

Automatic Prioritization of Self-Referential Stimuli in Working Memory



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**Shouhang Yin¹, Jie Sui², Yu-Chin Chiu³, Antao Chen¹,
and Tobias Egner³**

¹Key Laboratory of Cognition and Personality of the Ministry of Education, Faculty of Psychology, Southwest University; ²Department of Psychology, University of Bath; and ³Department of Psychology and Neuroscience, Center for Cognitive Neuroscience, Duke University

Abstract

People preferentially attend to external stimuli that are related to themselves compared with others. Whether a similar self-reference bias applies to internal representations, such as those maintained in working memory (WM), is presently unknown. We tested this possibility in four experiments, in which participants were first trained to associate social labels (self, friend, stranger) with arbitrary colors and then performed a delayed match-to-sample spatial WM task on color locations. Participants consistently responded fastest to WM probes at locations of self-associated colors (Experiments 1–4). This self-bias was driven not by differential exogenous attention during encoding or retrieval (Experiments 1 and 2) but by internal attentional prioritization of self-related representations during WM maintenance (Experiment 3). Moreover, self-prioritization in WM was nonstrategic, as this bias persisted even under conditions in which it hurt WM performance. These findings document an automatic prioritization of self-referential items in WM, which may form the basis of some egocentric biases in decision making.

Keywords

self-reference, self-prioritization effect, self-bias, working memory, internal attention, open data, open materials

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A large body of research has shown that people are biased toward preferentially processing self-related information compared with other-related social information (Banaji & Prentice, 1994): Self-referential stimuli capture exogenous attention, resulting, for instance, in faster responses to one's own face than to other faces (Alexopoulos, Muller, Ric, & Marendaz, 2012; Keyes & Brady, 2010; Liu, He, Rotstein, & Sui, 2016), and one's own face or name can act as a potent task-irrelevant distractor (Brédart, Delchambre, & Laureys, 2006; Devue & Brédart, 2008; Harris & Pashler, 2004). Moreover, stimuli that are encoded in a self-referential way are remembered better than those that are not (Kesebir & Oishi, 2010; Symons & Johnson, 1997). Although self-reference advantages in exogenous attention and long-term memory are thus well established, it is presently not known whether self-reference also modulates the prioritization of information in working memory (WM), which allows us to temporarily keep information

in mind for additional cognitive processing and the guidance of actions (Baddeley, 2003).

Many current views posit that information is maintained in WM via internally directed attention (Awh & Jonides, 2001; Barrouillet, Bernardin, & Camos, 2004; D'Esposito & Postle, 2015; Kiyonaga & Egner, 2013; Oberauer, 2009). Considering the pull that self-referential stimuli in the outside world exert on exogenously directed attention, it is plausible that self-referential representations in WM would similarly attract internal attention and thus be prioritized over items held in WM that are not self-related. This is an important topic to study not only for understanding mechanisms of WM and self-referential processing but also because maintaining and evaluating

Corresponding Author:

Antao Chen, Southwest University, Faculty of Psychology, No.1
Tiansheng Road, Beibei District, Chongqing 400715, China
E-mail: xscat@swu.edu.cn

information in WM is central to decision making and cognitive control (Baddeley, 2003; D'Esposito & Postle, 2015). Thus, a strong bias for representations of self-referential stimuli could have undesirable social side effects, such as promoting egocentric decisions. In the present study, we therefore aimed to test, for the first time, whether people exhibit a self-bias in WM.

A large literature on WM retrospective-cuing effects has shown that the differential prioritization of items in WM can be measured by the relative speed and accuracy with which these items are accessed on cued retrieval (Griffin & Nobre, 2003; Souza & Oberauer, 2016). We thus here tested whether this holds true for self-related stimuli in WM. Specifically, we addressed this question over four experiments by adapting a recently developed protocol as a spatial WM task; in this protocol, newly formed associations between the self and arbitrary stimuli modulated perceptual processing (Sui, He, & Humphreys, 2012).

Experiment 1

Method

Participants. We used G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) to estimate the effect size (Cohen's *d*) from a comparable previous study (Sui et al., 2012), which was 1.42. With a desired power of .8 for detecting an effect at an alpha level of .05, we would need a minimum sample of 18 participants. Thus, we set a target sample size of 25 for all experiments. Because of variability in participant scheduling reliability, we ended up with sample sizes of 27 in Experiments 1 and 2, 25 in Experiment 3, and 23 in Experiment 4. There was no overlap in participants across experiments, and all participants reported normal color vision and normal or corrected-to-normal visual acuity. This study was approved by the University Human Ethics Committee of Southwest University (China). Twenty-seven undergraduates from Southwest University (7 men; age: $M = 22.47$ years, range = 18–23) completed Experiment 1.

Stimuli and procedure. The experiment was run on a PC with an 18.5-in. monitor (1,366- × 768-pixel resolution; 60 Hz refresh rate) using E-Prime software (Version 2.0; Schneider, Eschman, & Zuccolotto, 2012). The experiment involved two tasks. The first task was a modified version of the associative-learning task used by Sui et al. (2012). Specifically, participants were trained to form associations between arbitrary colors and social labels (self, friend, stranger; for procedural details, see the Supplemental Material available online). This approach avoids the confounding impact of familiarity on self-reference effects (Humphreys & Sui, 2015; Sui et al., 2012; Sui & Humphreys, 2015; Sui, Sun, Peng, & Humphreys,

2014) and thus allowed us to probe self-prioritization in WM in a tightly controlled manner.

The second task was a delayed match-to-sample spatial WM task and was performed immediately after the learning phase, allowing us to assess the potential prioritization of the self- versus other-related color associations in WM. On each trial, two solid colored circles (drawn from the set of blue, green, and purple; $1.2^\circ \times 1.2^\circ$) were presented at two nonadjacent vertices of eight possible vertices of an invisible regular octagon ($9.6^\circ \times 9.6^\circ$). As shown in Figure 1a, a trial started with a 700-ms fixation cross, which remained on screen throughout the trial, followed by two colored circles shown together for 1,000 ms. Participants were asked to remember the locations and social associations linked to these colors (formed during the prior learning task). This initial stimulus presentation was followed by a 5,000-ms interstimulus interval in which participants were instructed to maintain the WM items. Next, a square was displayed around the fixation cross for 300 ms, which signaled the forthcoming presentation of a probe target and encouraged central fixation prior to probe onset. A target (a black circle) was then presented for 1,500 ms at one of the eight possible locations, during which time participants had to judge whether the target location matched either of the two remembered locations, responding with the index and middle fingers of their right hand on the keypad's 1 and 2 keys. The assignment of response finger to "match" or "nonmatch" responses was counterbalanced across participants. Target presentation was terminated by the key press or after 1,500 ms. If the target matched either of the two remembered locations, a label word was presented at the target location for 1,500 ms, and participants were required to judge whether the label word matched the remembered color in this location; on nonmatch trials, the trial ended with a 1,500-ms blank screen instead. This color-label probe was used to ensure that participants actively remembered the label words that the colors were associated with.

The different possible combinations of the color memory items resulted in three trial types, or pairings: self-friend, self-stranger, and friend-stranger. Each of these trial types occurred 96 times, including 24 match trials for each of the two items and 48 nonmatch trials. Altogether, there were 288 trials, consisting of 48 self-matched trials, 48 friend-matched trials, 48 stranger-matched trials, and 144 nonmatch trials, broken down into six blocks of 48 trials each (following 10 practice trials); trial types were presented in random order. Sorted by the social associations of match probes, this experiment had a three-level single-factor (social association: self, friend, and stranger) within-subjects design. The experiment lasted around 80 min.

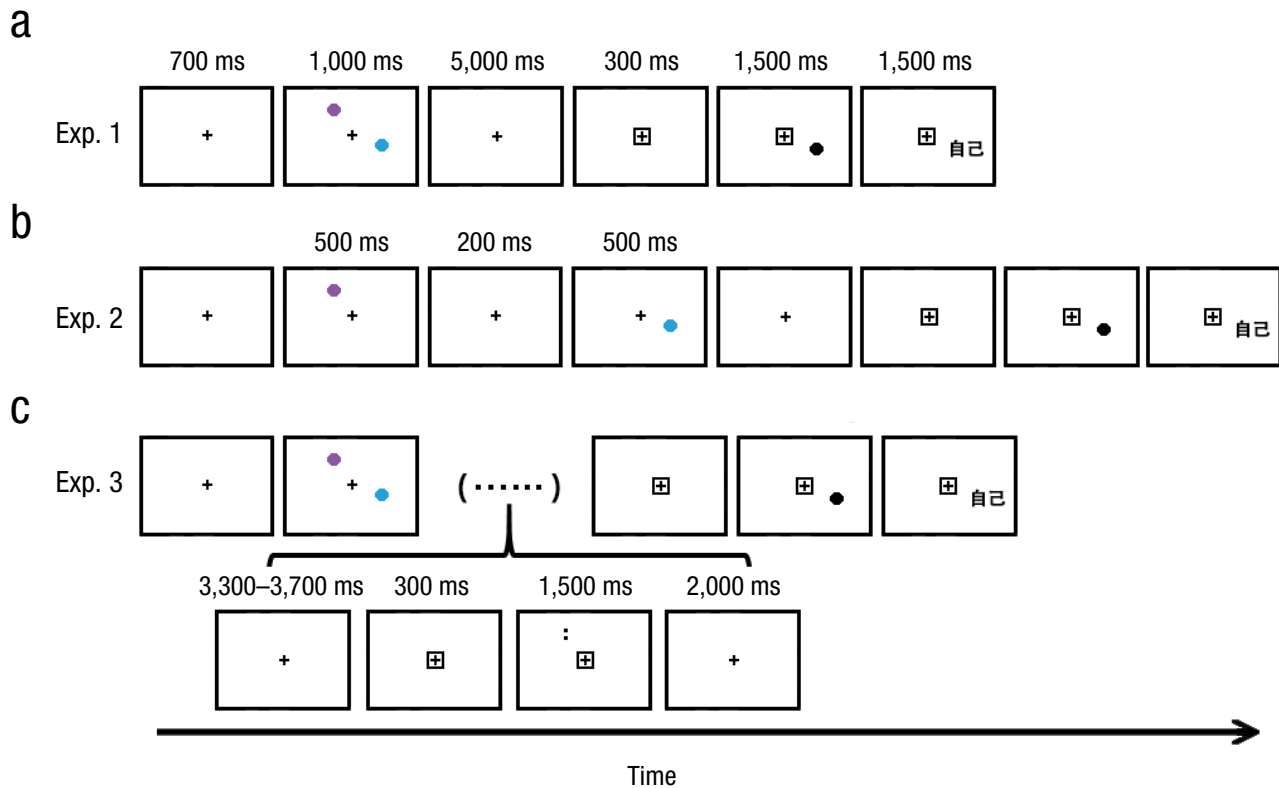


Fig. 1. Trial timing and example stimulus displays in the spatial working memory tasks of Experiment 1 (a), Experiment 2 (b), and Experiment 3 (c). The Chinese characters “自己” are identical to the English word *self*.

Results

Only correct responses greater than 200 ms and within 2.5 standard deviations from the participant-specific mean (for each condition) were used for the response time (RT) analysis.¹ Mean RT was used for all analyses. Results from the associative-learning task successfully replicated those found by Sui et al. (2012), documenting the successful learning of color–word associations with a significant bias for self-related items (results for the associative-learning phase from all experiments are shown in the Supplemental Material). In the spatial WM task, the mean accuracies of the probe and label response were 98% and 97%, respectively. Because every participant’s accuracy was higher than 95%, we did not analyze the accuracy data further.² A repeated measures one-way analysis of variance (ANOVA) on RT data of location-probe-match trials showed a significant main effect of social association, $F(2, 52) = 28.70$, $p < .001$, $\eta^2 = .53$ (see Fig. 2), with faster responses to self-match trials than to friend-match trials ($p < .001$) and to stranger-match trials ($p < .001$) as well as faster responses for friend-match trials than stranger-match trials ($p < .05$). For the RT data of the color–label probe (following location-match responses), the results were similar to those of the associative-learning task, documenting a

robust self-bias (for the color–label probe results of all experiments, see the Supplemental Material).

Discussion

These results document a significant WM self-prioritization effect, with faster retrieval for self-referential items. Because the target location probe consisted of a neutral stimulus, this result cannot reflect external attentional capture by a self-referential stimulus during WM retrieval. Rather, the effect must stem from biased processing during the encoding or maintenance stage. Notably, at encoding, the two color items were presented simultaneously, thus directly competing for attention; therefore, the self-bias observed in Experiment 1 could in theory reflect a consequence of greater bottom-up capture of attention to the self-associated color during encoding. Similarly, previous studies have shown serial-position effects of item encoding in WM, and the self-bias may result from encoding the self-referential item first (Blalock & Clegg, 2010; Hay, Smyth, Hitch, & Horton, 2007). In Experiment 2, we therefore tested whether the WM self-bias is driven by the attentional (or serial) prioritization of self-referential stimuli during the encoding stage by presenting the color cues serially.

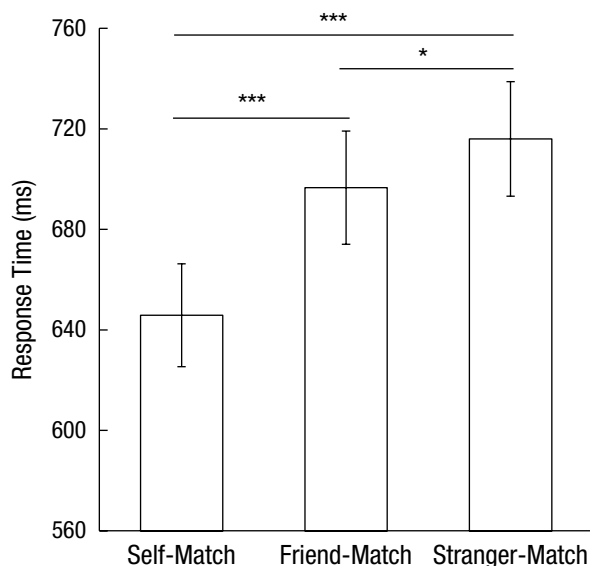


Fig. 2. Mean response time to the location probe in the self-match, friend-match, and stranger-match conditions of the spatial working memory task in Experiment 1. Error bars indicate standard errors of the mean. Asterisks indicate results significantly different from chance (* $p < .05$, *** $p < .001$).

Experiment 2

Method

Participants. Twenty-seven undergraduates from Southwest University (9 men; age: $M = 21.06$ years, range = 18–23) completed the experiment. None participated in the other experiments reported here, and all reported normal color vision and normal or corrected-to-normal visual acuity.

Stimuli and procedure. The stimuli and procedure were identical to those in Experiment 1, except that we presented the color circles at the start of the WM task sequentially instead of simultaneously. The two WM color items were presented one by one with an interval of 200 ms between them (see Fig. 1b). The task involved two within-subjects factors: serial order (two levels: first and second) and social association (three levels: self, friend, and stranger). The different trial types were presented 144 times each. For each of these, there were 72 trials in which one of the two items was presented first, and 72 trials in which the other one was presented first. At the probe stage, each of these conditions was associated with 36 match trials and 36 nonmatch trials. The task was broken down into six blocks of 72 trials each (following 10 practice trials). The experiment lasted around 100 min.

Results

Results for the learning task and color-label probe data replicated those of Experiment 1, documenting robust

learning and maintenance of color-label associations (see the Supplemental Material). Mean WM accuracy was 98% for the location and 96% for the color-label probe. A repeated measures 2 (serial order: first and second) \times 3 (social association: self, friend, and stranger) ANOVA on the RT data of location-probe-match trials revealed that the two main effects were significant—serial order: $F(1, 26) = 11.02$, $p < .01$, $\eta^2 = .30$; social association: $F(2, 52) = 11.46$, $p < .01$, $\eta^2 = .31$. Critically, there was no interaction between serial order and social association, $F(2, 52) = 0.42$, $p = .66$, $\eta^2 = .02$. Regardless of presentation order, the mean RT on self-match trials was significantly shorter than on friend-match trials ($p < .01$) and stranger-match trials ($p < .01$), as well as for friend-match trials compared with stranger-match trials ($p < .01$). Figure 3 displays mean RT for all conditions.

Discussion

The self-prioritization effect in WM was significant regardless of the serial position of the self-referential item, thus suggesting that this effect does not result from superior attentional capture during WM encoding. We also observed a main effect of serial order, but crucially, this effect did not interact with social association but exerted an independent effect. The observed primacy effect is compatible with previous findings of primacy rather than recency effects in immediate free recall

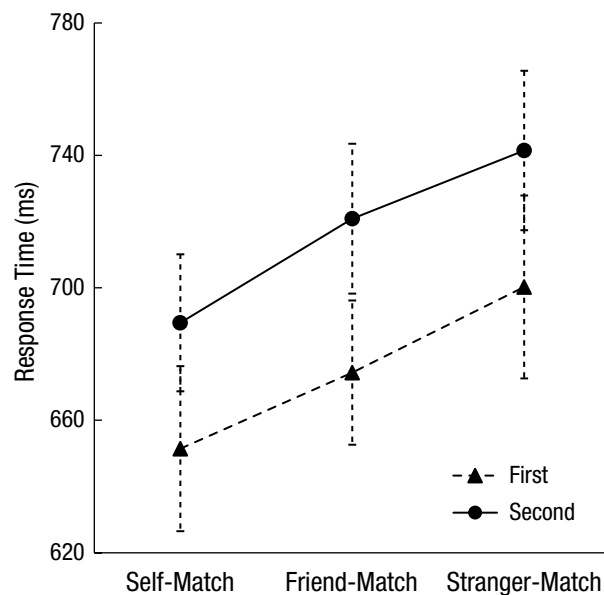


Fig. 3. Mean response time to the location probe in the self-match, friend-match, and stranger-match conditions of the spatial working memory task in Experiment 2. The dashed line represents the results when the matched item was presented first, and the solid line represents the results when the matched item was presented second. Error bars indicate standard errors of the mean.

under a fast rate of cue presentation (Davelaar, Goshen-Gottstein, Ashkenazi, Haarmann, & Usher, 2005). These results suggest that self-prioritization in WM is not driven by attentional prioritization processes at encoding. Combined with the absence of stimulation differences during the probe-retrieval stage, this suggests that the self-bias results from the manner in which the items are being maintained in WM, presumably via internally directed attention. Previous studies have documented that when attention is directed toward a location stored in WM, this results in improved processing of external stimuli at that location (Awh, Jonides, & Reuter-Lorenz, 1998). In Experiment 3, we employed this logic to test the hypothesis that the self-reference effect in WM results from a bias of internal attention toward self-relevant stimulus locations during WM maintenance.

Experiment 3

Method

Participants. Twenty-five undergraduates from Southwest University (5 men; age: $M = 19.62$ years, range = 18–22) completed the experiment. None participated in the other experiments reported here, and all reported normal color vision and normal or corrected-to-normal visual acuity.

Stimuli and procedure. The stimuli and procedure were identical to those in Experiment 1, except that, following the design of Awh et al. (1998), we added a dot-probe component to the WM task (see Fig. 1c). After simultaneous presentation of the WM items, there was a variable interval of 3,300 to 3,700 ms, after which two

small dots were presented at one of the to-be-remembered locations (see Fig. 1c). Participants had to indicate whether the dots were arranged horizontally or vertically using the index and middle fingers of their right hand on the keypad's 1 and 2 keys. The position-to-response assignment was counterbalanced across participants. The presentation of the dot probe was terminated by the key press or after 1,500 ms and was then followed by a blank screen for 2,000 ms. The remaining WM probe part of this task was identical to that in Experiment 1.

The spatial WM task of Experiment 3 involved one factor with three levels (social association: self, friend, and stranger). Each trial type was presented 96 times, with 48 dot-probe trials shown at each of the two item locations. For the location probes, there were 24 match trials for each of the two items and 48 nonmatch trials. Thus, there were 288 trials altogether, broken down into six blocks of 48 trials each (following 10 practice trials). The experiment lasted around 90 min.

Results

Results from the learning task and color-label probe data replicated those of Experiment 1, documenting robust learning and maintenance of color-label associations (see the Supplemental Material). Mean WM accuracy was 98% for the dot-probe judgment, 99% for the location probe, and 96% for the color-label probe on match trials. For the dot-probe RT data, a repeated measures one-way ANOVA with three levels (self-location, friend-location, and stranger-location) showed a significant main effect, $F(2, 48) = 14.47$, $p < .001$, $\eta^2 = .38$ (see Fig. 4a), with RT at the self-location being

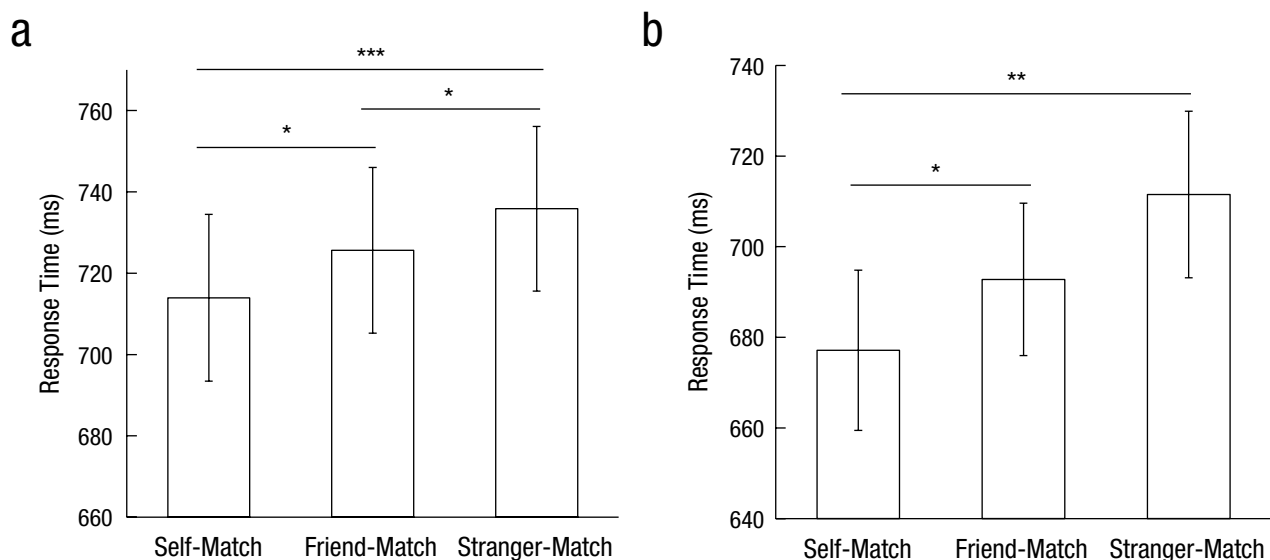


Fig. 4. Mean response time to the dot-probe judgment (a) and the location probe (b) in the self-match, friend-match, and stranger-match conditions in Experiment 3. Error bars indicate standard errors of the mean. Asterisks indicate results significantly different from chance (* $p < .05$, ** $p < .01$, *** $p < .001$).

significantly shorter than at the friend-location ($p < .05$) and the stranger-location ($p < .001$) and friend-location responses being faster than stranger-location ones ($p < .05$; for full descriptive statistics, see Table S3 in the Supplemental Material). For the WM RT data of location-probe-match trials, the main effect of social association was again significant, $F(2, 48) = 7.36$, $p < .01$, $\eta^2 = .24$ (see Fig. 4b). Specifically, RTs on self-match trials were faster than on friend-match trials ($p < .05$) and stranger-match trials ($p < .01$), and friend-match responses were marginally faster than stranger-match ones ($p = .07$).

Discussion

The results of Experiment 3 showed a significant self-prioritization effect on the dot-probe task during WM maintenance, with faster probe categorization at the location that corresponded to the self-related item held in WM. In line with prior studies of rehearsal effects in spatial WM (Awh & Jonides, 2001; Awh et al., 1998), we interpret these data as reflecting attentional prioritization of the self-referential item in WM, thus supporting our hypothesis that self-related information appears to attract greater internal attention than other-related representations during WM maintenance. In a final experiment, we sought to evaluate whether this WM self-bias simply reflects participants' preference or whether it displays some automaticity. A classic way to probe the relative automaticity of a cognitive process is to create conditions in which applying that process would produce suboptimal task performance. Previous research has shown that rarely probed items normally get deprioritized in WM (Berryhill, Richmond, Shay, & Olson, 2012; Gunseli, van Moorselaar, Meeter, & Olivers, 2015; Shimi, Nobre, Astle, & Scerif, 2014), but if the self-bias in WM is nonstrategic, we would expect this effect to survive such a manipulation.

Experiment 4

Method

Participants. Twenty-three undergraduates from Southwest University (7 men; age: $M = 20.59$ years, range = 18–23) completed the experiment. None participated in the other experiments reported here, and all reported normal color vision and normal or corrected-to-normal visual acuity.

Stimuli and procedure. The stimuli and procedure were identical to those in Experiment 1, except that in the spatial WM task, we manipulated the probability of the self-matched item being probed. As before, the WM

task involved one factor with three levels (social association: self, friend, and stranger), but the self-associated color was probed less than half as often (16.6%) as either of the other two colors (41.7% each). There were 384 trials in total, with equal numbers of trials (128) for the different color combinations (self–friend, self–stranger, and friend–stranger), broken down into eight blocks of 48 trials each (following 10 practice trials). Importantly though, within each block, there were 4 self-matched trials, 10 friend-matched trials, 10 stranger-matched trials, and 24 nonmatched trials. Thus, the breakdown of self to friend and stranger probes was 2:5:5. The experiment lasted around 80 min.

Results

Results from the associative-learning task replicated those of Experiment 1, documenting robust acquisition of color–label associations (see the Supplemental Material). Mean WM accuracies for the location and color-label probes were 98% and 96%, respectively. A repeated measures one-way ANOVA on the RT data from match trials for the location probes revealed a significant main effect of social association, $F(2, 44) = 8.02$, $p < .01$, $\eta^2 = .27$ (see Fig. 5). Importantly, in spite of the rareness of self-related probes, the mean RT on self-match trials was nevertheless significantly shorter than that on friend-match trials ($p < .05$) and stranger-match trials ($p < .01$), with friend-match responses being marginally faster than stranger-match ones ($p = .08$).

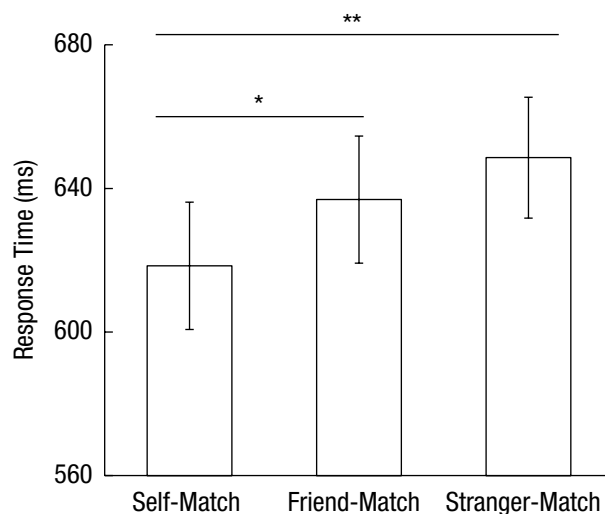


Fig. 5. Mean response time to the location probe in the self-match, friend-match, and stranger-match conditions of the spatial working memory task in Experiment 4. Error bars indicate standard errors of the mean. Asterisks indicate results significantly different from chance (* $p < .05$, ** $p < .01$).

Discussion

Even though we rendered self-related probes a low-probability event, the self-prioritization effect was still significant. This result is consistent with a recent study showing a robust advantage for bottom-up prioritization of self-related stimuli under low probability (Sui et al., 2014). The present results suggest that biases favoring the representation of self-referential items in WM occur relatively automatically, as this prioritization persists in conditions in which it represents a suboptimal task strategy.

General Discussion

Across four experiments, our results consistently showed a strong self-prioritization effect in WM, with probes at locations associated with self-referential items being responded to faster than probes at locations associated with other social agents. Moreover, we observed a reliable gradient of prioritization, with self-related stimuli being the most accessible, followed by friend-related stimuli and, finally, stranger-related stimuli. Whereas self-bias effects are well established in the domains of exogenous attention (Brédart et al., 2006; Devue & Brédart, 2008), perceptual processing (Humphreys & Sui, 2015; Sui et al., 2012), and long-term memory (Kesebir & Oishi, 2010; Symons & Johnson, 1997), the present study is the first to document a self-prioritization effect in WM.

The current experiments also speak to the locus of this self-bias effect. First, by adopting the associative-learning design of Sui et al. (2012), we preempted the possibility that greater familiarity with self-related stimuli could influence the data. Second, by probing the remembered locations with a neutral, black circle cue (rather than with colors from the memory set), we equated visual input and bottom-up salience across conditions during WM retrieval. This ruled out the possibility that the WM advantage for self-related stimuli was driven by differential exogenous attention capture during retrieval. Third, Experiment 2 explicitly tested whether the WM self-bias was driven by differential encoding, specifically, by preferential attention to, or ordering of, the self-related item relative to the other items. Although order of encoding did impact WM performance, this effect occurred in parallel and did not interact with the effect of self-prioritization. Thus, the latter effect most likely stems from a prioritized maintenance of the self-related item in WM. An interesting way of corroborating this conclusion could be to develop a retrospective-cue version of the current task that focuses more exclusively on the WM maintenance stage.

Many current views on WM posit that items are being maintained by mechanisms of internally directed attention (Barrouillet et al., 2004; D'Esposito & Postle, 2015; Kiyonaga & Egner, 2013; Oberauer, 2009). By this logic, the self-related stimulus held in WM attracts internal attention in a similar fashion to how an external self-related stimulus captures exogenous attention. In Experiment 3, we put this assumption to the test by adopting the design of Awh et al. (1998), testing for an attentional advantage for external probes presented at the self-related WM location during the maintenance interval. The results clearly supported the notion that the remembered location of the self-related item received more attention than the locations of other-related items. Thus, in line with the assumption that equivalent mechanisms drive the allocation of internally and externally directed attention (Kiyonaga & Egner, 2013), our results replicate an attentional bias for self-related items that had previously been demonstrated for external attention in the domain of internal attention. A worthwhile addition to the present study in this regard might be the tracking of eye movements, which could supply additional evidence for the preferred maintenance of the self-related item location over others (Williams, Pouget, Boucher, & Woodman, 2013).

Given that maintaining and evaluating information in WM is central to decision making and cognitive control (Baddeley, 2003; D'Esposito & Postle, 2015), the present results suggest that a self-prioritization in WM could lead to undesirable social outcomes, such as promoting egocentric decision making. Whether this is a serious concern depends in great part on the degree to which this self-bias is subject to strategic control, that is, whether people are able to strategically override the prioritization of self-related stimuli in WM. As an initial test of automaticity, Experiment 4 pitted the self-bias against task statistics by rendering probes of the self-related items less than half as likely as probes of other-related items. Previous studies have shown that, in the absence of self-bias, items with a low likelihood to be probed become deprioritized (Berryhill et al., 2012; Gunseli et al., 2015; Shimi et al., 2014). By contrast, the results of Experiment 4 showed that the self-bias in WM was robust to this probability manipulation. This suggests that self-prioritization in WM occurs automatically, recapitulating similar findings in perceptual processing (Sui et al., 2014), and highlights the importance of future research assessing whether WM self-bias has negative real-life consequences, for instance, whether individual differences in WM self-prioritization are predictive of the degree to which people make selfish decisions.

When considering limitations of our study, one should note that we cannot determine whether prioritization in

WM of self-related items is reflected in increased fidelity of self-related WM representations because item precision was not a limiting factor in the current task. Future experiments could be designed to render WM performance more challenging, allowing one to assess WM accuracy and precision effects. Additionally, with respect to probing the automaticity of the self-bias in WM, one could devise a stronger test than the manipulation we employed in Experiment 4, for instance, by probing the self-related item location even less frequently or by selectively rewarding performance for the other locations. It should also be noted that our inference in Experiment 4 is based on a lack of a frequency-driven change in performance, which presupposes that participants should be sensitive to such a probability manipulation in the first place. Although we did not demonstrate this explicitly in the present study, the sensitivity to frequency changes of other-associated (but not self-associated) stimuli has been previously documented in the context of externally oriented attention in a highly similar protocol (Sui et al., 2014).

In summary, over four experiments, we documented, for the first time, a robust prioritization of self-referential stimuli in WM. This effect appears to stem from an automatic attentional prioritization of self-related items during WM maintenance and complements the attraction of self-related stimuli on exogenous attention demonstrated in previous research. The present findings expand our understanding of the impact of self-reference on high-level cognitive processing and of the interaction among social salience, attention, and WM mechanisms, which may have profound impacts on social decision making.

Action Editor

Edward S. Awh served as action editor for this article.

Author Contributions

S. Yin and A. Chen initially conceived and designed the experiments, which were later improved and modified by discussions among A. Chen, J. Sui, Y.-C. Chiu, and T. Egner. S. Yin performed the experiments. The data were analyzed by S. Yin, A. Chen, and T. Egner. All the authors wrote and approved the final manuscript for submission.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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Supplemental Material

Additional supporting information can be found at <http://journals.sagepub.com/doi/suppl/10.1177/0956797618818483>

Open Practices



All data and materials have been made publicly available via the Open Science Framework and can be accessed at osf.io/9ua8f. The experiments reported here were not formally pre-registered. The complete Open Practices Disclosure for this article can be found at <http://journals.sagepub.com/doi/suppl/10.1177/0956797618818483>. This article has received the badges for Open Data and Open Materials. More information about the Open Practices badges can be found at <http://www.psychologicalscience.org/publications/badges>.

Notes

1. RT data were trimmed in the same manner for Experiments 2 to 4, eliminating less than 1% of trials overall.
2. The same applies for Experiments 2 to 4.

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