

1
2
3
4
5
6
7
8
9
10
11
12
13
14

Self-related objects increase alertness and orient attention through top-down saliency

Biqin Li^{*}, Wenyan Hu¹, Amelia Hunt², Jie Sui²

¹ School of Psychology, Jiangxi Normal University, Nanchang 330022, China

² School of Psychology, University of Aberdeen, Aberdeen AB24 3FX, UK

Word count (text + references): 6291

Abstract

1
2 Attention is influenced by information about relationships between ourselves and the objects
3 around us. Self-related objects can either facilitate or disrupt task performance, creating a
4 challenge for identifying the precise nature of the influence of self-relatedness on attention.

5 To address this challenge, we measured different components of attention (alertness and
6 orienting) in the presence of self-related objects using a revised attention network task (ANT).

7 In a self-association task, participants first learned colour-person associations (e.g., red-friend,
8 yellow-me) and then carried out a colour-person matching task. This was followed by the

9 ANT, in which these coloured boxes associated with self or friend were displayed as

10 peripheral cues; participants had to judge the direction of an arrow flanked by congruent

11 (low-conflict) or incongruent (high-conflict) distractors presented within one coloured box.

12 The results showed faster and more accurate responses to targets appearing within the self-

13 colour than friend-colour cues in the association task. In the ANT, the analysis of alertness

14 revealed that self-related cues facilitated task performance compared to friend-related cues.

15 The analysis of orienting demonstrated that relative to friend cues, self cues hampered task

16 performance in invalid trials. Critically, the effects of self cues on both orienting and

17 alertness were observed only in high conflict situations. These results indicated that self-

18 related objects are powerful cues that enhance attention intensity, which either facilitates task

19 performance when the upcoming target falls within their location, or disrupts performance

20 when the target falls outside their location. The data suggests that attentional functions can be

21 tuned by self saliency in high-demand contexts.

22 **Keywords:** self-relatedness, alerting, orienting, task performance

1 **Introduction**

2 Attention serves an essential but complex function for human behaviour, and is tuned by
3 information about relationships between ourselves and the objects around us (Holland, 1993;
4 Keenan et al., 1999). Direct evidence comes from work showing that stimuli related to the self
5 are given priority across a range of tasks. For example, people are faster and more accurate to
6 judge their own faces and objects compared to the faces and objects belonging to others, and
7 their memory tends to be better for stimuli that are encoded in relation to themselves than in
8 relation to others (Gronau, Cohen, & Ben-Shakhar, 2003; Macrae et al., 2018; Turk,
9 Cunningham, & Macrae, 2008; Kim et al., 2018). These self-biases are pervasive. On the one
10 hand, self-related stimuli facilitate task performance when they are task relevant or act as
11 targets (Alexopoulos et al., 2012; Yamada et al., 2012; Yang et al., 2013). On the other hand,
12 they hurt performance when they are distractors (Devue et al., 2012; Eichenlaub, Ruby, &
13 Morlet, 2012; Röer, Bell, & Buchner, 2013; Yankouskaya et al., 2017). Self-related stimuli
14 can either facilitate or disrupt task performance depending on a range of factors, which create
15 a challenge for identifying the precise nature of self-biases on attention.

16 One compelling account for these self-biases is that self-relatedness enhances the social
17 salience of stimuli, which in turn modulates attention and subsequently affects performance
18 related to the targets (Dalmaso et al., 2019; Humphreys, & Sui, 2015; Sui, Liu, Mevorach, &
19 Humphreys, 2015; Wade & Vickery, 2018; Yin et al., 2019). The self-saliency account has
20 been supported by evidence that social attributes of stimuli (e.g., self-associations) influence
21 neural responses in a manner similar to changes in perceptual salience (e.g., luminance
22 contrast) of stimuli in visual processing (Sui et al., 2015). It was also reported that the self-
23 bias in perceptual matching was associated with an increased functional connection from the
24 ventral medial prefrontal cortex (VMPFC) to the left posterior superior temporal sulcus (pSTS),

25 a part of the ventral attentional network, responding to social cues), consistent with self-
26 related representation in the VMPFC being linked to attentional responses operating in the left
27 pSTS (Sui et al., 2013). This top-down modulation was eliminated when brain activity in the
28 VMPFC was inhibited in a cathodal tDCS condition (Yin et al., 2021). From the perspective
29 of self-saliency, it is important to understand how the social salience of stimuli biases the
30 distribution of attention and, consequently, affects the subsequent target performance.
31 However, the majority of the evidence for self-bias comes from studies in which self-related
32 stimuli were either the target or simultaneously presented with a target, with the co-
33 occurrence of self salience and target salience. The question arises then whether self-bias can
34 emerge when self-related stimuli are presented before target onset, that is, when the
35 competition between self-saliency and target salience is controlled. Will self-biases in
36 attention be observed even when self-related stimuli and targets do not appear simultaneously?
37 Which attentional functions will be precisely tuned by self-related information?

38 We sought to address these questions by using an attention network task (ANT, Fan et al.,
39 2002; Fan et al., 2009; Posner, & Rothbart, 2007; Posner, Rothbart, & Ghassemzadeh, 2019)
40 because it is a well-established tool for separating complex attentional functions into more
41 detailed subsystems to better understand the attention mechanisms underlying self-biases (Sui
42 & Rotshtein, 2019). The ANT systematically assesses different functions of attention (e.g.,
43 alertness, orienting, conflict control) by manipulating the relationships between cue and target
44 (Fan et al., 2009). We combined the ANT with a simple self-association task which has been
45 used to study self-biases while controlling the effects of stimulus familiarity and complexity
46 (e.g., names, faces) (Sui et al., 2012). Therefore, there were two phases in the present study. In
47 Phase 1 (the self-association task), participants first learned the associations between different
48 personal labels (a named best friend or self) and neutral colours (red, yellow, or blue); then,

49 they were presented shape-personal label pairings and had to make a quick judge whether
50 colours and personal labels were in their originally learned pairing or had been re-paired.
51 Participants typically showed biased responses to self-pairings (faster and more accurate)
52 relative to pairings associated with others (Sui et al., 2009, 2012). In Phase 2 (the ANT), the
53 type of cue (no cue, single cue, or double cues) and spatial cuing validity were manipulated.
54 Participants focused on a central fixation and responded to a peripheral target surrounded by
55 congruent or incongruent flankers (Fig. 1). The neutral shapes (i.e., colour boxes learnt in the
56 association task) functioned as peripheral cues that primed the location of upcoming targets.
57 These cues either modulated attentional intensity (alertness: double cues) or attentional
58 selection (single cues: valid vs. invalid) based on personal significance (self vs. other).
59 Notably, these cues disappeared before target onset. Using the ANT allowed us to test
60 whether the self-relatedness, when presented before the target, would modulate the alertness
61 and/or orienting components of attention.

62 There is evidence that self-relatedness affects alertness. For example, a recent study
63 showed that compared to self names, less self-relevant stimuli disrupted performance in the
64 psychomotor vigilance test (Kaida & Iwaki, 2018). The researchers claimed that the presence
65 of self names enhanced individuals' alertness and engaged less cognitive processes of
66 competition, thus speeding up reaction time (RT). Landman & Steenbergen (2020) used a
67 colour flanker task where an emotional or neutral target word with self-relevance (e.g., my
68 despair, his despair) was flanked by the same word in either the same colour or a different
69 colour. The task was to indicate the colour of the target word. They found that emotional
70 words within a self-related context increased conflict adaptation, whereas this effect was not
71 observed in the other-related context. These converging results indicate that self-relatedness

72 tuned alertness for conflict processing. However, in these studies, self-related stimuli were
73 simultaneously presented as targets (or with targets).

74 Recent work has also established that self-related cues influence involuntary attentional
75 orienting. For example, Alexopoulos and colleagues (2012) reported a robust cuing effect for
76 self-related peripheral cues over other-related peripheral cues across different cue-target
77 stimulus onset asynchronies (SOA = 235, 133, or 400 ms, in Experiment 1, 2, or 4), regardless
78 of task relevance. Using exogenous cues, Zhou et al. (2019) showed that self-related
79 processing regulated attentional orientation in both children with dyslexia and typically
80 developing controls. In this study, the authors assigned identity-related labels to geometric
81 shapes during a training episode and then used the shapes as peripheral cues in the following
82 detection task. They observed an enhanced cuing effect derived from self-related cues
83 compared to other-related cues in the short SOA condition (100ms), but this effect was not
84 observed in the long SOA condition (350 ms). The latter may reflect that the long SOA leaves
85 no opportunity for self-related cues to influence the performance in the following detection
86 task. Although it is difficult to directly compare these conflicting findings due to variations in
87 the tasks and stimuli employed across these studies, they provide evidence for self-relatedness
88 affecting attentional orienting.

89 In the present study, we used the revised ANT combined with the self-association task to
90 examine whether self-related cues bias attentional functions (alertness and orienting; Fan et
91 al., 2009). We first trained participants to associate the colour of the cues with the personal
92 label “self” or “friend” and then carried out a colour-person matching task. The colourful
93 cues associated with the different people were then used as peripheral cues presented before
94 target onset in the subsequent ANT. There were three cue conditions (no-cue, double-cue,
95 single spatial-cue, which could be valid or invalid) and two target conditions (low conflict

96 (flanker congruent) vs. high conflict (flanker incongruent)). The effects of self-relatedness on
97 the attentional system were assessed for alertness (with double cues) and orienting (with
98 single cues). This design allowed us to assess how self-related cues preceding targets operate
99 on attention systems, by performing direct comparisons between the effects of self-related
100 and friend-related cues on different attentional components.

101 **Method**

102 **Participants**

103 Thirty-five college students (mean age = 19.7 years; 27 female) participated in this study.
104 All the participants had normal or corrected-to-normal vision. No studies have previously
105 investigated the effects of self-relatedness on alertness and cue validity using the ANT.
106 However, it has been suggested that a sample size of approximately 30 participants will be
107 required to detect the expected effect of interest, specifically, the interaction between two
108 within-subjects variables (e.g., the effect of self-relatedness on alertness, with two variables,
109 colour category - self vs. friend, flanker judgement - congruent vs. incongruent) with a
110 statistical power ($>.80$) and an α of 0.05¹ (Brysbaert, 2019). Thus, a sample size of
111 approximately 35 was planned for the critical analysis, which included 5 more participants
112 recruited to allow for data exclusion. The experiment was approved by the local university
113 ethics committee.

114 **Apparatus and Stimuli**

1 Our data showed that the effect sizes in the key conditions in which they were observed were medium, ranged from .37 to .60.. Any future confirmatory research would need to have $>.80$ chance of producing the same result with setting an α of 0.05. These can be one-tailed tests based on the direction of the different effects observed in the current study.

115 There were two phases in this experiment. The participants first carried out an
116 associative matching task (phase 1) followed by the ANT (phase 2). There were three types
117 of coloured boxes (red, RGB: 255, 0, 0; yellow, RGB: 255, 255, 0; blue, RGB: 0, 0, 255). In
118 phase 1, two of three types of coloured boxes were randomly assigned to each participant.
119 The order of assignment was counterbalanced across participants. The label (“YOU” or
120 “FRIEND”) subtended $2.6^\circ \times 1^\circ$ of visual angle and was presented 3° under fixation. In phase
121 2, the boxes ($3.8^\circ \times 1^\circ$) were presented 5.3° to either the left or right of a fixation crosshair
122 ($0.5^\circ \times 0.5^\circ$), which was continuously shown in the centre of the screen. There were three
123 cuing conditions in phase 2: no-cue as a baseline (no coloured boxes before the target
124 appears), double-cue (both coloured boxes prior to the upcoming target), and spatial cue (one
125 coloured box appeared before the target, in either the same (valid) or the opposite (invalid)
126 location as the target). Following the cue, the stimuli consisted of a row of five horizontal
127 white arrows (one central target plus four flankers, two on each side), pointing leftward or
128 rightward. A single arrow subtended $0.6^\circ \times 0.1^\circ$ of visual angle, and the contours of adjacent
129 arrows were separated by 0.1° of visual angle. There were two target conditions in phase 2:
130 flanker congruence and incongruence (based on congruency between the direction of the
131 central arrows and the two arrows on either side).

132 The stimuli were presented on a 20-in. LED monitor with a refresh rate of 60 Hz against
133 a grey background (128, 128, 128). Participants sat 60 cm away from the monitor screen in a
134 dimly lit room. E-Prime software (ver. 2.0) was used for stimulus presentation and response
135 collection.

136 **Procedure**

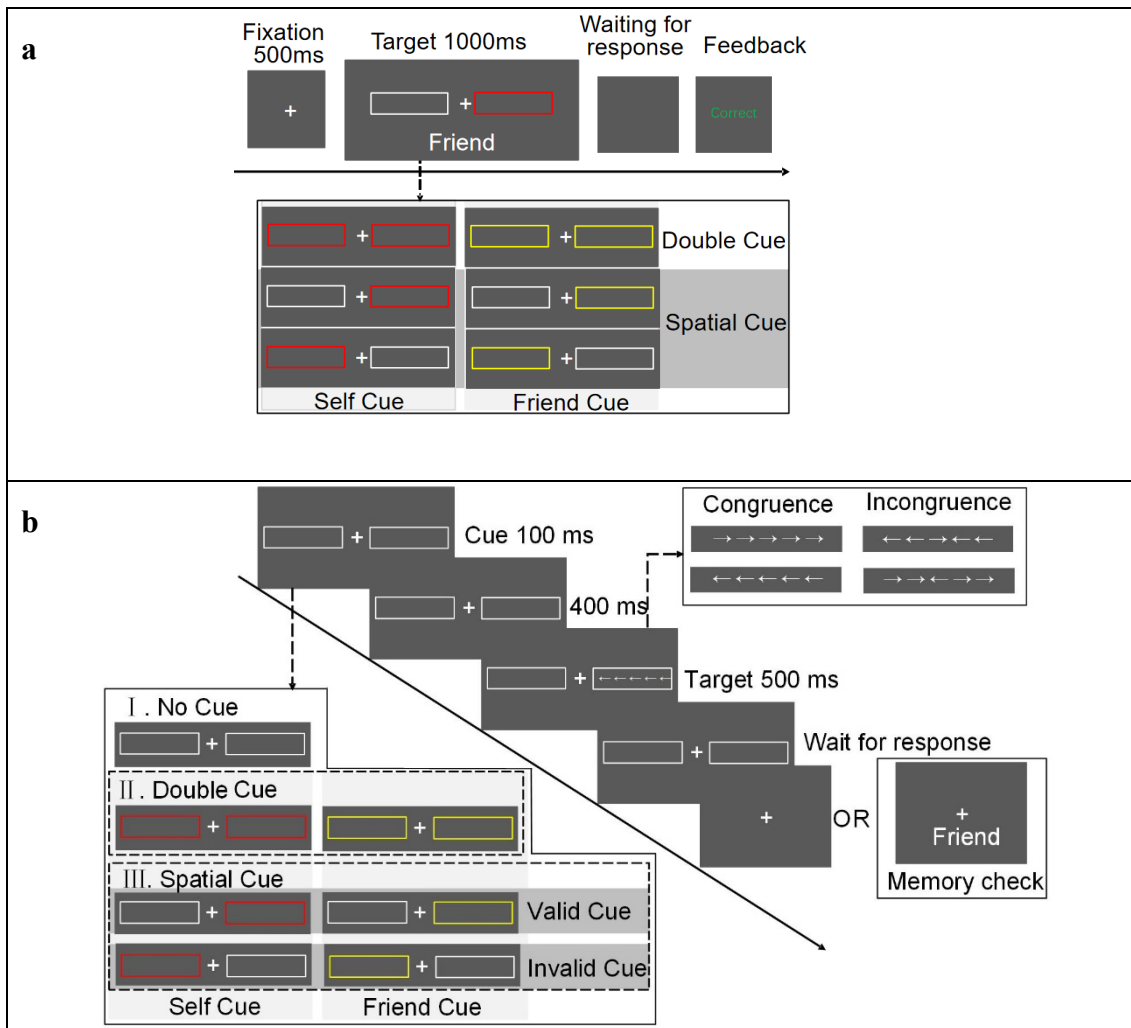
137 **The association matching task (phase 1).** In this task, the participants were instructed
138 to associate two people (self and friend) with two coloured boxes (Sui et al., 2009). For

139 example, participants were asked to imagine that “YOU are red boxes,” and “your FRIEND
140 is yellow boxes.” This association stage took approximately 1 minute. Following the
141 associations, the participants immediately performed the matching task where they had to
142 judge whether the colour-person pairings matched with how they were originally associated
143 (see Fig. 1a, upper panel). Each trial began with a central fixation cross for 500 ms, followed
144 by a target stimulus consisting of a colour-personal label pairing for 1000 ms. There were
145 three types of coloured boxes representing each person: left, right, or left plus right (see Fig.
146 1a, lower panel). The colour-personal label combinations were randomly presented across
147 trials, with an equal number of match and mismatch trials. The participants were instructed to
148 press the “J” and “K” keys using the index and middle fingers of the right hand as quickly
149 and accurately as possible. Keys assigned for match and mismatch responses were
150 counterbalanced across participants. The response time window was 2 s. Feedback was
151 provided by displaying correct and incorrect prompts for 500 ms at the end of each trial. RT
152 and accuracy were recorded. Each participant completed 180 trials (45 trials in each condition:
153 self-match, friend-match, self-mismatch, friend-mismatch), which should be sufficient to
154 establish the colour-person associations based on previous studies (Sui et al., 2019). The
155 performance for colour-label mismatch trials was calculated based on the colour.

156 **ANT (Phase 2).** Following the association matching task, the participants performed the
157 ANT (shown in Fig. 1b). Each trial began with a fixation cross with two white boxes
158 presented at the centre of the screen. Two boxes (two-coloured [double cue] vs. one-coloured
159 [spatial cue]) were presented for 100 ms, or two white boxes remained as a baseline condition
160 (no-cue). Then, the two white boxes were displayed again for 400 ms. The target, with
161 congruent or incongruent flankers, was then presented for 500 ms. The participants were
162 expected to report the direction that the central arrow was pointing with one of the two

163 response keys (“F” or “D” keys) within a 3-s time period while the two white boxes were
164 presented. The next trial then started. On 20% of trials, a personal label (self or friend) was
165 presented under the central fixation. The inclusion of these trials was to ensure that
166 participants remembered the social meaning of the coloured boxes linked to different people.
167 In these trials, the participants had to judge whether the label matched the coloured box(es)
168 by pressing one of the two buttons (“J” and “K”). The assignment of the buttons in this task
169 was consistent with the association matching task in phase 1. There were 15 practice trials
170 (with feedback) prior to the real experimental blocks. There were eight experimental blocks
171 of 40 trials each. The validity of the spatial cue was manipulated to measure disengagement
172 operations (see Posner et al., 1984). Specifically, 75% of single spatial cues (120 trials) were
173 valid, and 25% (40 trials) were invalid. The probability of a spatial cue over the experiment
174 (50%) was the sum of the probabilities of the individual no-cue, and double-cue conditions.
175 The participants were not informed of this information during the instruction. There were 120
176 trials for each of the self- and friend-cue types. Trial types were randomly presented.

177 **Data Analysis.** We calculated Bayesian factors via Bayesian statistics functions in JASP
178 0.14.0.0 to quantify the strength of evidence supporting the null results of postdoc t-tests
179 (Lakens et al., 2020). The value of the Bayesian factor (e.g., BF_{10}) was considered as the
180 strength of evidence supporting or rejecting the null hypothesis (Quintana & Williams, 2018).
181



182 **Fig. 1.** (a) Stimuli displays and a trial sequence in the matching task (Phase 1). For color-
 183 label pairings, a given color (self or friend associated) is mapped on 1 or 2 frameworks of the
 184 two rectangles: left and right, right, or left (the lower panel). (b) Illustration of a trial
 185 procedure in the ANT. Each trial depends on the cue condition (no cue, double cue, and valid
 186 or invalid cues), color category (self vs. friend), and the target-flanker concurrency
 187 (congruent vs. incongruent).

188 **Results**

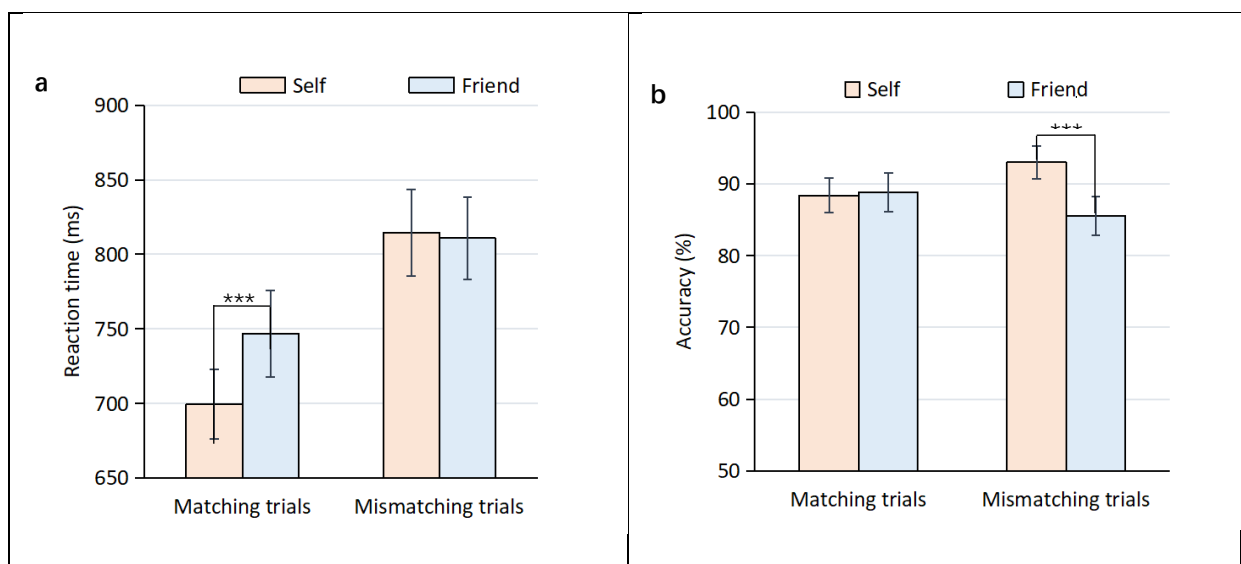
189 **Associative Matching (Phase 1)**

190 We conducted repeated measures ANOVAs with two within-subject variables of colour
 191 category (self vs. friend) and matching judgement (match vs. mismatch) on RTs and accuracy
 192 performance to examine the effects of self-association (phase 1). The analysis of RTs
 193 demonstrated significant main effects of colour category, $F(1, 34) = 30.94, p < 0.001, \eta^2 =$
 194 0.48 , and matching judgement, $F(1, 34) = 64.14, p < 0.001, \eta^2 = 0.65$. The two-way interaction

195 was also significant, $F(1, 34) = 30.49, p < 0.001, \eta^2 = 0.47$. Subsequent pairwise t-tests
196 demonstrated that there were faster responses to the self trials than to the friend trials in the
197 matched condition, $t(34) = 7.13, p < 0.001, d' = 1.19$; in contrast, there was no significant
198 difference in the mismatch condition, $t(34) < 1$ (see Fig. 2), which was supported by the
199 Bayesian paired-samples t-test ($BF_{10} = 0.22$) with default parameters to quantify the null
200 result (Quintana and Williams, 2018).

201 The analysis of accuracy showed a significant main effect of colour category, $F(1, 34) =$
202 $27.54, p < 0.001, \eta^2 = 0.45$; there were more accurate responses to the self than friend trials.
203 The effect of matching judgement was not significant, $F(1, 34) < 1$. The two-way interaction
204 was also significant, $F(1, 34) = 68.25, p < 0.001, \eta^2 = 0.47$. Subsequent pairwise t-tests
205 demonstrated that there was no significant difference between the self and friend trials under
206 the matched condition, $t(34) < 1$ ($BF_{10} = 0.21$). In contrast, there was a significant difference
207 in accuracy on the mismatch trials, $t(34) = 8.35, p < 0.001, d' = 1.44$.

208 The results from the matching task indicated a robust bias towards the self-association
209 over the friend-association.



210

211 **Fig. 2.** Means of RTs for correct trials only(a) and accuracy performance(b) as a function of
 212 colour category (self vs. friend) and matching judgement (match vs. mismatch) in the
 213 matching task. Error bars represent 95 % confidence intervals. *** $p < 0.001$.

214 **Attentional Network System (Phase 2)**

215 Error trials (2.30%) and trials with RTs shorter than 250 ms (0.01%) or longer than 1500
 216 ms (0.62%) were excluded from the data analysis (Kinoshita, Mozer, & Forster, 2011; Aben,
 217 Verguts, Van den Bussche, 2017). Mean response times and standard deviations for each
 218 condition are shown in supplementary material tables. Table 1 shows the attentional effects
 219 on RTs in self and friend conditions. The correlation coefficients between the attentional
 220 effects in self or friend condition (Fan et al., 2009), are also shown in the supplementary
 221 materials.

222 **Table 1.** Means and standard deviations of attentional effects in self and friend conditions.

| | | Alerting | Validity | Orienting | Disengaging | Conflict |
|--------|------|----------|----------|-----------|-------------|----------|
| Self | Mean | 58*** | 152*** | 63*** | 89*** | 102*** |
| | SD | 42 | 53 | 33 | 45 | 31 |
| Friend | Mean | 51*** | 147*** | 73*** | 75*** | 109*** |
| | SD | 41 | 51 | 30 | 48 | 36 |

223 Alerting = No cue - Double cue; Validity = Invalid cue - Valid cue; Orienting = Double
 224 cue - Valid cue; Disengaging = Invalid cue - Double cue; Conflict effect = Incongruent target
 225 - Congruent target.

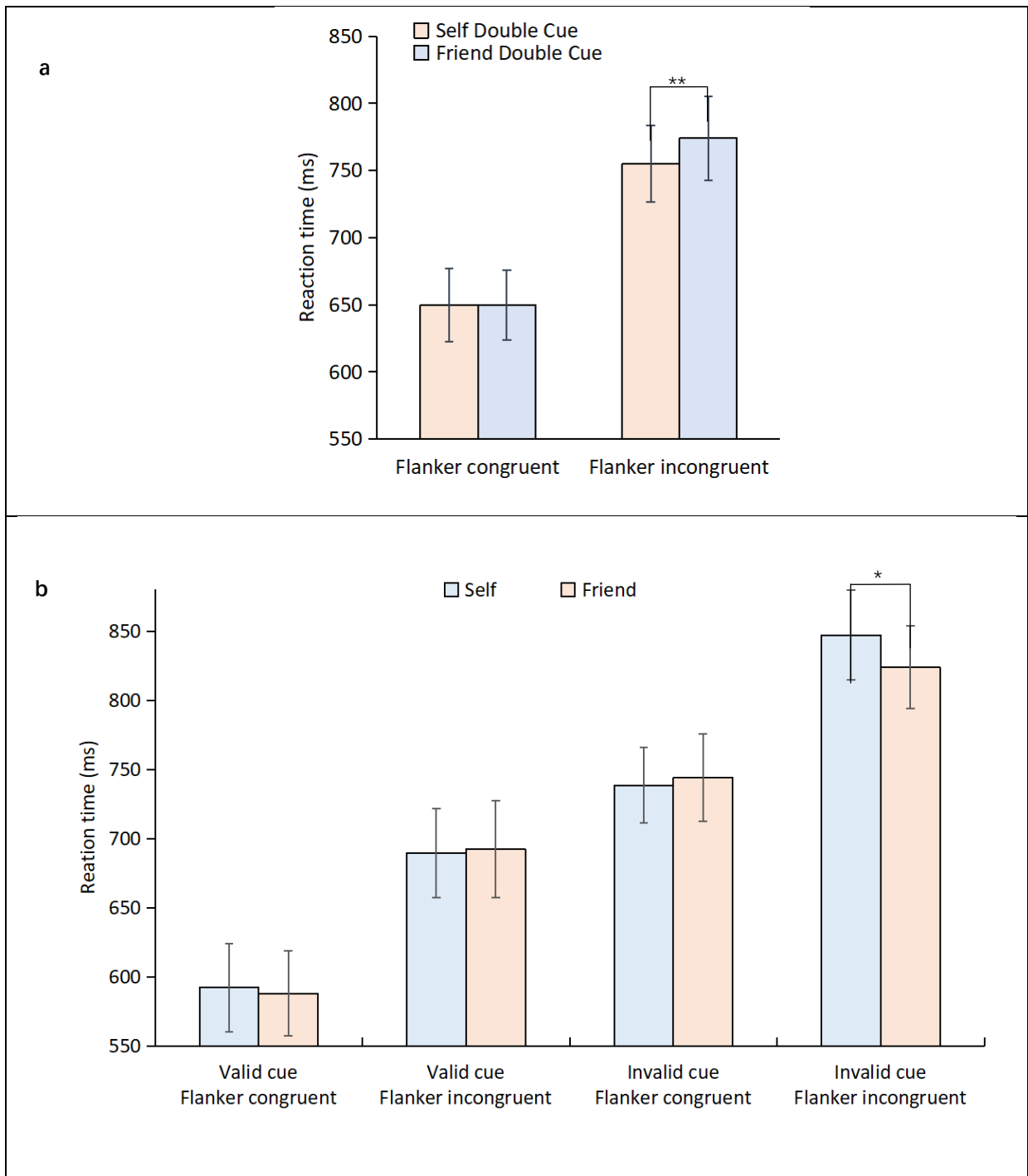
226 All attentional effects were significant with $p < 0.001$ (2-tailed)

227

228 **Effect of Associations on Alertness**

229 The analysis for alertness showed a general benefit for both self- and friend-alerting cues
 230 (double-cue) over the no-cue condition ($ps < 0.001$, see Table 1), suggesting that alerting
 231 improved response speed following both self- and friend-related double cues.

232 We then tested whether alerting cues (including self double-cue and friend double-cue
233 conditions) modulated flanker conflict, which was measured by subtracting the mean RT in
234 the incongruent condition from that of the congruent condition. The analysis on the double-
235 cue conditions revealed that there was a reduced flanker effect in the self-cue than in the
236 friend-cue conditions (friend vs. self: 122 vs. 102 ms, respectively), $t(34) = 2.34$, $p = 0.024$,
237 $d' = 0.37$. The result indicated that there was more efficient conflict processing in the self
238 double-cue than friend double-cue conditions. To verify whether the above effect was driven
239 by the processes involved in low- or high-conflict conditions (congruent vs. incongruent), we
240 conducted a repeated measures ANOVA on RT data with the two within-subject factors of
241 colour category (self vs. friend) and flanker judgement (congruent vs. incongruent). The
242 results revealed significant main effects of colour category, $F(1, 34) = 5.23$, $p = 0.029$, $\eta^2 =$
243 0.13 , and flanker judgement, $F(1, 34) = 330.20$, $p < 0.001$, $\eta^2 = 0.91$. The two-way interaction
244 was also significant, $F(1, 34) = 5.54$, $p = 0.024$, $\eta^2 = 0.14$. Subsequent pairwise t-tests
245 demonstrated that there was a significant difference between the self and friend trials in the
246 flanker incongruent condition, $t(34) = 3.41$, $p = 0.002$, $d' = 0.60$; in contrast, there was no
247 significant difference in the flanker congruent condition, $t(34) < 1$ ($BF_{10} = 0.18$, see Fig. 3a).



248 **Fig. 3. (a)** Mean reaction times for correct trials only in the ANT as a function of flanker
 249 judgement (congruent vs. incongruent) and colour category (self vs. other) in double-cue
 250 conditions. (b) Mean RTs as a function of cuing effect (valid vs. invalid), flanker judgement
 251 (congruent vs. incongruent), and colour category (self vs. other) in the spatial cuing condition.
 252 Error bars represent 95 % confidence intervals. * $p < 0.05$, ** $p < 0.01$.

253 **Effect of Associations on Orienting**

254 To examine the modulation of self-relatedness on orienting, we conducted a repeated
255 measures three-way ANOVA on the single-cue conditions only, with colour category (self vs.
256 friend), spatial cue (valid vs. invalid), and flanker judgement (congruent vs. incongruent) as
257 within-subject factors (see Fig. 3b). The analysis demonstrated significant main effects of
258 spatial cue, $F(1, 34) = 368.54, p < 0.001, \eta^2 = 0.92$, and flanker judgement, $F(1, 34) = 300.60,$
259 $p < 0.001, \eta^2 = 0.90$. The effect of colour category was not significant, $F(1, 34) = 1.65, p =$
260 0.208 . The two-way interactions between colour category and spatial cue, colour category
261 and flanker, and spatial cue and flanker were not significant ($F(1, 34) < 1; F(1, 34) = 2.47, p$
262 $= 0.125, \eta^2 = 0.07; F(1, 34) = 1.11, p = 0.299, \eta^2 = 0.03$). There was a significant three-way
263 interaction, $F(1, 34) = 5.01, p = 0.032, \eta^2 = 0.13$.

264 The three-way interaction was broken down for the invalid and valid trials. In the invalid
265 condition, there was a significant interaction between colour category and flanker judgement,
266 $F(1, 34) = 4.68, p = 0.038, \eta^2 = 0.12$ (Fig. 3b). Follow-up t -tests revealed that the valid cues
267 failed to show any significant effect, $F(1, 34) = 1.18, p = 0.286, \eta^2 = 0.03$, but there was a
268 general benefit from both self and friend valid spatial cues over the double-cue condition,
269 indicating that both self and friend valid spatial cues enhanced target performance compared
270 to the double-cue condition (see $ps < 0.01$, Table 1). The analysis of invalid self-cues
271 disrupted performance relative to friend-cues in the flanker incongruent condition, $t(34) =$
272 $2.44, p = 0.020, d' = 0.41$, while there was no difference between invalid self- and friend-cues
273 in the flanker congruent condition. These results indicate that when the self-related colour
274 acts as an invalid cue it hurts task performance more than friend-related colours; when acting
275 as valid cues, both self and friend colours comparably facilitated task performance.

276 **Discussion**

277 Using the revised ANT combined with the self-association task, the current study
278 investigated the effect of self-relatedness on attentional functions (alertness and orienting) by
279 presenting self-related cues before the target. In line with previous studies (Sui et al., 2012),
280 there were faster and more accurate responses to stimuli related to the self than friend in the
281 self-association task, confirming the presence of self-prioritization effect. In the ANT, we
282 observed that both double and valid (self and friend) cues improved performance by speeding
283 up responses to the targets, consistent with prior studies (Fan et al., 2009). Furthermore, the
284 analysis of flanker conflict revealed that relative to friend-alerting cues, self-related alerting
285 cues facilitated responses to the targets under the high conflict condition (with incongruent
286 flankers). There was also a larger interference from invalid self-cues than from invalid friend-
287 cues, specifically in the high conflict condition. These results indicated that when there is
288 more difficult processing slowing down the responses to the targets, as occurs in the high
289 conflict condition, then self-related cues modulate both alertness and attentional orientation
290 by top-down salience. With low-conflict flankers, in contrast, there were no differences
291 between self-cue and friend-cue conditions.

292 The current study showed a general benefit for both self- and friend-alerting cues over
293 the no-cue condition and for valid self and friend spatial cues over the double cue condition.
294 The comparable modulation by self- and friend-cues on alerting and orienting may partly
295 reflect the effects of personal significance and familiarity (i.e., one's self and close others) on
296 attention, consistent with previous studies showing that self-related stimuli and stimuli
297 associated with personally close others comparably enhanced spatial attention relative to a
298 neutral condition in patients with visual extinction (e.g., Sui & Humphreys, 2017). In the
299 current study, personal relevance/familiarity may enhance the social salience of cues related

300 to self and friend, which were both sufficient to facilitate responses to the upcoming target
301 presented at the same location over the baseline condition; thus, there was no self-related
302 effect that provided an advantage over the friend condition. Another account is also possible
303 that the colour cues themselves draw attention and leave no opportunity for self-related cues
304 to make any additional contribution to performance when the response to the target was
305 relatively simple to compute. Indeed, the overall RTs were faster in the double- and valid cue
306 conditions, irrespective of the colour associations.

307 In a patient study (Sui & Humphreys, 2017), the authors found that visual extinction
308 patients demonstrated an advantage in self-related relative to friend-related conditions in the
309 impaired visual field, only when the self- and friend-related stimuli were presented in
310 competition, and that there was no difference between self-neutral and friend-neutral pairing
311 competition conditions. The result indicated that the emergence of a self-specific modulation
312 of spatial attention might depend on task demand. This previous finding was in line with the
313 current result that compared to friend-alerting cues, self-alerting cues facilitated RTs only in
314 the high demand context (incongruent flanker condition) (e.g., Landman & Steenbergen,
315 2020). In addition, we observed that both self and friend alerting signals exerted a detrimental
316 effect on stimulus processing when a conflict occurred (incongruent) compared to when no
317 conflict occurred (congruent), consistent with previous studies (e.g., Fan et al., 2002;
318 Weinbach & Henik, 2012). It has been suggested that alerting cues increase arousal by
319 eliciting a global accessing bias through which distractors were processed at these attended
320 locations, leading to larger interference effects (e.g., Fan et al., 2002). Interestingly, in the
321 incongruent condition, our result showed that self-alerting cues led to faster conflict
322 resolution than friend-alerting cues. The result might reflect that in addition to eliciting a
323 global accessing bias for distractors presented at attended locations, self-alerting signals

324 promoted attentional focus at the locations of the upcoming target (the center of rectangle
325 cues), which subsequently facilitated performance for the upcoming target. These results
326 were also consistent with previous studies showing that self-relatedness can promote arousal
327 and then enhance task performance in attention capture and recognition tasks (Bola et al.,
328 2020; Fan et al., 2013; Tacikowski, Cygan, & Nowicka, 2014; Tacikowski & Nowicka, 2010).

329 For orienting, invalid self cues hindered performance compared to the invalid friend cues,
330 specifically in the conflict situation (incongruent flanker condition). The results contradicted
331 previous studies which showed an interaction between cue validity effects and self-
332 relatedness (e.g., Alexopoulos et al., 2012). The conflicting results might reflect lower task
333 demands in Alexopoulos et al.'s study, where participants were required to report the location
334 of a letter ('O') in one of the four locations or detect a target ('arrow'). In contrast, the
335 participants in the present study had to judge the orientation of the target surrounded by four
336 distractors. Another difference is that the present study did not manipulate the cue-target
337 interval, which was a factor typically manipulated in the previous studies. The current results
338 might reflect that invalid self-cues attract and hold spatial attention more strongly than friend
339 cues, and disengaging attention from invalid cue locations disrupts performance with
340 demanding targets when they appear in the opposite location. An important boundary
341 condition is that the self-relevance effect is observed only when processing demands for the
342 target are high.

343 The current results showing that self-relevant cues increase alerting and influence
344 orienting have support from neuroimaging studies. For example, a recent study has shown
345 differences in neural activity between self- and neutral-cue conditions under valid and invalid
346 conditions (Zhao et al., 2018). The authors found that neural activity in the dorsal and ventral
347 frontoparietal networks (attentional control networks, including the superior parietal lobule

348 and the right temporoparietal junction) was increased by self cues in the valid condition than
349 in the invalid condition. Alzueta et al. (2020) manipulated the levels of familiarity in faces of
350 the same gender and compared the gamma-band power in brain regions that engage in face
351 processing. The results showed a greater and sustained decrease in alpha-beta power during
352 processing self faces than the faces of familiar and unfamiliar others. The researchers argued
353 that a person's own face could trigger a special attentional mechanism that regulates activity
354 in cortical areas dedicated to facial perception and that the effect was self-specific and could
355 not be explained by familiarity. They proposed that self-bias effects in orienting might be
356 restricted to attentional control in visual selection driven by a top-down attentional control
357 mechanism, which might facilitate further processing of personally relevant events.

358 Additional evidence comes from neuropsychological studies showing the interaction between
359 executive control and automaticity of self-processing. For example, brain damage in the
360 dorsal frontoparietal cortex (associated with executive control) led to enhanced self-bias in
361 memory due to an exaggerated effect of strong attentional signals, while brain lesions in the
362 ventral prefrontal cortex, a region associated with self-evaluation, led to a decreased self-bias
363 (Sui, Enock et al., 2015).

364 In conclusion, the present results indicated that the presence of self-related cues
365 preceding a target modulated alertness and orienting, specifically in conflict situations. We
366 interpret this result as evidence that self-relevance enhances attention intensity, which can
367 lead to opposite consequences, either facilitating task performance when the upcoming target
368 falls in the same location, or disrupting performance when a demanding target falls outside
369 these locations. There is no difference between self and friend cues in the low conflict
370 conditions. The current results indicate that self salience of stimuli impacts how attention is
371 distributed, and consequently, how subsequent information is processed.

372

373 **Acknowledgements** Research reported in this publication was supported by the Leverhulme
374 Trust (project RPG-2019-010) to JS, and the CSC Scholarship (project 201809470005) to BL
375 and JS, and the Social Sciences and Humanities in Jiangxi Province (project XL20101) to BL.
376

377 **Open Practices Statement** The data for the experiments reported here is available. The raw
378 data for the association matching task and the ANT task can be found at Open Science
379 Framework: <https://mfr.osf.io/render?url=https%3A%2F%2Fosf.io%2Fgfwr4%2Fdownload>
380

381 **References**

- 382 Aben, B., Verguts, T., Van den Bussche, E. (2017). Beyond trial-by-trial adaptation: a
383 quantification of the time scale of cognitive control. *Journal of Experimental*
384 *Psychology: Human Perception and Performance*, 43(3), 509–517.
- 385 Alexopoulos, T., Muller, D., Ric, F., & Marendaz, C. (2012). I, me, mine: Automatic
386 attentional capture by self - related stimuli. *European Journal of Social Psychology*,
387 42(6), 770–779.
- 388 Alzueta, E., Melcón, M., Jensen, O. & Capilla, A. (2020). The ‘Narcissus Effect’: Top-
389 down alpha-beta band modulation of face-related brain areas during self-face
390 processing. *NeuroImage*, 213, 116754.
- 391 Blasi, G., Goldberg, T. E., Elvevag, B., Rasetti, R., Bertolino, A., Cohen, J., ... (2007).
392 Differentiating allocation of resources and conflict detection within attentional
393 control processing. *European Journal of Neuroscience*, 25(2), 594–602.
394 DOI:10.1111/j.1460-9568.2007.05283.
- 395 Bola, M., Paź, M., Doradzińska, L., & Nowicka, A. (2020). The self-face automatically

396 captures attention without consciousness. *bioRxiv preprint*, doi:
397 <https://doi.org/10.1101/2020.01.22.915595>.

398 Botwinick, M.M., Braver, T.S., Barch, D.M., Carter, C.S., & Cohen, J.D. (2001).
399 Conflict monitoring and cognitive control. *Psychological Review*, 108, 624–652.

400 Devue, C., Belopolsky, A. V., & Theeuwes, J. (2012). Oculomotor guidance and capture
401 by irrelevant faces. *PLoS ONE*, 7(4), e34598.

402 Dalmaso, M., Castelli, L., & Galfano, G. (2019). Self-related shapes can hold the eyes.
403 *Quarterly Journal of Experimental Psychology*, DOI:
404 [org/10.1177/1747021819839668](https://doi.org/10.1177/1747021819839668)

405 Eichenlaub, J. B., Ruby, P., & Morlet, D. (2012). What is the specificity of the response
406 to the own first-name when presented as a novel in a passive oddball paradigm? An
407 ERP study. *Brain Research*, 1447, 65–78.

408 Fan, J., McCandliss, B.D., Sommer, T., Raz, M., & Posner, M.I. (2002). Testing the
409 efficiency and independence of attentional networks. *Journal of Cognitive*
410 *Neuroscience*, 3, 340–347.

411 Fan, J., Gu, X. S., Guise, K. G., Liu, X., Fossella, J., Wang, H. B., & Posner, M. I.
412 (2009). Testing the behavioral interaction and integration of attentional networks.
413 *Brain and Cognition*, 70, 209–220.

414 Fan, W., Chen, J., Wang, X., Cai, R., Tan, Q., Chen, Y., & et al. (2013).
415 Electrophysiological correlation of the degree of self- reference effect. *PLoS One*, 8,
416 e80289.

417 Gronau, N., Cohen, A., & Ben-Shakhar, G. (2003). Dissociations of personally
418 significant and task- relevant distractors inside and outside the focus of attention: a
419 combined behavioral and psychophysiological study. *Journal of Experimental*

420 *Psychology: General*, 132(4), 512.

421 Holland, C. A. (1993). Self-bias in older drivers' judgments of accident likelihood.

422 *Accident Analysis & Prevention*, 25(4), 431–441.

423 Humphreys, G., & Sui, J. (2015). The salient self: social saliency effects based on self-

424 bias. *Journal of Cognitive Psychology*, 27, 129–140.

425 Kaida, K., & Iwaki, S. (2018). Hearing own or other' s name has different effects on

426 monotonous task performance. *PLoS One*, 13(9), e0203966.

427 Keenan, J. P., McCutcheon, B., Freund, S., Gallup, G. G., Sanders, G., & Pascual-Leone,

428 A. (1999). Left hand advantage in a self-face recognition task. *Neuropsychologia*,

429 37(12), 1421–1425.

430 Kim, K., Jeon, Y. A., Banquer, A. M., & Rothschild, D. J. (2018). Conscious awareness

431 of self-relevant information is necessary for an incidental self-memory advantage.

432 *Consciousness and Cognition*, 65, 228–239.

433 <https://doi.org/10.1016/j.concog.2018.09.004>

434 Kinoshita, S, Mozer, M.C., Forster, K.I. (2011). Dynamic adaptation to history of trial

435 difficulty explains the effect of congruency proportion on masked priming. *Journal*

436 *of Experimental Psychology: General*, 140(4), 622–636.

437 Landman, L. L., & van Steenbergen, H. (2020). Emotion and conflict adaptation: the role

438 of phasic arousal and self-relevance. *Cognition and Emotion*, 1–14.

439 DOI:10.1080/02699931.2020.1722615.

440 Macrae, C. N., Visokomogilski, A., Golubickis, M., & Sahraie, A. (2018). Self-relevance

441 enhances the benefits of attention on perception, *Visual Cognition*, DOI:

442 10.1080/13506285.2018.1498421.

443 Posner, M. I., Rothbart, M.K. (2007). Research on attention networks as a model for the

444 integration of psychological science. *Annual review of psychology*, 58, 1–23.

445 Posner, M. I., Rothbart, M. K., & Ghassemzadeh, H. (2019). Restoring attention
446 networks. *Yale Journal of Biology and Medicine*, 92(1), 139–4.

447 Posner, M. I., Walker, J. A., Friedrich, F. J., & Rafal, R. D. (1984). Effects of parietal
448 injury on covert orienting of attention. *Journal of Neuroscience*, 4(7), 1863–1874.

449 Quintana, D. S., & Williams, D. R. (2018). Bayesian alternatives for common null-
450 hypothesis significance tests in psychiatry: a non-technical guide using JASP. *BMC*
451 *Psychiatry*, 18, 178. <https://doi.org/10.1186/s12888-018-1761-4>.

452 Schacht, R., Bell, R., & Buchner, A. (2013). Self-relevance increases the
453 irrelevant sound effect: Attentional disruption by one's own name. *Journal of*
454 *Cognitive Psychology*, 25, 925–931. DOI:10.1080/20445911.

455 Sui, J., He, X., & Humphreys, G. W. (2012). Perceptual effects of social salience:
456 evidence from self-prioritization effects on perceptual matching. *Journal of*
457 *Experimental Psychology: Human Perception and Performance*, 38(5), 1105–1117.

458 Sui, J., & Humphreys, G. W. (2017). The ubiquitous self: what the properties of self-bias
459 tell us about the self. *Annals of the New York Academy of Sciences*, 1396(1), 222-
460 235.

461 Sui, J., Liu, M., Mevorach, G., & Humphreys, G. W. (2015). The salient self: The left
462 intraparietal sulcus responds to social as well as perceptual-salience after self-
463 association. *Cerebral Cortex*, 25, 1060–1068.

464 Sui, J., Liu, C. H., Wang, L., & Han, S. (2009). Attentional orientation induced by
465 temporarily established self-referential cues. *The Quarterly Journal of Experimental*
466 *Psychology*, 62, 844–849.

467 Sui, J., & Rotshtein, P. (2019). Self-prioritization and the attentional systems. *Current*

468 *Opinion in Psychology*, 29, 148-152.

469 Tacikowski, P., & Nowicka, A. (2010). Allocation of attention to self-name and self-face:
470 An ERP study. *Biological Psychology*, 84,318–324.

471 Tacikowski, P., Cygan, H. B., & Nowicka, A. (2014). Neural correlates of own and
472 close-other's name recognition: ERP evidence. *Frontiers in Human Neuroscience*,
473 DOI: 10.3389/fnhum.2014.00194.

474 Turk, D. J., Cunningham, S. J., & Macrae, C. N. (2008). Self- memory biases in explicit
475 and incidental encoding of trait adjectives. *Consciousness and Cognition*, 17(3),
476 1040–1045.

477 Wade, G. L., & Vickery, T. J. (2018). Target self-relevance speeds visual search
478 responses but does not improve search efficiency. *Visual Cognition*, 26(8), 563–582.
479 <https://doi.org/10.1080/13506285.2018.1520377>.

480 Wang, Y., Jing X., Liu, F., Li, M., Long, Z., Yan, J., & Chen, H. (2015). Reliable
481 Attention Network Scores and Mutually Inhibited Internetwork Relationships
482 Revealed by Mixed Design and Non-orthogonal Method. *Scientific Reports*, 5,
483 10251.

484 Weinbach, N., & Henik, A. (2012). The relationship between alertness and executive
485 control. *Journal of Experimental Psychology: Human Perception and Performance*,
486 38, 1530–1540.

487 Yamada, Y., Kawabe, T., & Miura, K. (2012). One's own name distorts visual space.
488 *Neuroscience letters*, 531(2), 96–98.

489 Yang, H., Wang, F., Gu, N., Gao, X., & Zhao, G. (2013). The cognitive advantage for
490 one's own name is not simply familiarity: An eye-tracking study. *Psychonomic*
491 *bulletin & review*, 20(6), 1176–1180.

492 Yankouskaya, A., Palmer, D., Stolte, M., Sui, J., & Humphreys, G. (2017). Self-bias
493 modulates saccadic control. *The Quarterly Journal of Experimental Psychology*,
494 *70*(12), 2577–2585.

495 Yin, S., Sui, J., Chiu, Y.-C., Chen, A., & Egner, T. (2019). Automatic Prioritization of
496 Self-Referential Stimuli in Working Memory. *Psychological Science*,
497 DOI:10.1177/0956797618818483.

498 Zhao, S., Uono, S., Li, C., Yoshimura, S., & Toichi, M. (2018). The Influence of Self-
499 Referential Processing on Attentional Orienting in Frontoparietal Networks.
500 *Frontiers in Human Neuroscience*, DOI: 10.3389/fnhum.2018.00199.

501 Zhou, A., Duan, B., Wen, M., Wu, W., Li, M., Ma, X., & Tan, Y. (2019). Self-
502 Referential processing can modulate visual spatial attention deficits in children with
503 dyslexia. *Frontiers in Psychology*, *10*, 2270. DOI: 10.3389/fpsyg.2019.02270.