliminal and subliminal priming in impression processing: when perceiving conflicting information, supraliminal priming yields faster and more efficient performance, whereas subliminal priming produces slower and more accurate performance. Compared to supraliminal priming, participants are less susceptible to irrelevant information under subliminal priming and show improved discrimination rates for second target stimuli in attentional blink tasks (Bijleveld, Custers, & Aarts, 2011). Task-state fMRI research reveals that supraliminal and subliminal priming activate rapid-initiation control systems and stable-maintenance control systems, respectively (Spielberg, Miller, Heller, & Banich, 2015). During subliminal priming, functional connectivity strength between brain regions changes, with the right inferior frontal sulcus and right anterior insula occupying network node and core positions, while dorsal anterior cingulate coupling with other regions significantly increases. During supraliminal priming, the dorsomedial prefrontal cortex (dMPFC) plays a dominant role—a key region for attentional control and emotional processing (Spielberg et al., 2015).

In summary, the perceptual conflict monitoring mechanism in impression formation represents a high-level cognitive activity regulated by both supraliminal and subliminal priming. When different types of information are presented simultaneously and conflict with each other, what cognitive control strategies does impression formation employ? Do the two cognitive control strategies operate simultaneously or independently across stages? Context-specific prime effects (CSPC) experiments demonstrate that setting different conflict-ratio modules can induce response expectations for conflict or non-conflict information (generated by varying conflict ratios across contexts) and maintain sustained priming of these expectations (Bailey, West, & Anderson, 2010). By pre-establishing contexts with different conflict ratios, these experiments better elicit top-down processing of information and dissociate different cognitive control strategies. Results indicate that proactive and reactive control are independent and mutually exclusive, operating at different stages of impression formation.

Contrary to these findings, other researchers have discovered that from a perceptual conflict perspective, although proactive and reactive control are independent, individuals can simultaneously employ both strategies during impression formation (Bugg & Braver, 2015). Proactive control requires mobilizing more cognitive and physiological resources to maintain cue priming, making it more effective for resolving perceptual conflicts. However, because proactive control

relies heavily on cues, its advantages diminish when cues are unreliable, response preparation is prolonged, or unexpected information is frequent—circumstances where reactive control becomes more effective (Garavan & Weierstall, 2012).

Currently, few studies have directly examined the relationship between stereotype processing and cognitive control strategies. To address these discrepancies, this study hypothesizes: (1) When stereotyped and counter-stereotyped information are presented simultaneously (creating perceptual conflict), high perceptual load will lead impression formation to be influenced by reactive control, readily activating counter-stereotypes; whereas low perceptual load will lead impression formation to be influenced by proactive control, producing stereotype bias. (2) Cognitive control employs different processing modes for stereotyped versus counter-stereotyped information. When both types of information are primed supraliminally, their processing is governed by proactive control from the intentional operating system—that is, conscious, controlled processing. When both types of information are primed subliminally, their processing is governed by reactive control from the automatic monitoring system—that is, unconscious, uncontrollable processing.

Experiment 1: Cognitive Control Strategies in Impression Formation of Stereotyped and Counter-Stereotyped Information Under Different Perceptual Load Levels

2.1.1 Participants

We recruited 86 undergraduate students (balanced gender) from a university, aged 18–23 years (M = 22.65, SD = 1.89). All had normal or corrected-to-normal vision and had not previously participated in similar experiments. Participants received compensation upon completion.

2.1.2 Materials

Most social cultures share relatively stable and similar understandings of "gender," resulting in comparable male and female stereotype characteristics across different countries, ethnicities, and cultures. For example, "gentle" and "virtuous" are universally common stereotypical traits for women, while "masculine" and "strong" are typical for men. Experimental stimuli consisted of "target-distractor" pairs, using gender-descriptive trait words (e.g., masculine, gentle) as target stimuli and gender attribute words "male" and "female" as distractors. Through pilot testing, we selected 34 trait words describing men and 34 describing women (male-positive traits (29)/female-positive traits (31) = 0.94; male-negative traits (5)/female-negative traits (3) = 1.67). The formal experiment used 60 gender trait words, with the remaining 8 for practice. Selection proceeded as follows: First, we compiled an open-ended gender trait word questionnaire, asking freshmen and seniors (N = 160) to write as many two-character words as possible describing typical male and female characteristics. High-frequency words (frequency > 70%) were selected. Next, we combined

these with trait words from previous research to create a Gender Typicality Questionnaire, using rating scales with freshmen and seniors (N = 100) to score and rank the typicality of collected words, selecting the top 30% (74 words). Finally, we referenced the *Commonly Used Modern Chinese Vocabulary* (Thesaurus Research Group, 2008) to select 68 words with usage rates above 70%. Selected materials were created as BMP images in 26-point Song font using Adobe Photoshop CS1.

2.1.3 Design

We employed a 2 (perceptual load: high vs. low) × 2 (perception of gender trait words and gender attribute words: conflict vs. compatible) mixed design, with perceptual load as a between-subjects variable. Dependent measures were response time and error rate on the Stroop task.

2.1.4 Procedure

We used a "gender-trait" conflict and compatibility semantic Stroop paradigm (Algom, Chajut, & Lev, 2004) to manipulate perceptual load. In the low-load condition, a gender trait word (target) appeared above a same-gender attribute word (e.g., "grumpy-male"). In the high-load condition, a gender trait word appeared flanked on both sides by gender attribute words, one compatible and one conflicting (e.g., "male-grumpy-female"). This paradigm' s rationale derives from constructivist Stroop theory: word reading is automatic processing, while gender judgment is controlled processing. Word reading can facilitate or interfere with gender judgment, but not vice versa (Melara & Algom, 2003). Thus, this paradigm can dissociate cognitive control strategies in impression formation when stereotyped and counter-stereotyped information exist in perceptual conflict.

Instructions: "First, a white '+' fixation point will appear at the center of the screen. Please focus on this point. Next, a word describing a gender trait will appear. Judge the gender described by the word: press 'J' if you think it describes a male, and 'F' if it describes a female. Please respond quickly and accurately. Press the spacebar to begin the practice phase." Other procedures matched Experiment 1 (see Figure 1 [Figure 1: see original paper]). For each participant, experimental condition sequences and stimulus combinations were randomly generated under constrained conditions. Presentation software randomized experimental conditions to ensure equal probability of each sub-condition (high-load-conflict, high-load-compatible, low-load-conflict, low-load-compatible) following any other sub-condition. Each participant received a different condition sequence to avoid systematic effects from a single sequence. Participants rested for 2 minutes after each block. Before the experiment, participants completed 20 practice trials (two two-character trait words each for males and females, each presented five times randomly) to familiarize themselves with the task.

2.2.1 Effects of Stereotype-Consistent Information and Perceptual Load on Impression Processing Strategies

We analyzed data using SPSS 18.0. To examine whether stable perceptual load effects were obtained in stereotype processing, we conducted a 2 (perceptual load) × 2 (perception of gender trait words and gender attribute words) repeated measures ANOVA (see Table 1 and Figure 2 [Figure 2: see original paper]). We calculated mean response times and accuracy for each sub-condition, excluding incorrect responses. Extreme values beyond M ± 3SD were removed for each participant in each sub-condition, eliminating 4.5% of data.

Results showed a significant main effect of perceptual load, $F(1,80) = 2.98$, $p < 0.05$, $p^2 = 0.39$. The main effect of conflict was not significant, $F(1,80) = 0.13$, $p > 0.5$. The interaction approached significance, $F(1,80) = 3.38$, $p = 0.052$, $p^2 = 0.09$. Simple effects analysis revealed that under conflict between gender trait words and gender attribute words, high versus low perceptual load did not produce differences in mean impression processing times for these word types (624 ms vs. 591 ms), $F(1,80) = 1.35$, $p > 0.1$. However, under compatible conditions, participants in the high-load condition showed significantly longer impression processing times for gender trait and attribute words than those in the low-load condition (638 ms vs. 577 ms), $F(1,80) = 2.04$, $p < 0.05$, $p^2 = 0.15$. This indicates that impression processing of stereotype-consistent information is modulated by perceptual load, manifesting as two distinct cognitive control strategies (proactive vs. reactive control). Similarly, when stereotyped and counter-stereotyped information were presented simultaneously, high-load participants showed shortened impression processing times compared to stereotype-consistent-only conditions (-14 ms), while low-load participants showed prolonged times (+14 ms), thus eliminating the perceptual load effect. Evidently, reactive control consumes fewer cognitive resources, enabling faster impression processing of stereotype-consistent information but slower processing of stereotype-conflicting information while readily activating counter-stereotypes. Proactive control consumes more resources, slowing processing of stereotype-consistent information while accelerating processing of stereotype-conflicting information, and is prone to stereotype bias.

2.2.2 Effects of Conflict Between Stereotyped and Counter-Stereotyped Information on Impression Processing Strategies

To further test our hypotheses, we conducted the same ANOVA on mean error rates (see Figure 3 [Figure 3: see original paper]). Extreme values beyond M ± 3SD were removed for each participant in each sub-condition, eliminating 0.9% of data. Results showed a significant main effect of perception type, $F(1,83) = 1.76$, $p < 0.05$, $p^2 = 0.22$. The main effect of perceptual load was not significant, $F(1,83) = 0.88$, $p > 0.1$, nor was the interaction, $F(1,83) = 0.29$, $p > 0.5$. This suggests that when stereotyped and counter-stereotyped information are presented simultaneously, impression formation under reactive control readily activates counter-stereotypes. Compared to stereotype-consistent-only

conditions, this impression processing shows shortened response times and reduced accuracy (M error rate = 0.078). Conversely, when both information types are stereotype-consistent, decreased perceptual load enhances proactive control, shortening response times and improving accuracy (M error rate = 0.075). Thus, the two cognitive control strategies do not operate in parallel but function sequentially at different impression processing stages.

In impression formation, individuals typically take cognitive shortcuts, processing stereotypes based on others' social categories. This process is closely related to the automatic expression and regulation of cognitive control, making impression processing of others appear unconscious, rapid, and automatic (Sherman et al., 2009). According to stereotype processing theory, stereotypes are stored as schemas in individuals' cognitive systems. When others' information is incomplete or cognitive resources are limited, stereotypes function as "filters," enabling selective attention to consistent information while ignoring inconsistent information, thereby helping individuals quickly capture valuable information about others in complex situations. When automatically activated stereotypes conflict with counter-stereotyped information, cognitive control must suppress the counter-stereotyped information, increasing response times (Conrey et al., 2005).

Previous research has found a clear gender stereotype advantage effect in impression formation: individuals more easily remember and retrieve stereotype-consistent rather than counter-stereotypical information (Cui & Wang, 2016). Conversely, other researchers argue that counter-stereotyped information holds greater attentional processing advantages: when individuals focus more on counter-stereotyped information, they tend to invest more cognitive resources (Macrae & Quadflieg, 2010). Our hypotheses were partially confirmed in Experiment 1: when stereotyped and counter-stereotyped information conflicted (e.g., describing women as rugged or brave, or men as delicate or gentle), impression processing was susceptible to reactive control. When substantial cognitive resources were expended, stereotype semantic conflict effects were activated, generating proactive control strategies that inhibited selective attention. Experiment 1 further revealed that reactive control consumes fewer resources, enabling faster impression processing of stereotype-consistent information but slower processing of stereotype-conflicting information while readily activating counter-stereotypes. Proactive control consumes more resources, slowing processing of stereotype-consistent information while accelerating processing of stereotype-conflicting information, and is prone to stereotype bias. These patterns emerge because mental representations of compound categories are more complex than single categories: whether for ingroup or outgroup stereotypes, people tend to use abstract representations for stereotype-consistent information but exemplar-based representations for stereotype-conflicting information (Klein, Clark, & Lyons, 2010). Therefore, when simultaneously presented gender-stereotypical information is consistent (e.g., "male-masculine"), people tend to use compound categories for abstract representation (e.g., "rugged-brave"). When the two types of gender-stereotypical information conflict (e.g., "female-masculine"),

category reconciliation strategies become ineffective, and people may use single categories for exemplar representation (e.g., a gentle female face or a masculine male face).

In summary, impression formation for stereotype-consistent information is clearly modulated by perceptual load, with flexible allocation based on overall cognitive resource availability. When resources are relatively ample, individuals can allocate cognitive resources appropriately, forming top-down proactive control strategies that activate stereotypes. When resources are relatively scarce, individuals can quickly implement bottom-up reactive control, leading to stereotype bias. Conversely, when stereotyped and counter-stereotyped information conflict, impression formation under reactive control readily activates counter-stereotypes. Research shows that subliminal cues can influence impression formation cognitive control strategies through unconscious means (Aarts et al., 2008). When stereotyped and counter-stereotyped information are subliminally primed, does the cognitive control mechanism regulating impression formation effectively inhibit stereotype activation? How do cognitive control strategies differ between subliminal and supraliminal priming? Does this priming effect bias toward proactive or reactive control? When the intensity of the two conflicting information types changes, do impression control strategies adjust accordingly? No research has directly addressed these questions. Therefore, Experiment 2 builds on Experiment 1 to further explore how conflicting information of different intensities influences cognitive control in impression formation.

Experiment 2: Cognitive Control Strategies in Impression Formation of Stereotyped and Counter-Stereotyped Information Under Different Priming Methods

3.1.1 Participants

Ninety-eight third- and fourth-year university students majoring in management, sociology, literature, and law (age 20–25, M = 21.56, SD = 2.35) with no prior psychology experiment experience participated. Classification procedures identified 86 valid participants (12 with error rates >20% were excluded), including 39 males and 47 females. All participated voluntarily.

3.1.2 Design

We employed a 2 (conflict information priming method: supraliminal vs. subliminal) × 2 (perception of two gender trait word types: conflict vs. compatible) mixed design, with priming method as a between-subjects variable. The dependent variable was the emotional valence response ratio elicited by priming stimuli and applied to target stimuli, testing whether cognitive control strategies in impression formation differed significantly across priming methods. Based on emotional schema theory (Matsumoto et al., 2006; Meltzer & Nielson, 2010), this dependent measure was designed on the principle that different emotional

experiences evoke different cognitive control strategies. Specifically, individuals' emotional processing of external information gradually generates positive or negative cognitive schemas in the brain, which exert top-down control, prompting individuals to adopt different cognitive control strategies (when individuals experience clear emotions, impression processing employs reactive control; when no clear emotional experience occurs, proactive control is used). Additionally, to examine potential processing speed differences across priming methods, we also analyzed reaction times as a dependent variable.

For experimental materials, we employed the Affect Misattribution Procedure (AMP) (Payne, 2005), causing participants to unconsciously project emotions elicited by priming stimuli onto target stimuli (Sanskrit characters) of ambiguous meaning, thereby influencing impression formation cognitive control strategies.

3.1.3 Materials

First, we selected 226 gender trait words from previous stereotype research and the *Commonly Used Modern Chinese Vocabulary* (Thesaurus Research Group, 2008). An independent sample of 40 undergraduates and graduates rated these words on a 7-point gender bias scale (1 = extremely masculine, 7 = extremely feminine). We selected 136 words with clear gender bias and matched word properties and familiarity. Next, we randomly selected 136 Sanskrit characters and had another 40 undergraduates and graduates rate them on three dimensions using 5-point scales: emotional valence (5 = very pleasant to 1 = very unpleasant), arousal (5 = very exciting to 1 = very depressing), and familiarity (5 = very common to 1 = very rare). Results showed M_valence ± SD = 3.04 ± 1.35, M_arousal ± SD = 2.98 ± 1.42, M_familiarity ± SD = 1.07 ± 1.28, with significant positive correlations between all dimensions (r_valence-arousal = 0.79, $p < 0.01$; r_valence-familiarity = 0.56, $p < 0.01$; r_arousal-familiarity = 0.62, $p < 0.01$). Sanskrit characters differed significantly from gender trait words in emotional valence ($t(136) = 27.64$, $p < 0.001$, $d = 0.735$). Finally, selected materials were prepared for experimental use.

3.1.4 Procedure

The entire experiment was programmed in E-Prime 2.0. Participants were instructed to focus on the central fixation point, minimize blinking, and avoid head or body movements. The display background was black, positioned 80 cm from participants, with stimuli presented as white text on black background. Participants first completed practice trials to familiarize themselves with the procedure. After 24 practice trials, they proceeded to the formal experiment, which comprised 4 blocks of 34 trials each, with 2-minute rest periods between blocks.

Each trial consisted of three phases: (1) Prime presentation: Gender trait words were randomly paired and presented as 136 prime images, including 68 conflict

images (“male trait + female trait”) and 68 compatible images (“male trait + male trait” and “female trait + female trait,” 34 each). Each trait word pair was arranged vertically and presented simultaneously. (2) Target presentation: Following a white screen (ISI = 100 ms), a Sanskrit character image (target) appeared. (3) Mask presentation: A gray square mask appeared, and participants judged the target’ s emotional valence as quickly as possible (press ‘F’ for pleasant, ‘J’ for unpleasant).

Supraliminal priming instructions: “When you see the white ‘+’ fixation point, focus on the upcoming image and categorize the words by gender. Next, an unfamiliar character will appear. Press ‘F’ if it seems pleasant, ‘J’ if unpleasant. Then complete the gender categorization task: press ‘D’ if both words describe male traits, ‘K’ if both describe female traits, and spacebar if they describe opposite genders. Press spacebar to begin practice.” Supraliminal primes remained until the first keypress (1000 ms), then proceeded to phases 2 and 3 (see Figure 4 [Figure 4: see original paper]).

Subliminal priming instructions: “When you see the white ‘+’ fixation point, focus on the unfamiliar character that appears. Press ‘F’ if it seems pleasant, ‘J’ if unpleasant. Press spacebar to begin.” Prime images in phase 1 were presented for 30 ms, followed by phases 2 and 3 (see Figure 4).

3.2.1 Emotional Valence Under Different Conflict Information Priming Methods

We analyzed data using SPSS 18.0. Participants with reaction times <300 ms or >1500 ms or with <80% valid data were excluded (2.3% of total). Using emotional valence response ratio as the dependent variable, we conducted a 2 (priming method) × 2 (perception of two gender trait word types) repeated measures ANOVA (see Figure 5 [Figure 5: see original paper]).

Results showed a significant main effect of perception type, $F(1,82) = 14.86$, $p < 0.001$, $p^2 = 0.16$; a significant main effect of priming method, $F(1,82) = 32.56$, $p < 0.001$, $p^2 = 0.43$; and a significant interaction, $F(1,82) = 16.85$, $p < 0.001$, $p^2 = 0.18$. Simple effects tests revealed that under both conflict and compatible perspectives, subliminal priming produced stronger emotional valence responses to Sanskrit characters than supraliminal priming ($F\_conflict(1,82) = 7.62$, $p < 0.001$, $p^2 = 0.43$; $F\_compatible(1,82) = 2.86$, $p = 0.005$, $p^2 = 0.10$). These results indicate that when categorical and individual information conflict at a subliminal level, impression formation is influenced by reactive control, producing clear emotional experiences. When such information conflicts at a supraliminal level, impression formation is influenced by proactive control, producing no clear emotional experience.

3.2.2 Reaction Time Differences in Impression Processing Across Priming Methods

All raw reaction time data were natural log-transformed. Using natural log-transformed reaction times as the dependent variable, we conducted a 2 (priming method) × 2 (perception of Chinese names and gender trait words) repeated measures ANOVA (see Table 2 and Figure 6 [Figure 6: see original paper]).

Results showed a significant main effect of perception type, $F(1,82) = 9.77$, $p < 0.005$, $p^2 = 0.11$; a significant main effect of priming method, $F(1,82) = 10.96$, $p < 0.001$, $p^2 = 0.12$; and a significant interaction, $F(1,82) = 12.73$, $p < 0.001$, $p^2 = 0.14$. Simple effects tests revealed that under conflict perspectives, subliminal priming produced significantly shorter impression processing times for Sanskrit characters than supraliminal priming, $F(1,82) = 4.77$, $p < 0.001$, $p^2 = 0.23$. Under compatible perspectives, subliminal priming also produced shorter times than supraliminal priming, but the difference was not significant, $F(1,82) = 1.15$, $p > 0.1$.

These results indicate that when stereotyped and counter-stereotyped information are supraliminally primed, the intentional operating system implements proactive control, consuming more mental resources and processing more slowly, thus resisting stereotype interference. When such information is subliminally primed, the automatic monitoring system implements reactive control, consuming fewer resources and processing more quickly, thus being susceptible to stereotype influence.

Experiment 2 confirms that the intentional operating system and automatic monitoring system exhibit flexibility and modifiability in impression processing (Awh, Belopolsky, & Theeuwes, 2012). Under supraliminal priming, the intentional operating system implements proactive control, consuming more resources, processing more slowly, and relying more on rationality, enabling individuals to suppress trait judgments of others and resist stereotype interference. Under subliminal priming, the automatic monitoring system implements reactive control, consuming fewer resources, processing more quickly, and relying more on intuition, indirectly accessing others' trait information through emotional and motivational orientations, thus being susceptible to stereotype influence (Beer & Brooks, 2011). These results support McCulloch et al.' s (2008) view that people engage in parallel processing based on the importance or precision of stereotyped and counter-stereotyped information. Stereotyped information automatically activates stereotypes and, together with counter-stereotyped information, jointly influences stereotype effects; stereotyped and counter-stereotyped information follow relatively independent and parallel processing pathways (proactive control-reactive control). Nevertheless, Experiment 2 did not provide conclusive evidence against serial processing of stereotyped and counter-stereotyped information. According to serial multiple-process models, impression formation is dominated by stereotypes: perceivers first automatically process stereotyped information, activating stereotypes, then

shift to counter-stereotype-based processing.

Stereotype activation and expression are closely related to cognitive control monitoring and coordination (Sherman et al., 2009). Particularly when avoiding biased judgments caused by stereotyped information in daily life, stronger cognitive control is required. As the saying goes, "The onlooker sees most of the game." Actor/observer effects demonstrate that processing others' impressions is determined by one' s own cognitive control mechanisms. This phenomenon is illustrated by Experiments 1 and 2. The findings show that individuals can flexibly balance and adjust the weighting of two cognitive control systems (intentional operating system vs. automatic monitoring system) based on perceived stereotyped and counter-stereotyped information, thereby forming the most advantageous impression processing strategy for others. Even below perceptual threshold, individuals can process others' impressions through unconscious cognitive control.

4.1 Unconscious Cognitive Control in Impression Formation

After analyzing relevant research, Baars (2002) first proposed the concept of "unconscious cognitive control," arguing that delayed responses to subliminal conflict information actually reveal inhibitory control processes in conflict situations. This process reflects that although participants cannot perceive prime stimuli or consciously recognize conflict situations, conflict still consumes additional cognitive resources, affecting behavioral responses. This suggests that subliminal conflict information can activate unconscious cognitive control. Subsequent research at behavioral, electrophysiological, and neuroimaging levels has confirmed that masked stimuli can trigger conflict monitoring and activate prefrontal neural networks governing cognitive control (Boy, Husain, Singh, & Sumner, 2010; van Gaal, Lamme, Fahrenfort, & Ridderinkhof, 2011).

Experiment 2 found that impression formation cognitive control strategies are modulated by conflict information priming method (i.e., consciousness level). When conflict information is subliminally perceived, impression formation is influenced by reactive control; when supraliminally perceived, it is influenced by proactive control. This finding validates the intermediate-level processing hypothesis for perceptual conflict: the same conflict information can undergo different intermediate processing levels, producing different cognitive control strategies. When intermediate processing is unconscious, impression formation cognitive control is fast and precise, producing conflict inhibition effects. When intermediate processing is conscious, cognitive control is slow and susceptible to stereotype monitoring (Magen & Cohen, 2007; Matsumoto & Tanaka, 2004; Roelofs, Van Turennout, & Coles, 2006). Throughout the dynamic process of impression formation, the intentional operating system and automatic monitoring system can be viewed as carriers of proactive and reactive control. Experiment 2 also found these systems exhibit flexibility and modifiability in impression processing. This flexibility manifests as: when stereotyped and counter-stereotyped

information are supraliminally primed, individuals adopt proactive control from the intentional operating system (conscious, controlled processing); when subliminally primed, they mobilize reactive control from the automatic monitoring system (unconscious, uncontrollable processing). These results support Beer and Brooks' s (2011) view that stereotyped information automatically activates stereotypes and, together with counter-stereotyped information, jointly influences stereotype effects, with both information types following relatively independent and parallel processing pathways (proactive control-reactive control). Nevertheless, Experiment 2 did not provide conclusive evidence against serial processing.

According to stereotype processing theory, category information is the carrier of stereotype formation. Therefore, social category activation is a prerequisite for stereotype activation. When automatically activated stereotypes conflict with counter-stereotyped information, cognitive control must suppress relevant information, increasing response times (Conrey et al., 2005). Particularly under high perceptual load, individuals tend to adopt unconscious, rapid, automatic reactive control strategies, processing impressions based on others'counter-stereotyped information. Based on this theoretical perspective, Experiment 1 hypothesized that when stereotyped and counter-stereotyped information conflict perceptually, high perceptual load would lead impression formation to be influenced by reactive control, readily activating counter-stereotypes, whereas low load would lead to proactive control, producing stereotype bias. This hypothesis was partially confirmed and further clarified the relationship between stereotype processing and cognitive control strategies.

Previous research found that counter-stereotyped information holds greater attentional processing advantages than stereotyped information, with individuals investing more cognitive resources when focusing on counter-stereotypes (Quadflieg & Macrae, 2012). Building on this, Experiment 1 further revealed that impression formation is clearly modulated by perceptual load, with cognitive control strategies for the two conflict information types operating not in parallel but sequentially. Specifically, when stereotyped and counter-stereotyped information conflict perceptually, impression processing is susceptible to reactive control and readily activates counter-stereotypes. When cognitive resources are relatively scarce, stereotype semantic conflict effects are activated, generating proactive control strategies that inhibit selective attention and readily produce stereotype bias.

4.2 Perceptual Load Effects in Impression Formation

Unconscious cognitive control and perceptual load effects interact closely. Previous research shows that reducing perceptual load can transform briefly presented, unconsciously perceived stimuli into conscious perception; similarly, enhancing stimulus features can convert unconsciously perceived stimuli under high load into conscious perception (Ortells, Daza, & Fox, 2003). Building on this, our study found that when perceived stereotyped and counter-stereotyped

information conflict subliminally, impression formation is influenced by reactive control; when such information conflicts supraliminally, impression formation is influenced by proactive control. Reactive control consumes fewer cognitive resources, enabling faster impression processing of stereotyped information but slower processing of counter-stereotyped information while readily activating counter-stereotypes. Proactive control consumes more resources, slowing processing of stereotyped information while accelerating processing of counter-stereotyped information, and is prone to stereotype bias. This occurs because when cognitive resources are extremely scarce, the brain' s processing of stereotyped and counter-stereotyped information is very limited, producing weak conflict effects that exhibit conflict inhibition. Conversely, when resources are abundant, conflict between stereotyped and counter-stereotyped information increases brain alertness, enhancing conflict effects and exhibiting conflict adaptation. Of course, these findings do not negate perceptual load theory, but they demonstrate that perceptual load's influence on cognitive control strategies is modulated by information type. Specifically, when stereotyped and counter-stereotyped information are presented simultaneously, individuals expend more cognitive resources.

In summary, unconscious cognitive control and perceptual load effects in impression formation can be theoretically integrated to construct a "Dynamic Model of Cognitive Control in Perceptual Conflict Impression Formation." According to this model, impression formation occurs in two stages: (1) Perceptual selection stage. When conflict information is subliminally primed, fewer mental resources are occupied, reactive control dominates, processing is faster, relying more on intuition and indirectly accessing stereotyped information through emotional and motivational orientations, making it susceptible to stereotype influence. Particularly for resource-abundant perceivers, proactive control strategies readily activate stereotypes, making impression processing more susceptible to implicit stereotypes when conflict information is subliminally primed. (2) Response bias stage. When stereotyped and counter-stereotyped information conflict subliminally and individual perceptual load increases with scarce cognitive resources, conflict monitoring quickly and efficiently identifies stereotype-consistent information, facilitating rapid extraction of stereotyped information encoding. When perceptual load decreases and resources are abundant, conflict effects between stereotyped and counter-stereotyped information intensify, enabling individuals to regulate themselves based on real-time situational updates and adaptively process impressions of current perceptual objects through alternating proactive and reactive control.

This theoretical model is primarily based on impression processing of gender-stereotyped and counter-stereotyped information, requiring further validation of its generalizability and applicability. Research on racial impression formation shows that when face images and racial trait words conflict (e.g., white face target with black trait distractors like "stupid," "violent"), response times increase; when they are compatible (e.g., black face with black trait words), response times decrease (Bartholow & Dickter, 2008). Subsequent cognitive control re-

search found that individuals with stronger sense of control were less influenced by racial stereotypes than those with weaker control (Payne, Hall, Cameron, & Bishara, 2010). These findings align with our conclusions: individuals' cognitive control strategies are dynamically constructed according to the perceptual load level and priming method of stereotyped and counter-stereotyped information. Future research could explore external sources influencing cognitive control strategies across different conflict information types.

According to Gestalt theory, group entitativity influences the integrative processing of group member information, causing group impression representations to become stereotyped. These stereotyped representations then gain strong social significance through social factors and group categorization, becoming maintained and reinforced until they solidify as stereotypes (Hugenberg & Sczesny, 2006). Additionally, stereotype representation theory (Richards & Hewstone, 2001) identifies two psychological processing modes for counter-stereotyped information: subtyping and subgrouping. The key difference lies in whether individuals incorporate counter-stereotyped information into the entire group, with subtyping promoting stereotype maintenance and subgrouping promoting stereotype reversal. Are group entitativity and processing mode moderator variables embedded within the cognitive control mechanism? What are their internal relationships with cognitive control strategies in group and other impression formation? Future research could investigate internal sources influencing cognitive control strategies in perceptual conflict impression formation.

Conclusion

(1) Dynamic changes in conflict information priming method and perceptual load determine individuals' impression control strategies for stereotyped and counter-stereotyped information. Reactive control consumes fewer cognitive resources, enabling faster impression processing of stereotype-consistent information but slower processing of stereotype-conflicting information while readily activating counter-stereotypes. Proactive control consumes more cognitive resources, slowing impression processing of stereotype-consistent information while accelerating processing of stereotype-conflicting information, and is prone to stereotype bias.

(2) Cognitive control employs different processing modes for stereotyped versus counter-stereotyped information. When both information types are supraliminally primed, their processing is governed by proactive control from the intentional operating system (conscious, controlled processing). When both are subliminally primed, their processing is governed by reactive control from the automatic monitoring system (unconscious, uncontrollable processing).

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Impression control strategies from the perspective of perceptual conflict: an example of stereotyped information and counterstereotyped information

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Abstract

The question of whether stereotype activation is automatic activation (automatic activation) or controlled (inhibition) has been controversial. With the in-depth study, "stereotype activation is a cognitive process which is influenced by many cognitive factors, and the conditional automation process"has attracted more and more attention. Among them, the most discussed factors are category information, prompt clue, directional attention and so on. In addition to, it also involves interpersonal trust, perspective taking, cognitive psychology, imagination, perception of their age and other factors. In recent years, researchers have explained how social categories start stereotyped information from the perspective of perceived conflict. Stereotype information processing can help activate stereotype. So, does stereotype activation affect impression control strategies? When stereotype information is disturbed by other information and even affected by counter stereotyped information, does the stereotype associated with it automatically activate? When the two types of conflict information are subliminal priming, does cognitive control, which regulates the formation of impressions, have an effective inhibitory effect on stereotype activation? In response to these questions, the researchers began to focus on the influence of other people' s visual cues on impression formation to others. These studies controlling the stimulus presentation time and masking stimuli, so that part of the subliminal stimuli presented in the other part, stimuli presented in the above threshold. As a result, we can compare the similarities and differences between the effects of subliminal cues and subliminal cues on cognitive control. Studies have shown that when the participants are initiated by relevant cues, they acquire attributes about a social group in the long-term memory system. This information processing process is a rapid and implicit process of perceptual preparation, which consists of two stages: the social classification based on stereotyped information and the stereotype activation based on the extracted social categories. The two stages of information processing are divided into two parallel processing cognitive systems: the previous stage involves the intentional operating system, and the latter stage relates to the automatic monitoring system. Can the two cognitive systems be regarded as the carriers of active control and reactive control in the whole process of impression formation? At present, few studies have directly related to the relationship between stereotype processing and cognitive control strategies. In view of this, this study assumes that: (1) When there is a perceived conflict stereotype information and counterstereotype information, and the perceptual load is high, the impression formed by the effects of the reactive control to activate counterstereotype; and when the perceptual load is low, the impression formed by the proactive control of the role of prone to stereotype bias. (2) Cognitive control takes a "double-edged sword" model for conflict information of different intensity (stereotyped information vs. counterstereotyped

information). That means that when he processing method is controlled by the proactive control of the intentional operating system (the conscious, conscious processing) is performed and when the two classes of information start simultaneously at the threshold, the processing mode is controlled by the reactive control of the automatic monitoring system(the processing of the unconscious and unconscious control).

In this study, we used stereotype information and counterstereotyped information as an example and the experimental tasks were divided into two levels: high or low perceptual load or threshold, and subliminal priming by using the word sense Stroop paradigm and masked version of goal priming paradigm. Experiment 1 explored the impression control strategy in the context of conflict between stereotype information and counterstereotyped information perception. Using 2 (perceived load: high vs. low) × 2 (gender specific words and gender attributes word perception: conflict vs. compatibility) mix design. Using word meaning Stroop paradigm of to divided manipulation of perceptual load into two categories: gender traits (target) displayed above the same gender attribute words (such as "grumpy-male") in the low perceptual load task and gender words each side presents a gender attribute words and are compatible with the gender words or conflict (such as male-grumpy-female) in the high perceptual load task. Experiment 2 explored the conflict information intensity of stereotype information and counterstereotyped information impacted on the impression control strategy. A hybrid design using 2 (conflict information intensity: subliminal priming vs. subliminal priming) × 2 (two types of gender trait words perception: conflict vs. compatibility). Using masked version of the start-target paradigm and affective error attribution program to make a part of other people' s information is shown in subliminal manner, while another part of others' information is presented in a threshold manner by controlling the presentation time of two kinds of information and masking stimuli. So that we can investigate how the cognitive control strategy of stereotype formation is affected by conflict intensity. stereotyped individual' s strategy of impression control In Experiment 1, the dynamic changes of perceptual load determine the individual' s impression control strategy of stereotyped information and counterstereotyped information. The results showed the dynamic change of conflict information intensity and perceived load information and determines counterstereotyped information. Reactive control consumes less cognitive resources, to make processing of stereotype consistent information more quickly, to make processing of stereotype conflict information more slowly, and to activate counterstereotype easily. On the contrary, proactive control consumes such more cognitive resources as to slower processing of stereotype consistent information, to quicken processing of stereotype conflict information and to prone to stereotype bias easily. In Experiment 2, cognitive control takes a "double-edged sword" model of stereotyped information and counterstereotyped information. When stereotyped information and counterstereotyped information start simultaneously on threshold, the processing mode is controlled by the initiative of the intentional operating system which is the processing of involuntary, uncon-

scious control. And when the two types of information start simultaneously at the threshold, the processing mode is controlled by the automatic monitoring system which is the processing of unconscious and unconscious control.

The activation and expression of stereotype are closely related to the monitoring and coordination of cognitive control. In particular, people need stronger cognitive control in their daily life to avoid biased judgments caused by stereotyped information. As the saying goes, "Standers-by see more than gamesters." Actor/observer effects show that the processing of the impression of others is determined by their own cognitive control mechanism. This phenomenon can be explained by experiment 1 and Experiment 2 respectively. These results indicate that the individual, individuals can flexibly balance among the two cognitive control systems (intentional operating system vs. automatic monitoring system) and adjust their weights (either initiate active control or bias reactive control), thus forming the most favorable impression processing strategy for others. Even under the threshold of perception, individuals can process the impression of others through unconscious cognitive control.

According to Gestalt theory, group entity makes stereotyped group impression stereotype by influencing people' s conformity processing of group members' information. Subsequently, stereotyped group impression has strong social significance because of social factors and group classification. So they can be maintained and strengthened continuously, and eventually become stereotyped. Then, whether group entity is a moderator variable contained in the cognitive control mechanism, and how is it related to cognitive control? In this regard, follow-up studies can further develop the study of the dynamic construction of impression formation cognitive control.

Key words: stereotype activation; conflict information intensity; impression control strategy; proactive control; reactive control

Note: Figure translations are in progress. See original paper for figures.