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OBSERVATION

Testing the Idea of Privileged Awareness of Self-Relevant Information

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Self-relevant information is prioritized in processing. Some have suggested the mechanism driving this advantage is akin to the automatic prioritization of physically salient stimuli in information processing (Humphreys & Sui, 2015). Here we investigate whether self-relevant information is prioritized for awareness under continuous flash suppression (CFS), as has been found for physical salience. Gabor patches with different orientations were first associated with the labels *You* or *Other*. Participants were more accurate in matching the self-relevant association, replicating previous findings of self-prioritization. However, breakthrough into awareness from CFS did not differ between self- and other-associated Gabors. These findings demonstrate that self-relevant information has no privileged access to awareness. Rather than modulating the initial visual processes that precede and lead to awareness, the advantage of self-relevant information may better be characterized as prioritization at later processing stages.

Keywords: self-relevance, self-prioritization, visual awareness, continuous flash suppression

The processing of various types of self-relevant information is enhanced compared to information that is not directly relevant to the self. For example, observers are faster and more accurate in responding to their own face or name than to some other person's face or name. This benefit extends to newly learned associations between arbitrary visual information (e.g., simple shapes) and the label *You*. Recently, Humphreys and Sui (2015) have suggested that this advantage reflects an automatic bottom-up process that can alter the saliency of a stimulus in a manner that mimics the effects of perceptual saliency.

Evidence for the prioritization of arbitrary visual information associated with oneself comes from matching tasks: Participants have been found to be much faster in matching the label *You* with an arbitrary shape than in doing so with the labels *Friend* or *Other* (Sui, He, & Humphreys, 2012; Sui, Liu, Mevorach, & Humphreys, 2015). To test the idea that self-relevant information can indeed directly affect the perceptual representation, Sui and colleagues (2012) manipulated the luminance contrast of shapes associated with the labels *You* or *Stranger* in a matching task. Matching responses to stimuli associated with the label *You* were much less affected by a reduction in stimulus contrast than were stimuli not associated with the self. Furthermore, both self-relevant shapes and perceptually salient shapes have been found to induce increased interference in a global/local task (Sui et al., 2015). To account for such findings, Sui and colleagues have proposed that giving a shape greater personal significance by associating it with the self had effects on initial visual processing equivalent to altering perceptual salience.

If personally significant information were indeed prioritized in initial visual processing, one would expect self-relevant information to have an advantage in gaining access to visual awareness. The present study directly tested this assumption using a breaking continuous flash suppression (b-CFS) paradigm (Jiang, Costello, & He, 2007; Stein, Hebart, & Sterzer, 2011). In b-CFS a high-contrast mask flashed into one eye renders an image presented to the other eye invisible for several seconds. The time that different stimuli need to overcome such suppression represents a measure of the stimuli's potency to gain access to awareness. It has been proposed that b-CFS offers unprecedented sensitivity for measuring differences in stimulus detectability (Gayet, Van der Stigchel, & Paffen, 2014; Stein et al., 2011; Stein & Sterzer, 2014; Yang, Brascamp, Kang, & Blake, 2014). Stimuli that are physically more salient in terms of luminance contrast (e.g., Akechi et al., 2015; Tsuchiya & Koch, 2005) as well as stimuli that are otherwise prioritized in visual processing, for example because of greater familiarity or meaningfulness, break into awareness more quickly (reviewed by Gayet et al., 2014). Also, one's own face is detected more quickly than famous other faces in b-CFS (Geng, Zhang, Li, Tao, & Xu, 2012), demonstrating that such highly familiar self-associated stimuli are prioritized in initial visual processing.

Thus, we reasoned that b-CFS would be optimally suited for determining any effect of newly learned associations between the self and arbitrary visual information on initial visual perception

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(also see Ocampo & Kahan, 2015, who recommended CFS to evaluate the idea of automatic attentional capture of information relevant to the self). If self-relevant stimuli are privileged for access to awareness in a way akin to physical salience, we expected to observe reduced suppression times for the stimulus associated with the label *You* compared with the stimulus associated with the label *Other.*

Method

Participants

Twenty-two volunteers (19 female, age range 18–33 years, mean 22.6 years) with normal or corrected-to-normal vision participated for course credit or payment. This sample size was at the upper end of the common sample size of previous, comparable b-CFS studies (cf. Tan & Yeh, 2015).

Apparatus and Stimuli

Observers viewed a 19-in. CRT monitor (1,280 × 1,024 pixels resolution, 60-Hz refresh rate) dichoptically through a custom-built mirror stereoscope. Visual stimuli were presented with Matlab (The MathWorks, Natick, MA), using the Cogent 2000 toolbox functions (http://www.vislab.ucl.ac.uk/cogent.php). The observer's head was stabilized by a chin-and-head rest at a viewing distance of approximately 50 cm. The mirrors of the stereoscope were adjusted for each observer to promote stable binocular fusion. The screen was black except for two gray areas in which the stimuli were presented. Two blue frames (6.8° × 6.8°, enclosing the gray area) were displayed side-by-side on the screen such that one frame was shown to each eye. Noise contours (width 0.4°) were presented within the blue frames. A blue fixation dot (0.5° × 0.5°) with a black dot (0.2° × 0.2°) in its center was displayed in the center of each frame. Participants were asked to maintain stable fixation throughout the experiment. To induce interocular suppression in the b-CFS experiment, we generated high-contrast, contour-rich CFS masks (6.0° × 6.0°) consisting of randomly arranged white, black, and gray circles (diameter 0.2°–1.1°).

Target stimuli were Gabor patches (2.8° × 2.8°, 2.1 cycles per degree, randomized phase, 30% contrast, same mean luminance as the gray area against which they were presented) that were oriented vertically or horizontally. Half of the participants were instructed to associate the vertical patch with themselves (label *Tu,* the Italian word for "you") and the horizontal patch with a stranger (label *Altro,* the Italian word for "stranger," signifying "other"), and for the other half of the participants the associations were reversed (see Figure 1a; see Sui et al., 2012).

Matching Task

Each trial began with a 700-ms presentation of the blank frames only, followed by a 700-ms fixation period and then 100 ms of fixation offset to mark the presentation of the target stimuli: A

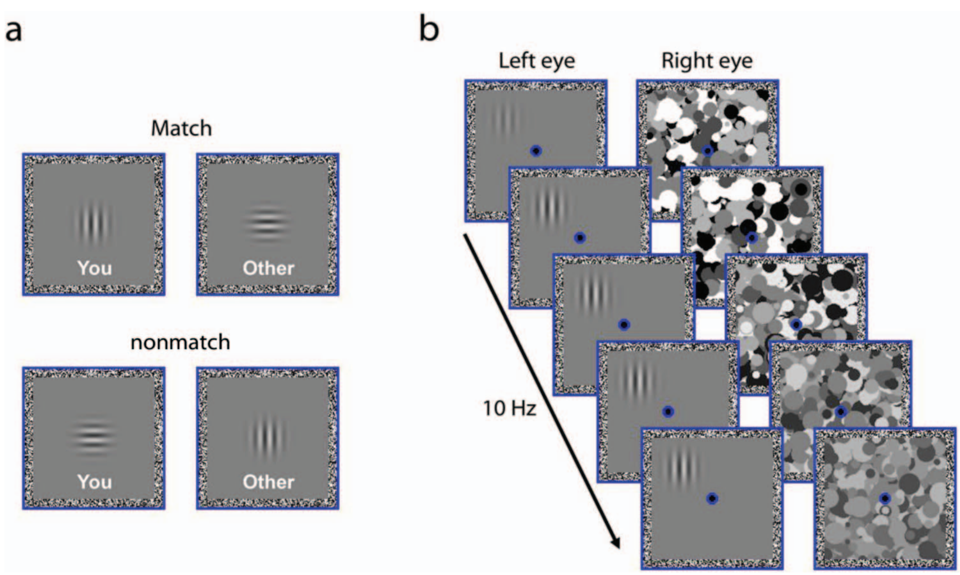

Figure 1. a: The four trial types in the matching task. Half of the participants were instructed to associate the vertical Gabor patch with themselves (label *Tu,* Italian word for "you") and the horizontal Gabor patch with someone else (label *Altro,* the Italian word for "stranger," signifying "other"), and for the other half of the participants the associations were reversed. The Gabors were then presented with the labels, and participants indicated as quickly and accurately as possible whether the Gabor–label combination matched or did not match the instructed association. b: Schematic of an example trial of the breaking continuous flash suppression (b-CFS) task. To induce interocular suppression, CFS masks updated at 10 Hz were presented to one randomly selected eye, while a Gabor patch was gradually introduced to the other eye. Participants indicated in which quadrant the Gabor target or any part of it became visible. The contrast of the Gabor increased over the first second of a trial, while the contrast of the CFS masks was slowly ramped down over the course of a trial. See the online article for a color version of this figure.

vertically or horizontally oriented Gabor patch was presented for 100 ms in the center of each frame, together with the label *Tu* or *Altro* in white Arial font (18 points) presented just below the Gabor patch. Participants were asked to indicate as accurately and quickly as possible whether the presented Gabor–label combination matched (left arrow key) or did not match (right arrow key) the instructed association. A change of the color of the fixation dot to green or red provided feedback on the accuracy of the response. If no response was given until 1.5 s from the onset of the target stimuli, the fixation dot turned red and the program advanced to the next trial.

After 12 practice trials, participants completed 200 trials of the matching task (separated by three obligatory breaks) in which each combination of trial type (match, nonmatch) and label (self, other) occurred 50 times. Trial order was randomized.

Breaking CFS Task

A schematic trial sequence is depicted in Figure 1b. After a 700-ms fixation period, CFS masks changing at 10 Hz were presented to one eye, and a vertically or horizontally oriented Gabor patch was gradually introduced to the other eye by increasing its contrast over the first second of the trial. Beginning 1 s after trial onset, the contrast of the CFS masks was linearly decreased to zero over 7 s. The Gabor target was presented until response, or for a maximum trial length of 10 s. Gabor targets were presented in one of the quadrants of the frames, centered at an eccentricity of 2.1° from the fixation dot. Participants were asked to press one of four keys on a QWERTY keyboard corresponding to the four quadrants (*F* or *V* with their left hand and *J* or *N* with their right hand) to indicate as fast and accurately as possible in which quadrant a Gabor or any part of a Gabor emerged from suppression.

Following eight practice trials, there were 128 trials (separated by one obligatory break) in which each combination of two eyes for target presentation, Gabor orientation (corresponding to the self/other label), and four quadrants for Gabor presentation occurred eight times. Trial order was randomized.

Results and Discussion

Matching Task

We first determined whether the label-orientation Gabor matching task successfully induced associations between the self-relevant label and the respective Gabor orientation. From Figure 2a it can be seen that in matching trials, participants were much faster to respond to the self label than to the other label. Indeed, a repeated-measures analysis of variance (ANOVA) with the factors label (you, other) and trial type (match, nonmatch) on the mean response times (RTs) from the matching task revealed a main effect of label, $F(1, 21) = 44.92$, $p < .001$, $\eta_p^2 = .68$, reflecting faster RTs to the *You* label (740 ms) than to the *Other* label (816 ms), a main effect of trial type, $F(1, 21) = 32.68$, $p < .001$, $\eta_p^2 = .61$, reflecting faster RTs in match trials (742 ms) than in nonmatch trials (815 ms), and a significant interaction, $F(1, 21) = 68.85$, $p < .001$, $\eta_p^2 = .77$. For match trials, RTs were faster for the *You* label (635 ms) than for the *Other* label (850 ms), $t(21) = 8.90$, $p < .001$, $d = 1.90$; for nonmatch trials, responses to the *Other* label (783 ms) were faster than to the *You* label (846 ms), $t(21) = 4.12$, $p < .001$, $d = 0.88$.

For the response accuracies from the matching task, there was a similar pattern of results: The ANOVA revealed a significant main effect of label, $F(1, 21) = 15.71$, $p < .001$, $\eta_p^2 = .43$, with overall higher accuracy for the *You* label (92.4% correct) than for the *Other* label (86.8% correct), and a significant interaction, $F(1, 21) = 26.15$, $p < .001$, $\eta_p^2 = .56$. For match trials, participants responded more accurately to the *You* label (98.0% correct) than to the *Other* label (81.0% correct), $t(21) = 5.69$, $p < .001$, $d = 1.21$; for nonmatch trials, responses to the *Other* label (92.5% correct) were more accurate than to the *You* label (86.7% correct), $t(21) = 2.60$, $p < .017$, $d = 0.55$. It is important to note that the highly significant interactions for both mean RTs and response accuracies indicate that the “self-advantage” in match trials was much larger than the “other-advantage” in nonmatch trials, thus replicating previous findings of self-prioritization in similar matching tasks (Sui et al., 2012, 2015).

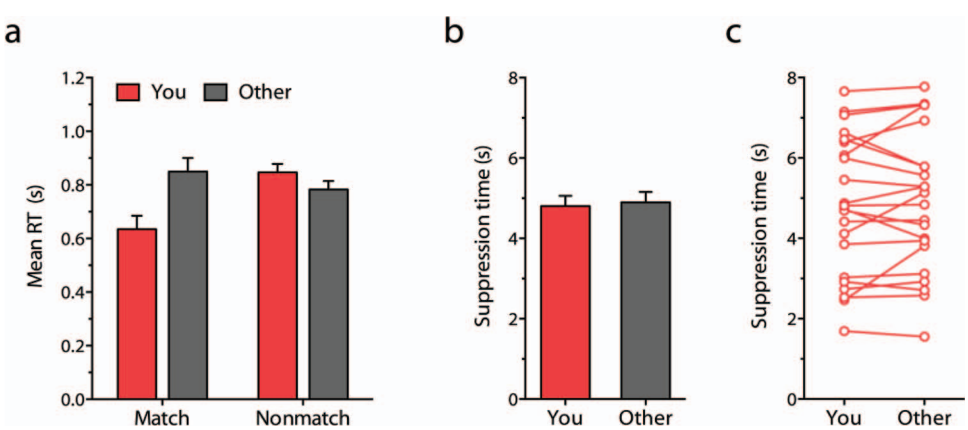

Figure 2. a: Results from the matching task. Error bars show 95% confidence intervals (Cis) for the comparisons of *You* and *Other,* separately for match and nonmatch trials. b: Results from the breaking continuous flash suppression (b-CFS) task. Error bars show 95% CIs for the comparisons of *You* and *Other*. c: Results from the breaking CFS task for all 22 individual observers. RT = response time. See the online article for a color version of this figure.

In line with previous research (Sui et al., 2012, 2015), these results show a clear prioritization of the self-relevant association. Having confirmed that the association between self-relevant labels and arbitrary visual information was successfully established, we next asked whether self-relevant information would also be prioritized for access to awareness under CFS.

Breaking CFS Task

Response accuracy in the b-CFS experiment was high and did not differ significantly between trials with self-associated (97.2% correct) and other-associated (96.9% correct) stimuli, $t(21) = 0.34$, $p = .741$. However, contrary to our predictions on the basis of the existing literature, the mean suppression times from the b-CFS experiment did not differ significantly between self- and other-associated Gabor patches, $t(21) = 0.76$, $p = .456$ (see Figure 2b and 2c). Thus, there was no evidence for privileged access to awareness of self-relevant information.

To explore whether a potential effect of the *You/Other* association on suppression times could have been restricted to the trials at the beginning of the b-CFS experiment, we analyzed suppression times by an additional ANOVA with the factors trial bin (Trials 1–32, 33–64, 65–96, 97–128; bins in which all experimental conditions were fully randomized) and label (see Figure 3). This ANOVA revealed only a significant main effect of trial bin, $F(3, 63) = 10.49$, $p < .001$, $\eta_p^2 = .33$, with overall shorter suppression times for trials later in the experiment but no significant main effect of label, $F(1, 21) = 0.63$, $p = .437$, $\eta_p^2 = .03$, and no significant interaction, $F(3, 63) = 1.13$, $p = .344$, $\eta_p^2 = .05$. Thus, also at the beginning of the b-CFS task, when learned associations were potentially strongest, there was no evidence for a self-advantage in access to awareness.

This absence of a statistically significant difference is unlikely due to a lack of statistical power. With a sample size of 22 participants, we had 80% power for detecting an effect size of $d = 0.63$. Note that the self-advantage in the RTs from the matching trials was reflected in a much larger effect size of $d = 1.90$. Thus, the b-CFS experiment had sufficient power to detect a potential effect even if the self-advantage under CFS had been only less than half the size of the self-advantage in the matching task.

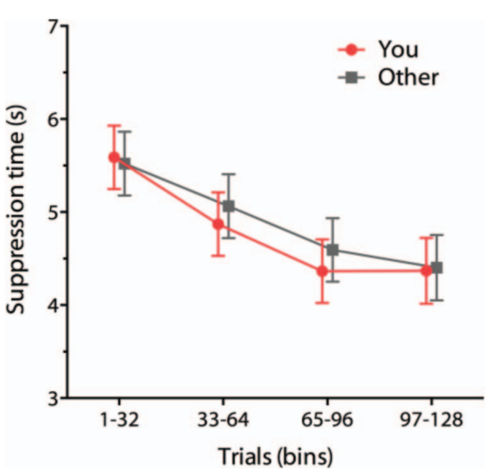

Figure 3. Results from the breaking continuous flash suppression task as a function of trial bin. Error bars show 95% confidence intervals for the comparisons of *You* and *Other,* separately for each trial bin. See the online article for a color version of this figure.

These results indicate that new self-associations do not modulate initial visual processing. Thus, although stimuli that have been associated with the self over a lifetime (such as one's own face) have privileged access to awareness (Geng et al., 2012), this is not the case for newly formed associations between the self and arbitrary visual information. This suggests that for self-relevancy to have an effect on awareness, such associations need to be established in a real-life context over a much longer time frame. One limitation of the present study is that we did not manipulate stimulus complexity and tested only associated Gabor orientations. Although these orientations were successfully associated with the self, resulting in a clear self-prioritization effect in the matching task, the difference in spatial orientation between levels of self-relevance may have been too subtle for detecting an effect with b-CFS. Future studies are required to test whether our findings extend to somewhat more complex stimuli such as simple shapes (e.g., Sui et al., 2012, 2015).

On the basis of this study, we cannot exclude the possibility that self-relevancy may modulate initial perception in experimental paradigms other than b-CFS (for similar findings from oculomotor visual search, see Siebold, Weaver, Donk, & van Zoest, in press). Our main motivation for using this method of interocular suppression was that b-CFS is regarded as a particularly powerful device for measuring detection threshold differences. Thus, we reasoned that b-CFS would also be capable of determining very subtle differences in the potency of self- and other-related stimuli to gain access to awareness. This same idea was recently proposed by Ocampo and Kahan (2015), who recommended CFS to test the idea of attentional capture by self-relevant information. In all truth, if it had not been for their recently published commentary, which motivated us to report our findings, our results would likely have remained in the file drawer, adding to the problem of publication bias in psychology (Ferguson & Heene, 2012; Kühberger, Fritz, & Scherndl, 2014).

Conclusion

To test whether self-associations modulate the initial processing of arbitrary visual information in a manner similar to the effects of perceptual saliency (Humphreys & Sui, 2015), the present study measured access to awareness for self-relevant stimuli under CFS. Although we obtained a clear advantage of self-relevant information in a matching task, there was no evidence for enhanced processing of self-relevant information under CFS. These findings represent a first step in delineating the effect of self-prioritization at different levels of the processing hierarchy. Instead of self-relevant information's reflecting a form of saliency that affects early and automatic perceptual representations, its advantage may better reflect prioritization at later processing stages, such as response priming, response selection, or memory encoding (cf. Firestone & Scholl, 2015).

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