Journal of Experimental Psychology:
Human Perception and Performance
2012, Vol. 38, No. 5, 1105–1117

0096-1523/12/$12.00 DOI: 10.1037/a0029792

Perceptual Effects of Social Salience: Evidence From Self-Prioritization Effects on Perceptual Matching

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We present novel evidence showing that new self-relevant visual associations can affect performance in simple shape recognition tasks. Participants associated labels for themselves, other people, or neutral terms with geometric shapes and then immediately judged whether subsequent label–shape pairings were matched. Across 4 experiments there was a reliable self-prioritization benefit on response times and perceptual sensitivity that remained across different presentation contexts (with self, best friend, and unfamiliar others in Experiment 1; with self, best friend, and neutral terms, and with self, mother, and neutral terms in Experiments 2A and 2B, respectively. Control studies in Experiment 3 indicated that the results did not reflect the length, concreteness, or familiarity of the words. The self-prioritization effect on shape matching also increased when stimuli were degraded (self shapes showing weaker effects of degradation) in Experiment 4A, consistent with self-information modulating perceptual processing. A similar effect was found when people associated different reward values to the shape in Experiment 4B. The results indicate that associating a stimulus to the self modulates its subsequent perceptual processing, and this may operate by self-associated shapes automatically evoking the reward system.

Keywords: self-relevance, self-representation, learning, association, reward

It is well known that the social salience of a stimulus, such as whether a stimulus is relevant to ourselves or not, or whether it is attractive or dangerous, can guide attention (Gronau, Cohen, & Ben-Shakhar, 2003; Sui & Liu, 2009; Vuilleumier, 2005). However, the vast majority of studies on the effects of social salience use stimuli that already have learned associations (e.g., the image of our own face or of an attractive person) and many examine processes involved in memory and higher level decision making (Cunningham, Turk, Macdonald, & Macrae, 2008; Turk, Cunningham, & Macrae, 2008); there are few data on whether social salience modulates relatively low-level tasks, such as simple perceptual matching. The question of whether social salience permeates perceptual processing is crucial for understanding our capacity to adapt to complex and dynamically changing environments in ways that optimize self-survival. For example, evidence that self-relevant information pervades perceptual processing would fit with the idea of an organism tuned to self-survival at multiple levels of processing, not just through relatively high-level processes of self-related decision making. Here, we present a novel demonstration of the effects of the social salience of self-related information on simple perceptual matching tasks. The data indicate the rapid, online modulation of visual processing by self-relevance that operates in a manner qualitatively similar to the effects of reward. We review the implications in the General Discussion.

There is mounting evidence that self-related information, conveyed by our face and name, has high processing priority relative to other types of social information. For example, participants are faster to respond to their own than to other peoples' faces, no matter whether the task requires explicit face recognition for categorizing the familiarity of the stimulus (self vs. familiar others, familiar vs. unfamiliar) or judgments about face orientation without explicit face recognition being required (Keenan et al., 1999; Keyes & Brady, 2010; Sui, Chechlacz, & Humphreys, 2012; Sui, Liu, & Han, 2009). Attention can also be automatically attracted by self-related information presented as a distractor compared with when distractors are associated with other people (Brédart, Delchambre, & Laureys, 2006; Gronau et al., 2003). These studies have typically used highly familiar self-related stimuli learned over long periods of time, but they do not touch on whether new self-associations can quickly modulate perceptual processing. This was examined here.

To test whether new self-associations affect perceptual processing, we developed a novel associative learning approach in which

This article was published Online First September 10, 2012

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This work was supported by a Royal Society Newton Fellowship and the National Nature Science Foundation of China (Project 31170973) to Jie Sui and by a grant from the Economic and Social Research Council to Glyn W. Humphreys.

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participants were asked to associate an abstract geometric shape to a label indicating either themselves (e.g., *you*), either a familiar other (e.g., *friend*) or an unfamiliar other (e.g., *stranger*), or a neutral word (e.g., *none*). Immediately after this, the task was to judge whether subsequent pairs of labels and shapes were matched. We asked not only whether people can associate an abstract geometric shape with the different labels, but whether there is evidence for social salience affecting perceptual matching performance, indicated by an advantage in matching a newly established self-related association compared with associations to other labels. In contrast to prior studies of self-prioritization that have used very familiar self-related stimuli (e.g., Keenan et al., 1999; Kesebir & Oishi, 2010; Keyes & Brady, 2010; Klein, Loftus, & Burton, 1989; Sui et al., 2009), the same shapes here appeared in the self, familiar other, and stranger/neutral conditions (counterbalancing across participants). This rules out effects being based on the differential familiarity of the shape stimuli rather than on their association to self-information. Thus, the associative learning procedure we adopted can overcome fundamental methodological problems in prior empirical work on self-perception using self faces and names by eliminating potentially confounding differences that exist between self-relevant and other stimuli.

We assessed whether the association between a self label and an arbitrary shape can immediately lead to a self-prioritization effect and whether the self-association permeates even simple perceptual matching tasks using label–shape associations. This would be consistent with studies of self-prioritization in face perception (e.g., Keenan et al., 1999; Keyes & Brady, 2010) and on high-level cognitive tasks (e.g., Cunningham et al., 2008; Klein et al., 1989; Roger, Kuiper, & Kirker, 1977; Turk et al., 2007).

To examine the effect of self–shape association, we report four experiments. We measured self-prioritization on accuracy and reaction times (RTs) in shape matching. In Experiment 1, we asked participants to associate the geometric shapes to words representing the self, the participant's best friend, and an unfamiliar other. If a self-association rapidly triggers self-referential information, we should observe a self-advantage effect. Namely, RTs should be faster and perceptual sensitivity greater for self-relevant than for other stimuli. This advantage was confirmed using a bootstrapping procedure, which highlights the central tendency in each association condition. Mean bootstrapped samples were calculated based on the re-pairing of accuracy–reaction time data points for each condition. We predicted that there would be a distinctive distribution for self-associations compared with other associations (see also Sui & Humphreys, 2011). In Experiment 2, we examined whether the self-prioritization effect was stable by manipulating the associative context and the task demands in the matching task. Experiment 2A used associations formed between shapes and words representing the self, the participant's best friend, and a neutral label. Experiment 2B had participants associate a shape with a label referring to their mother rather than their best friend. We assessed whether a reliable self-association advantage would emerge across the different learning contexts, independent of associations with different others (highly familiar others, mother, and best friend) and the nature of any nonpersonal association (stranger, neutral term). In Experiment 3, we conducted a series of control studies that counter arguments that the present results reflect factors such as the length and/or the concreteness of the words. Finally, in Experiment 4A, we present converging evidence for self-related information affecting perceptual processing by examining the effects of stimulus degradation on matching with self- and other-related shapes. The data indicate that effects of stimulus degradation were lessened for self-related shapes, consistent with self-associations modulating perceptual processing. In Experiment 4B, we show that a similar interaction to that between self-information and stimulus degradation occurs when associations are made to different reward values, indicating that self-prioritization operates in an analogous manner to the effects of high reward. We discuss the implication for understanding both self-prioritization and perceptual processing more generally.

Experiment 1: Self- Versus Best Friend and Stranger Associations

Method

Participants. There were 18 college students (four men; 18 to 35 years of age, $M = 21.78 \pm 5.80$). All participants were right-handed and had normal or corrected-to-normal vision. Informed consent was obtained from all participants prior to the experiment according to procedures approved by a local ethics committee.

Stimuli and tasks. Three geometric shapes (triangle, square, and circle, each $3.8° \times 3.8°$), were presented above a white fixation cross ($0.8° \times 0.8°$) at the center of the screen. The association of the three shapes to the self, friend, or stranger conditions was counterbalanced across participants. The word *you*, *friend*, or *stranger* ($3.1°/3.6° \times 1.6°$) was displayed below the fixation cross. The distance between the center of the shape or the word and the fixation cross was 3.5°. All stimuli were shown on a gray background. Participants judged whether the pairings of shape and label matched (e.g., Is the circle your friend?). The experiment was run on a PC using E-prime software (Version 1.1). The stimuli were displayed on a 17-in. monitor ($1,024 \times 768$ at 60 Hz).

Procedure. The experiment had two stages. First, there was a training stage. Participants were asked to code named geometric shapes (triangle, square, and circle) as the self, a named best friend, or an unfamiliar person (pretest lasting 60 s). For example, a participant was told, "Mary [the stated best friend of the participant] is a circle; you are a triangle; and a stranger is represented by a square." The shapes themselves were not presented at this stage. After this, the matching stage of the experiment was conducted. In the matching task, participants judged whether shape–label pairings, which were subsequently presented, were correct. Each trial started with the presentation of a central fixation cross for 500 ms. Subsequently, a pairing of a shape and label (*you*, *friend*, or *stranger*) was presented for 100 ms. The pairing could conform to the verbal instruction for each pairing given in the training stage, or it could be a recombination of a label with a different shape, with the shape–label pairings being generated at random. The next frame showed a blank for a variable time ranging from 800 to 1,200 ms. Participants were expected to judge whether the shape was correctly assigned to the person by pressing one of the two response buttons as quickly and accurately as possible within this timeframe (to encourage immediate responding). Feedback (correct or incorrect) was given on the screen for 500 ms at the end of each trial. Participants were informed of their overall accuracy at the end of each block. Each participant performed three blocks of 120 trials following 12 practice trials, where self, friend, unfamiliar, and re-paired stimuli occurred equally often in a random order. Thus, there were 60 trials in each condition (self-matched, self-nonmatching, familiar-matched, familiar-nonmatching, unfamiliar-matched, and unfamiliar-nonmatching).

Results and Discussion

There were two within-subjects variables, shape category (self, familiar, or unfamiliar) and matching judgment (matched vs. nonmatching). Correct responses shorter than 200 ms were excluded from the analysis, eliminating less than 1% of the trials overall.

Table 1 shows the accuracy and RT data in Experiment 1. To assess the overall training effect, we adopted a bootstrapping procedure to examine the distribution characteristic of matching judgments in each condition, combining accuracy and RT performance (Davison & Hinkley, 1997; Efron & Tibshirani, 1993). This approach emphasizes the central tendency of matching judgments and provides a description of judgment efficiencies for each association condition. For each participant in each condition, accuracy and RT were paired as a single data point (x, y). A bootstrapped data set was then created by resampling the data with replacement, keeping the sample size of data as the number of participants. Then, we calculated the mean of this bootstrapped data set and plotted it as a single point in the distribution (x, y). The same procedure was repeated 2,000 times to estimate the population mean and variation for each condition. Figure 1 visually demonstrates the different distributions across the association judgments. The bootstrapped sample mean observations for self-matched judgments fall in the lower right corner of the figure. In contrast, the unfamiliar-matched judgments fall in the upper left locations, and the familiar-matched judgments fall in the middle locations (see Figure 1A). The distributions for responses to nonmatching shape–label pairs overlapped (see Figure 1B).

The bootstrapped data show a clear boundary between self- and other associations for correct matches. To test the self-prioritization effect, we first analyzed accuracy performance using a signal detection approach. Performance in each match condition was combined with that in the nonmatching condition with the same shape to form a measure of d', with the data analyzed using analyses of variance (ANOVAs) with a within-subjects factor shape category (self, familiar, or unfamiliar). There was a significant effect of category shape, $F(2, 34) = 11.95$, $p < .001$, $\eta^2 = .41$; d' was larger for self- than for the other associations ($ps < .005$), whereas there was no difference between familiar and unfamiliar associations ($p = .22$; see Figure 1C).[1]

ANOVAs for the RTs showed a significant effect of shape category, $F(2, 34) = 27.13$, $p < .001$, $\eta^2 = .62$, because of a benefit for the self- relative to other associations ($ps < .001$) and a benefit for the familiar relative to unfamiliar other associations ($p < .05$). The interaction of shape category and matching judgment was also significant, $F(2, 34) = 21.74$, $p < .001$, $\eta^2 = .56$. The analyses for the matched and nonmatched pairs were then conducted. The data showed a significant effect of shape category for the matched pairs, $F(2, 34) = 34.87$, $p < .001$, $\eta^2 = .67$, reflecting a self-association advantage over other associations ($ps < .001$) and a familiar other association advantage relative to unfamiliar other association ($p < .05$). In contrast, there was no significant effect of shape category for the nonmatched pairs ($p = .88$).

The results indicate that geometric shapes can quickly be associated with representations of the self and this may then trigger such self-associations rapidly enough to modulate ongoing matching tasks. Experiment 3 reports control data as we try to rule out effects of other factors (such as the concreteness and familiarity of the words), which could also contribute to this apparent self-prioritization effect.

Table 1
Mean Reaction Times and Accuracy as a Function of Match Condition (Matched vs. Unmatched) and Shape Category (Self, Friend, and Unfamiliar Other) in Experiment 1

Condition	Shape category	Mean RT (ms)	Accuracy
Matched	Self	674 (77)	0.95 (0.04)
	Friend	803 (143)	0.81 (0.14)
	Unfamiliar	850 (149)	0.71 (0.18)
Nonmatching	Self	859 (111)	0.80 (0.14)
	Friend	854 (116)	0.82 (0.11)
	Unfamiliar	851 (108)	0.85 (0.11)

Note. RT = reaction time; Accuracy = proportion correct. Standard deviations appear within parentheses.

Experiment 2: Self- Versus Familiar, Mother, and Neutral Associations

Method

In Experiment 2, a new baseline condition was introduced in which participants had to learn an association between a shape and a word without any social connotation—the word *none*. In Experiment 2A, the additional labels were *you* and *friend*; in Experiment 2B, they were *you* and *mother*. Prior work indicates that mother associations can be particularly strong, in some cultures matching effects with self-information (e.g., Zhu, Zhang, Fan, & Han, 2007; for a review, see Han & Northoff, 2009). Also, it can be argued that the *mother* label and concept are as familiar as the self-concept, and there may be a developmental advantage for mother associations having earlier onset (Damon & Hart, 1982; Montemayor & Eisen, 1977). By contrasting self- and mother associations, we tested whether there is something special about self-associations not easily attributed to familiarity, age of concept development, and so forth. For each subexperiment, 18 students participated. For Experiment 2A, one participant was excluded from the data analysis because no response was made for the neutral association stimulus. In Experiment 2A, there was one man, and participants were between 18 and 20 years of age ($M = 18.76 \pm 0.83$); in Experiment 2B, there was again one man, and the ages were between 18 and 20 years ($M = 18.89 \pm 0.83$). In Experiment 2B, all the participants had grown up with their mothers.

The procedure was the same for each subexperiment. Each trial was terminated by the participants' response or by exceeding a maximum response limit of 1,100 ms. Each participant performed

[1] The data on participants' response criteria are reported in the Appendix.

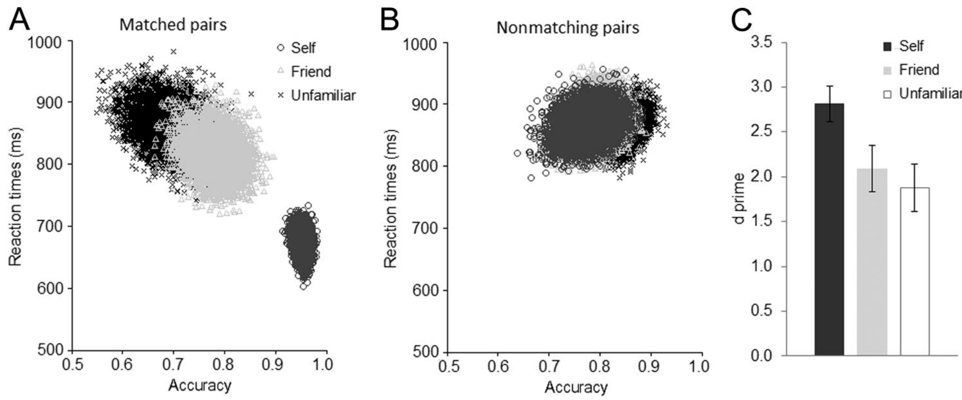

Figure 1. The self-association effect in Experiment 1. Distributions of bootstrapped sample means for matched (A) and nonmatching pairs (B). The horizontal axis represents the accuracy rates and the vertical axis reaction times. C shows the data for the measure of d' as a function of shape category. Error bars represent standard errors.

three blocks of 54 trials, where the shapes and labels of self, friend/mother, and neutral were re-paired and occurred equally often in a random order. Thus, there were 18 trials in each match condition and 36 trials in each nonmatch condition. In all other respects, the method matched that in Experiment 1.

Results and Discussion

Correct responses shorter than 200 ms were excluded from the analysis; less than 1% of the trials were eliminated.

Experiment 2A. Figure 2 shows the bootstrapped data. In line with the evidence for self-prioritization in Experiment 1, the bootstrapped sample mean observations from the self-match judgments fall in the lower right corner. In contrast, the neutral matches fall in the upper left locations, and the familiar match judgments fall in the middle locations (see Figure 2A). For nonmatching pairs based on shape, however, there was overlap across the different associations (see Figure 2B). The data show (a) the benefit of self-matched judgments relative to matched judgments for familiar and nonpersonal (neutral) associations, along also with (b) a benefit for matches of a shape to a familiar label relative to a neutral label.

Table 2 shows the accuracy and RT data for Experiment 2. We first conducted the analysis for d' with a within-subjects variable, shape category (self, familiar, or neutral). The results showed that there was a significant effect of shape category, $F(2, 32) = 18.26$, $p < .001$, $\eta^2 = .53$; d' was larger for the self- than for the familiar and neutral associations ($ps < .05$ and .001, respectively), and it was larger for familiar than for neutral associations ($p < .001$; see Figure 2C). Because participants showed poor accuracy for the matched neutral pairs ($M = 0.35 \pm 0.20$),[2] ANOVAs on the RTs focused only on the self- and familiar associations. There were two within-subjects variables, shape category (self vs. familiar) and matching judgment (matched vs. nonmatching). The data showed a significant effect of shape category, $F(1, 16) = 15.49$, $p < .001$, $\eta^2 = .49$, reflecting faster responses to the self- relative to familiar associations. There was also a significant interaction between shape category and matching judgment, $F(1, 16) = 8.32$, $p < .02$, $\eta^2 = .34$. This interaction reflected a self-advantage over the familiar association for the matching pairs, $F(1, 16) = 13.18$, $p < .005$, $\eta^2 = .45$, but no such effect was observed in the nonmatching condition ($p = .95$).

Experiment 2B. Figure 3 illustrates the bootstrapped data. As before, the bootstrapped sample mean observations from the self-matched judgments fell in the lower right corner. In contrast, the neutral association judgments fell in the upper left locations, and the judgments for matches to the mother shape fell in the middle locations (see Figure 3A). For nonmatching pairs based on shape, there was an overlap across the different associations (see Figure 3B). The figure indicates the presence of a benefit for self-match judgments relative to judgments for the mother and neutral associations and an advantage for mother over neutral associations.

Table 3 shows data for both response accuracy and RT measures. Analysis of the d' data revealed a significant effect of shape category, $F(2, 34) = 36.56$, $p < .001$, $\eta^2 = .68$; d' was larger for the self- than for the mother and neutral associations ($p < .05$ and .001, respectively); there was also a larger d' for mother than for neutral associations ($p < .001$; see Figure 3C). The neutral condition was excluded from the RT analyses because of the low accuracy on matching trials ($M = 0.31 \pm 0.20$). The ANOVAs for RTs with shape category (self vs. mother) and matching judgment (matched vs. nonmatching) showed a significant effect of shape category, $F(1, 17) = 9.92$, $p < .01$, $\eta^2 = .37$, because of a self-advantage over the mother association. There was also a reliable significant interaction of shape category and matching judgment, $F(1, 17) = 13.51$ $p < .005$, $\eta^2 = .44$. Responses to the self-association were faster than to the mother association for matching pairs, $F(1, 17) = 20.46$, $p < .001$, $\eta^2 = .55$, but there was no such effect for the nonmatching pairs ($p = .57$).

Both subexperiments show that both self- and familiar associations are matched better than nonpersonal (neutral) associations. Here, accuracy on match trials with the neutral associations was poor, indicating that participants found it difficult to judge the correct shape–label pairing under the present conditions (with a

[2] When we took nonmatch trials with the neutral shape ($M = 0.75 \pm 0.12$) into account, performance for neutral associations was above chance, but this was still relatively poor.

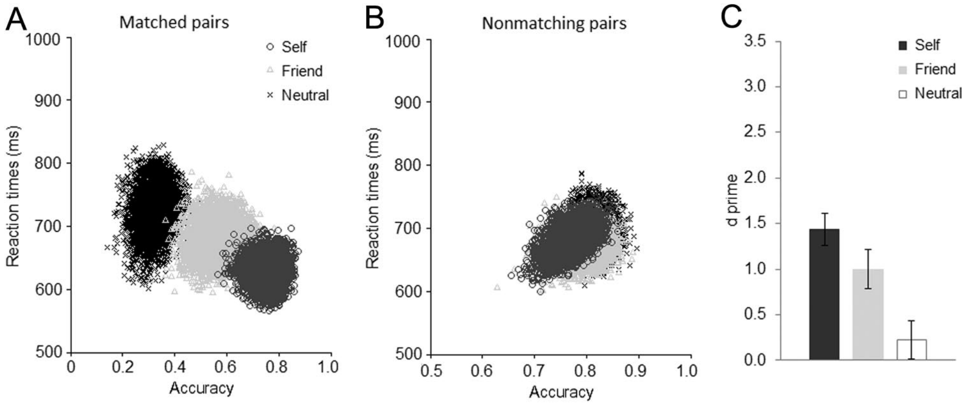

Figure 2. The self-association effect in Experiment 2A. Distributions of bootstrapped sample means for matched (A) and nonmatching pairs (B). The horizontal axis represents the accuracy rates and the vertical axis reaction times. C shows the data for the measure of d' as a function of shape category. Error bars represent standard errors.

relatively short learning procedure and nine different shape–label pairings) unless the label was related to a familiar person. However, familiarity was not fully determining because self-associations were still responded to more easily than mother associations (see Experiment 2B), although the mother concept is highly familiar and may be established before any self-concept. In Experiment 3, we report attempts to assess whether other factors (word concreteness, word frequency, and word length) could generate the self-advantage in Experiments 1 and 2.

Experiment 3: Control Experiments

3A: Assessment of the Effects of Word Concreteness

One account of the self-advantage is that it is due to the self being a more concrete concept than concepts such as friend, mother, or stranger, and the increased concreteness of the self-concept leads to the self-prioritization effect in a matching task.[3] However, this seems an unlikely account of the data. According to the database of word norms provided by Nelson, McEvoy, and Scheiber (1998), the terms *friend*, *mother*, and *stranger* (concreteness scores: 4.40, 5.47, and 5.55, respectively) are more concrete than the word *you* (concreteness score: 3.66). So, at least in relation to the terms used, the self was not the most concrete label. To confirm this, we recruited a group of participants to fill in a questionnaire of word concreteness.

Method.

Participants. Twenty-five college students (three men; 18 to 26 years of age, $M = 19.08 \pm 1.66$) rated the concreteness of words. Informed consent was obtained from all participants prior to the experiment according to procedures approved by a local ethics committee.

Questionnaire of word concreteness. Participants were required to fill in a questionnaire of word concreteness on a 7-point scale (1 = *very hard to think of a context* and 7 = *very easy to think of a context*; Clark & Paivio, 2004) for a series of words *friend*, *mother*, *stranger*, *other*, *you*, and *yourself* used in this study.

Results. We first conducted a one-way repeated measures ANOVA with the factor of word (*friend*, *you*, or *stranger*) to assess the concreteness of the words used in Experiment 1. There was a reliable main effect of word, $F(2, 48) = 12.87$, $p < .001$, $\eta^2 = .35$; participants rated the word *friend* as more concrete than *you* and *stranger* (ps < .005 and .001, respectively, pairwise post hoc comparisons), which did not differ ($p = .27$).

We then conducted a subsequent ANOVA, this time on the items used across Experiments 1–3. The data again showed a significant main effect of word, $F(3, 72) = 13.15$, $p < .001$, $\eta^2 = .35$; *you* and *yourself* were rated as less concrete than *friend* and *mother* (ps < .01), but there was no difference between *you* and *yourself* ($p = 1.00$) or between *friend* and *mother* ($p = 1.00$).

Finally, an ANOVA was conducted on the items from Experiment 4A. The data revealed a significant main effect of word, $F(2, 48) = 41.28$, $p < .001$, $\eta^2 = .63$. Participants rated the word *friend* as being more concrete than *you* and *other* (ps < .005 and .001, respectively), and *you* was rated as more concrete than *other* ($p < .001$).

Table 2
Mean Reaction Times and Accuracy as a Function of Match Condition (Matched vs. Unmatched) and Shape Category (Self, Friend, and Neutral) in Experiment 2A

Condition	Shape category	Mean RT (ms)	Accuracy
Matched	Self	619 (81)	0.79 (0.16)
	Friend	700 (111)	0.56 (0.26)
	Neutral	756 (157)	0.35 (0.20)
Nonmatching	Self	675 (107)	0.73 (0.10)
	Friend	676 (87)	0.78 (0.09)
	Neutral	695 (101)	0.75 (0.12)

Note. RT = reaction time; Accuracy = proportion correct. Standard deviations appear within parentheses.

[3] Against this note that participants were asked to select a particular concrete example of a friend during the familiarization period; note also that they should have a concrete concept of their mother.

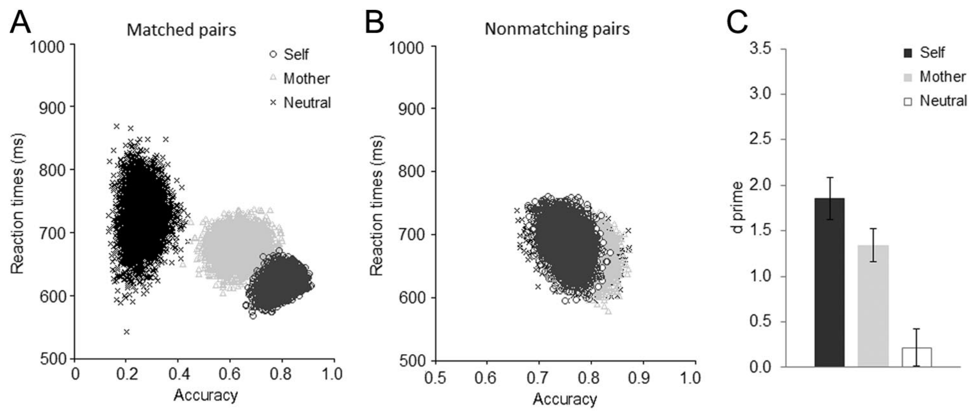

Figure 3. The self-association effect in Experiment 2B. Distributions of bootstrapped sample means for matched (A) and nonmatching pairs (B). The horizontal axis represents the accuracy rates and the vertical axis reaction times. C shows the data for the measure of d' as a function of shape category. Error bars represent standard errors.

These results suggest that the self-prioritization effect in the matching task was unlikely to be due to differences in the concreteness of the words, as self-related words were, if anything, less concrete than words relating to friend and mother.

3B: Assessment of Word Frequency

Performance in Experiments 1 and 2 cannot reflect differences in the familiarity of the shapes because these were randomly assigned to the self, familiar other, and stranger conditions. On the other hand, there may be effects of word frequency. According to the English Lexicon Project (Balota et al., 2007; http://elexicon.wustl.edu/), the word *you* (whose log transformed Hyperspace Analogue to Language frequency norms is 15.4) has a higher frequency than the words *friend* (11.3), *mother* (10.7), and *stranger* (8.6), so this could have contributed to the differences in performance. However, in Experiment 3C, the label *you* was replaced with *yourself*, which has a relatively low frequency (11.3), and *stranger* was replaced with *other*, which has a slightly higher frequency (13.7); nevertheless, the self-prioritization effect was replicated. Word frequency does not seem critical.

To further assess effects of word familiarity, we asked a group of participants to rate how frequently they used the words *friend*, *mother*, *stranger*, *other*, *you*, and *yourself* (using a 1–7 scale, where 7 = *very high frequency use*). Participants rated using the word *you* (5.96) more frequently than *mother* (3.86) and *stranger* (2.79), but there were no differences between the ratings for *you* and *friend* (6.09). More important, they rated *yourself* with a lower frequency (3.36) than *friend* and *mother*. Converging with the experiments in which either using *you* or *yourself* consistently showed a reliable self-prioritization effect compared with the *friend* and *mother* conditions, the familiarity of the words was unlikely to be a critical factor to self-prioritization effect.

Table 3
Mean Reaction Times and Accuracy as a Function of Match Condition (Matched vs. Unmatched) and Shape Category (Self, Mother, and Neutral) in Experiment 2B

Condition	Shape category	Mean RT (ms)	Accuracy
Matched	Self	610 (76)	0.81 (0.17)
	Mother	682 (90)	0.62 (0.20)
	Neutral	718 (185)	0.31 (0.20)
Nonmatching	Self	678 (115)	0.76 (0.10)
	Mother	670 (101)	0.92 (0.09)
	Neutral	669 (106)	0.78 (0.13)

Method.

Participants. Twenty-two college students (two men; 18 to 40 years of age, $M = 20.72 \pm 6.18$) rated the frequency of words. Informed consent was obtained from all participants prior to the experiment according to procedures approved by a local ethics committee.

Questionnaire of word frequency. Participants were instructed to rate how frequently they used a series of words *friend*, *mother*, *stranger*, *other*, *you*, and *yourself* on a 7-point scale, in which 1 = *very low frequency use* and 7 = *very high frequency use*.

Results. We first conducted one-way repeated measures ANOVA with the factor word (*friend*, *you*, or *stranger*) to assess the frequency of the words used in Experiment 1. There was a significant main effect of word, $F(2, 42) = 102.98$, $p < .001$, $\eta^2 = .83$. Ratings of judged frequency of use were higher for *friend* and *you* than for *stranger* ($ps < .001$ on pairwise post hoc comparisons). There was no difference between *friend* and *you* ($p = 1.00$).

A further ANOVA was conducted with word (*friend*, *mother*, *you*, or *yourself*) as the factor to assess the judged frequency of the words used across Experiments 1–3. The data showed a significant main effect of word, $F(3, 63) = 22.24$, $p < .001$, $\eta^2 = .51$. Ratings for the words *yourself* and *mother* were less than ratings for *friend* and *you* ($ps < .005$); there was no difference in the rated frequency of *yourself* and *mother* ($p = 1.00$).

A further ANOVA with word (*friend*, *you*, or *other*) as the factor was then conducted to assess the frequency of the words used in Experiment 4. The data revealed a significant main effect of word, $F(2, 42) = 12.68$, $p < .001$, $\eta^2 = .63$; participants rated *friend* and *you* as more frequent than *other* ($ps < .005$ and .001, respectively), whereas there was no difference in the rated frequency for *friend* and *you* ($p = 1.00$).

3C: Test of Word Length

A further possibility is that the self-prioritization advantage in Experiments 1 and 2 could reflect the benefit in processing the short label *you* relative to longer labels *friend* and *stranger*. If the word length of the labels does account for the self-prioritization observed in Experiment 1, then the effect should disappear when the short label *you* is replaced by the longer term *yourself*. To assess this, we ran a further control experiment using the terms *yourself*, *friend*, and *other* to correspond to the self, a named best friend, and an unfamiliar other, respectively.

Method. Fourteen college students (two men; 18 to 29 years of age, $M = 19.29 \pm 2.13$) participated this experiment. The method was identical to that in Experiment 2 except that the labels were *yourself*, *friend*, and *other* referring to the self, a named friend, and an unfamiliar other, respectively.

Before the experiment, participants were instructed to rate the familiarity for their named best friend using a 7-pont scale in which 1 = *not very familiar* and 7 = *highly familiar*. The data showed that participants were highly familiar with their named friends ($M = 6.86 \pm 0.36$).

Results. Correct responses shorter than 200 ms were excluded from the analysis, eliminating less than 1% of the trials overall.

There was a significant effect of shape category on d', $F(2, 26) = 9.40$, $p = .001$, $\eta^2 = .42$; d' was larger for the self-association than for the familiar and unfamiliar associations ($ps < .01$), but there was no difference between the familiar and the unfamiliar associations ($p = .70$) (see Figure 4A), consistent with the results in Experiment 1.

The neutral condition was again excluded from the analysis of RTs because of its low accuracy on matching trials ($M = 0.53 \pm 0.19$). ANOVAs on RTs with shape category (self vs. familiar) and matching judgment (matched vs. nonmatching) showed a significant effect of shape category, $F(1, 13) = 7.23$, $p < .02$, $\eta^2 = .36$, reflecting a benefit for the self- relative to the familiar associations. There was also a significant interaction of shape category and

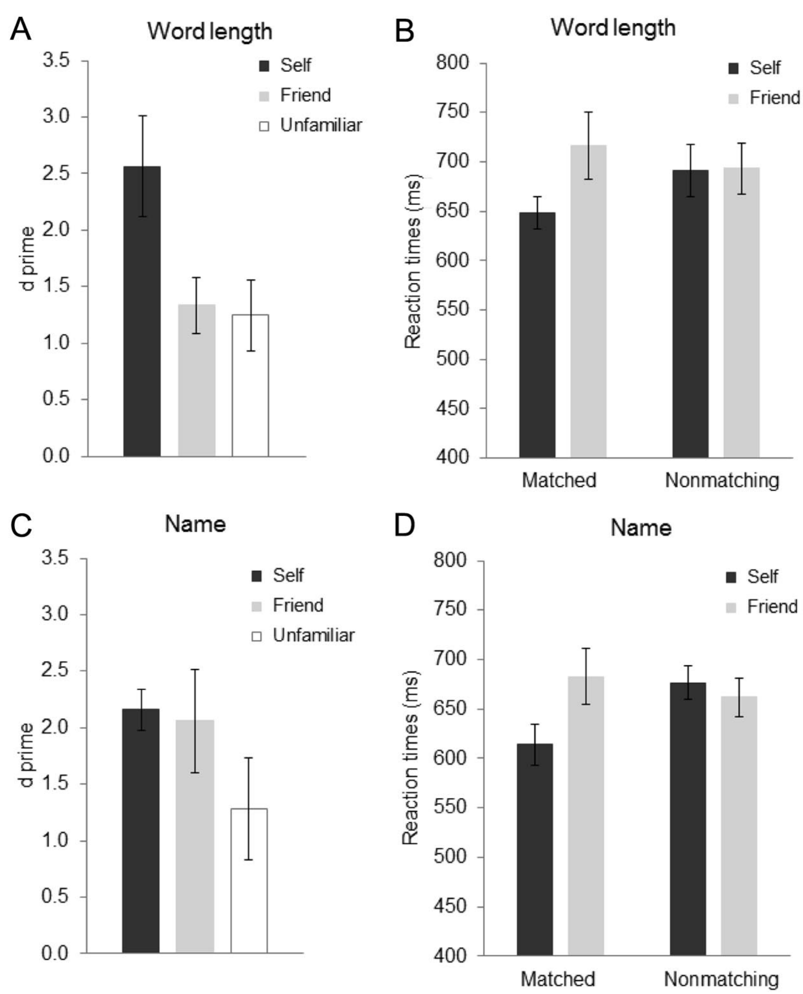

Figure 4. The self-association effect in Experiment 3C to control word length (A and B) and Experiment 3D using names (C and D). A and C show the data for d' as a function of shape category. B and D show the reaction time results as a function of shape category and matching judgment. Error bars represent standard errors.

matching judgment, $F(1, 13) = 4.74$ $p < .05$, $\eta^2 = .27$ (see Figure 4B). This interaction resulted from faster responses to the self- than to the familiar association for matching pairs, $F(1, 13) = 6.57$, $p < .03$, $\eta^2 = .34$; no such effect occurred for the non-matched pairs ($p = .81$).

3D: Effects of Own Name

In the previous experiments, the labels *you* and *yourself* were used, rather than names, to assess performance independent of differences reflecting particular self-associated stimuli (e.g., the individual's face; Northoff & Bermpohl, 2004). In this control experiment, however, we used labels associated with a particular individual, given that an individual's name was not more likely to be higher frequency than other names. Would a self-advantage still occur?

Method. Thirteen college students (two men; 18 to 26 years of age, $M = 19.81 \pm 2.21$) participated. The method was identical to that in Experiment 2 except that the labels were the participant's own name, the name of a best friend, and a common name referring to an unfamiliar other.

Before the experiment, participants were instructed to rate the familiarity for their named best friend using a 7-pont scale (1 = *not very familiar* and 7 = *highly familiar*). The data showed that individuals were highly familiar with their named friends ($M = 6.73 \pm 0.44$). Participants also rated how frequently they used their own name and their best friend's name using a 7-point scale (1 = *low frequency* and 7 = *high frequency*). Paired *t* test showed that they used their friend's name ($M = 5.54 \pm 1.13$) more frequently than their own name ($M = 4.23 \pm 1.59$), $p < .03$.

Results. Correct responses shorter than 200 ms were excluded from the analysis, eliminating less than 1% of the trials overall.

There was a marginally significant effect of shape category on d', $F(2, 24) = 2.84$, $p = .08$, $\eta^2 = .19$; d' was larger for the familiar association than for the unfamiliar association ($p < .01$), and there was a marginal self-advantage over the unfamiliar association ($p = .09$), but there was no difference between the self- and the familiar association ($p = .82$; see Figure 4C).

ANOVAs for the RTs excluded the neutral condition because of poor accuracy on matching trials ($M = 0.58 \pm 0.17$), and showed a marginal significant effect of shape category, $F(1, 12) = 3.92$, $p = .07$, $\eta^2 = .25$, because of a self-advantage over the familiar association. There was a reliable significant interaction of shape category and matching judgment, $F(1, 12) = 10.66$ $p < .01$, $\eta^2 = .34$ (see Figure 4D). There were faster responses to the self- than to the familiar associations on matching trials, $F(1, 12) = 7.69$, $p < .02$, $\eta^2 = .39$, whereas no significant effect was observed on nonmatching trials ($p = .13$). These RT data replicated the results in the prior experiments.

Discussion

The results from Experiment 3 show that the self-advantage is robust and is unlikely to reflect the concreteness, frequency, or length of the labels. The advantage occurs when the labels linked to the self are rated as being less frequent than the other labels and when the self-associated label is longer than the other labels. We argue that the effects are not confounded by covarying factors. Moreover, a self-advantage emerged regardless of whether self-related abstract labels (*you*, *yourself*) or names were used.

Experiment 4: Effects of Stimulus Degradation

There is a long tradition in cognitive psychology of trying to assess the processing locus at which a variable takes effect by evaluating how the variable influences performance in relation to another factor introduced to affect a particular processing stage (e.g., Donders, 1969; Sternberg, 1969). A typical example of a factor introduced to affect a particular processing stage is visual degradation, which is assumed to modulate early stages of visual processing (e.g., see Mechelli, Humphreys, Mayall, Olson, & Price, 2000, for evidence from brain imaging). If self-prioritization affects early stages of visual processing, then it may interact with the effects of stimulus degradation—for example, self-associated stimuli may show weaker effects of degradation because their perceptual processing is bolstered relative to the processing of other stimuli. In contrast, if the self-advantage arises at a later processing stage, then it may combine additively with effects of degradation (Donders, 1969; Sternberg, 1969). We tested this in Experiment 4A. We also examined one possible mechanism that may be responsible for the self-advantage, namely that self-association is inherently rewarding (de Greck et al., 2008; Northoff & Hayes, 2011). To test whether effects of reward may be important, Experiment 4B had participants learn associations between shapes and different reward values, and we also rewarded participants in relation to the shapes. We then assessed whether high reward, like self-association, reduced effects of degradation on matching performance. Is performance with self-association and reward qualitatively similar?

4A: Self-Association and Stimulus Degradation

Method. Twenty-eight college students (three men; 18 to 43 years of age, $M = 22.71 \pm 6.43$) participated in this experiment. Two participants were excluded because no responses were made for one condition. The method was identical to that in Experiment 2 except that a new variable was added—stimulus contrast (high vs. low). The labels assigned for the self, friend, and unfamiliar other associations were *you*, *friend*, and *other*, respectively. Shape contrast was manipulated in a similar manner to the manipulation reported by Braet and Humphreys (2007), in which low-contrast stimuli were light gray presented on a dark-gray background; high-contrast stimuli were white shapes presented on the same background. The conditions were randomly presented. Luminance values were 37 cd/m^2 for low-contrast shapes, 110 cd/m^2 for high-contrast shapes, and 17 cd/m^2 for the background.

Before the experiment, participants were instructed to rate the familiarity for their named best friend using a 7-pont scale (1 = *not very familiar* and 7 = *highly familiar*). The data showed that individuals were highly familiar with their named friends ($M = 6.75 \pm 0.55$).

Results. Correct responses shorter than 200 ms were excluded from the analysis, eliminating less than 1% of the trials overall.

We first conducted the ANOVAs for d' with two within-subjects variables, shape category (self, familiar, or unfamiliar) and contrast (high vs. low). There was a significant main effect of shape category, $F(2, 50) = 12.10$, $p < .001$, $\eta^2 = .33$, reflecting the self- and familiar advantage over the unfamiliar associations ($ps < .001$) and no overall difference between the self- and familiar associations ($p = .17$). This main effect was qualified by a significant interaction of contrast and shape category, $F(2, 50) =$

3.23, $p < .05$, $\eta^2 = .11$ (see Figure 5A). Analyses for the high- and low-contrast conditions were then conducted separately. The results showed a significant main effect of shape category for the high-contrast condition, $F(2, 50) = 7.08$, $p < .005$, $\eta^2 = .22$; there was an advantage for the self- and familiar associations over the unfamiliar association ($p < .001$ and .01, respectively) but no difference between the self- and familiar association ($p = .91$). For the low-contrast condition, there was also a significant effect of shape category, $F(2, 50) = 15.07$, $p < .001$, $\eta^2 = .38$; however, different from the high-contrast condition, there was a consistent self-benefit relative to both the familiar and unfamiliar associations ($p < .005$ and .001, respectively) as well as an advantage for the familiar compared with the unfamiliar associations ($p < .03$).

The analyses on the RTs did not include the unfamiliar condition because there was poor accuracy on matching trials in this case (high vs. low contrast: $M = 0.40 \pm 0.20$ vs. 0.38 ± 0.20). There were three within-subjects variables, shape category (self vs. familiar), matching judgment (matched vs. nonmatching), and contrast (high vs. low). There was a reliable significant interaction of shape category and matching judgment, $F(1, 25) = 11.86$, $p < .005$, $\eta^2 = .32$ (see Figure 5B). The analyses for the match and nonmatch conditions were conducted separately. For the match condition, responses to self-associated shapes were faster than those to familiar associated shapes, $F(1, 25) = 8.40$, $p < .01$, $\eta^2 = .25$, but there was an inverse effect for the nonmatched pairs, $F(1, 25) = 6.04$, $p < .03$, $\eta^2 = .20$. There were no any significant effects involving contrast ($ps > .42$).

The data on d' indicated that the advantage for the self- over the familiar associations increased for low- relative to high-contrast stimuli, but there was a reduced trend for an advantage for familiar over unfamiliar associations when the stimuli were degraded. Thus, we conclude that the self-advantage, in particular, interacts with perceptual processing.

4B: Reward Associations and Stimulus Degradation

To examine the contribution of reward to self-prioritization, in Experiment 4B, we asked participants to associate three types of shapes with high, medium, or low reward (£9, £6, or £1, respectively). Then, they completed a matching task in which they were presented with shapes paired with either the same or different reward values. Participants had to judge whether shape–value pairs matched. For correct match and nonmatching judgments, participants gained extra rewards according the value assigned to the shape. There were equal numbers of trial for each shape–value pairing. Contrast was manipulated in the same manner as in Experiment 4A. If the self-prioritization effect reflects the high reward associated with self, one would expect the prioritization of high reward relative to medium- and low-reward conditions in the

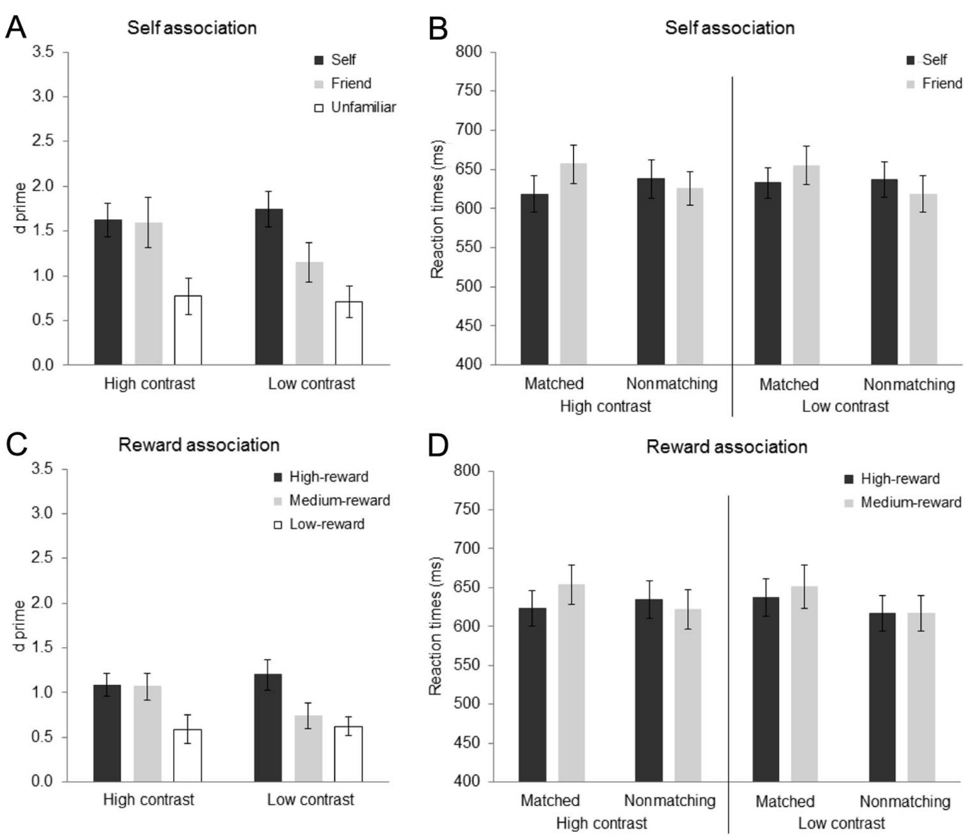

Figure 5. The self/reward-association effect in Experiments 4A and 4B. A and C show the data for d' as a function of shape category and contrast. B and D show the reaction time results as a function of shape category, matching judgment, and contrast. Error bars represent standard errors.

matching task, and, moreover, this may interact with stimulus degradation.

Method. Twenty-nine college students (10 men; 19 to 41 years of age, $M = 24.11 \pm 4.48$) participated. One participant was excluded from the data analyses because no responses were made in one condition. The method was identical to that in Experiment 4A except that the shapes were assigned to different rewards (high, medium, and low) rather than to different people (self, familiar, and unfamiliar). The labels were £9, £3, and £1 referring to the high-, medium-, and low-reward conditions, respectively (see Izuma, Saito, & Sadato, 2008; Kable & Glimcher, 2007, for prior studies showing differential effects of reward with similar reward ratios).

Results. Correct responses shorter than 200 ms were excluded from the analysis, eliminating less than 1% of the trials overall.

ANOVAs for d' were conducted first. There were two within-subjects variables, shape category (high, medium, or low reward) and contrast (high vs. low). The results showed a significant effect of shape category, $F(2, 54) = 10.44$, $p < .001$, $\eta^2 = .28$; there was a consistent benefit for the high-reward association over the medium- and low-reward associations ($p < .05$ and .001, respectively) and a benefit for the medium-reward relative to the low-reward association ($p < .02$). There was also a significant interaction between shape category and contrast, $F(2, 54) = 3.22$, $p < .05$, $\eta^2 = .11$ (see Figure 5C). For the high-contrast stimuli, there was a significant main effect of shape category, $F(2, 54) = 6.85$, $p < .005$, $\eta^2 = .22$, reflecting a benefit for the high- and medium-reward associations relative to the low-reward association ($p < .005$ and .02, respectively), but there was no difference between the high- and medium-reward associations ($p = .89$). For the low-contrast condition, there was again a significant main effect of shape category, $F(2, 54) = 8.51$, $p = .005$, $\eta^2 = .24$, but now there was a consistent advantage for the high-reward association over the medium- and low-reward associations ($ps < .005$), and there was no significant difference between the medium- and low-reward associations ($p = .41$).

The analyses on the RTs did not include the low-reward condition because of the low accuracy for the matched pairs (for both high and low contrast, $M = 0.44 \pm 0.23$ and $.42 \pm .20$, respectively). There were three within-subjects variables, shape category (high vs. medium reward), matching judgment (matched vs. nonmatched), and contrast (high vs. low). ANOVAs revealed a marginal significant interaction of shape category and matching judgment, $F(1, 27) = 3.55$, $p = .07$, $\eta^2 = .12$. (see Figure 5D). There were no significant effects involving contrast and shape category ($ps > .16$).

The data were then analyzed combining Experiments 4A and 4B to test for differences in the magnitude of self versus reward effects and the way in which these factors modulated the effects of contrast. For d', ANOVAs were conducted with a between-subjects variable of experiment (self vs. reward) and two within-subjects variables—shape category (self/high reward, familiar/medium reward, or unfamiliar/low reward) and contrast (high vs. low). The results revealed a marginal significant effect of experiment, $F(1, 52) = 3.77$, $p = .06$, $\eta^2 = .07$, reflecting larger d' scores for the self than the reward experiment. There was also a significant main effect of shape category, $F(2, 104) = 22.24$, $p < .001$, $\eta^2 = .30$. There was an advantage for the self/high-reward association over the familiar/medium-reward and unfamiliar/low-reward associations ($ps < .03$ and .001, respectively), along also with an advantage for the familiar/medium-reward over the unfamiliar/low-reward association ($p < .001$). This effect was qualified by a significant interaction of shape category and contrast, $F(2, 104) = 6.43$, $p < .005$, $\eta^2 = .11$ (see Figures 5A and 5C). For the high-contrast condition, there was a significant effect of shape category, $F(2, 106) = 13.35$, $p < .001$, $\eta^2 = .20$. There was an advantage for the self/high-reward association and the familiar/medium-reward association relative to the unfamiliar/low-reward association ($ps < .001$), but no difference between the self/high-reward and the familiar/medium-reward associations ($p = .88$). For the low-contrast condition, the effect of shape category was also significant, $F(2, 106) = 22.78$, $p < .001$, $\eta^2 = .30$. In this case, there was a benefit for the self/high-reward relative to both the familiar/medium-reward and the unfamiliar/low-reward associations ($ps < .001$), and this occurred along with a benefit for the familiar/medium-reward compared with the unfamiliar/low-reward association ($p < .03$). There were no significant interactions involving experiment ($ps > .16$).

A similar ANOVA for RTs revealed a significant two-way interaction between shape category and matching judgment, $F(1, 52) = 13.46$, $p = .001$, $\eta^2 = .21$ (see Figures 5B and 5D). For the matched pairs, responses to the self/high-reward associations were faster than those to the familiar/medium-reward associations, $F(1, 53) = 7.46$, $p < .01$, $\eta^2 = .12$, whereas there was a reversed effect for the nonmatching pairs, $F(1, 53) = 6.07$, $p < .02$, $\eta^2 = .10$.

The data indicate that, similar to the self-association advantage, shape–label matching varies according to the reward values associated with the shape. It is notable that performance benefits when the shape reflects a high- relative to a low-reward value. In addition, for the d' measure, the effects of self/reward interacted with stimulus degradation, with self and high-reward stimuli showing weaker effects of degradation than the familiar/medium-reward condition, and this effect was not qualified by the experiment (i.e., whether the association was self-related or reward-related). That is, effects of reward as well as self-association modulate perceptual processing, and there are no qualitative differences between the two effects. In this experiment, RTs were both faster to accept self/high-reward stimuli and slower to reject them on nonmatching trials, which may in part reflect lowered response criteria for self/high-reward associated shapes (see the Appendix).

Effects of Experimental Context on the Self- and Familiar Friend Advantage

To assess the relations between self-related processing and the processing of familiar others further, we examined the influence of the experiments (presentation and decision contexts) on (a) the self-advantage (relative to the familiar other and unfamiliar/neutral shape associations) and (b) the familiar other advantage (relative to unfamiliar/neutral shape associations). We only assessed the data on d', given the accuracy levels for unfamiliar/neutral associations. The factors were shape category and experiment (Experiments 1–4A, combining the high- and low-contrast conditions in Experiment 4A). The analysis on the self-prioritization effect over familiar others revealed a significant main effect of shape category, $F(1, 88) = 34.94$, $p < .001$, $\eta^2 = .28$, but no significant interaction of shape category and experiment ($p = .10$). Likewise, ANOVAs for the self-prioritization effect over the unfamiliar/neutral conditions showed a reliable significant main effect of shape category, $F(1, 88) = 118.54$, $p < .001$, $\eta^2 = .58$, but no significant interaction of shape category and experiment ($p = .21$). The results indicated that there was a consistent self-advantage effect, independent of the presentation and decision contexts. In contrast to this, the familiar other advantage showed not only an overall benefit for familiar relative to neutral stimuli, $F(1, 88) = 47.22$, $p < .001$, $\eta^2 = .35$, but also a significant interaction of experiment and shape category, $F(4, 88) = 4.87$, $p = .001$, $\eta^2 = .18$, because of variation in the size of the familiar other advantage across experiments (Experiment 1 $p = .22$; Experiment 2A $p < .001$; Experiment 2B $p < .001$; Experiment 3C $p = .70$; Experiment 4A $p < .001$). The data indicate that the different contexts affected the familiar other advantage.

General Discussion

We examined effects of the social salience of self-related information on simple perceptual matching tasks by employing a novel learning approach in which participants associated labels for themselves (e.g., *you*, *yourself*), other familiar people (e.g., *friend*, *mother*), or neutral terms (e.g., *stranger*, *none*) with geometric shapes and then immediately judged whether subsequent label–shape pairings matched. Across four experiments we demonstrated a substantial advantage for matching shapes to a self label, relative to when the shapes were linked to familiar others and/or to an unfamiliar person/a neutral label. This advantage was underpinned by a distinct RT–accuracy distribution relative to the other conditions and generally in an improved d'. There was a weaker advantage also for associations to familiar others (best friend, mother) when compared with associations to unfamiliar others, although this effect was less robust than the self-advantage and varied across the experiments. Relative to the familiar condition, the self-advantage also increased when the stimuli were degraded (see Experiment 4A). In particular, matches to visually degraded shapes associated to a familiar other label were disrupted, relative to matches to the self.[4] This last result is consistent with an effect of self-association on early stages of visual processing. These data indicate that even simple shape–label perceptual matching can be modulated by prior associations of the shape with the self and with familiar other people.

In Experiment 4B, we assessed whether the self-association effects were similar to the effects of reward. It has previously been argued that the attribution of self-relevance to stimuli recruits the reward system (Northoff & Hayes, 2011), and this may reinforce responding to the same stimulus pairing when subsequently presented. Indeed, at a neural level, there is evidence that self-related and reward-related processes evoke similar neutral circuits including the ventral medium prefrontal cortex, the ventral striatum, and ventral tegmental areas (e.g., de Greck et al., 2008; Enzi, de Greck, Prösch, Tempelmann, & Northoff, 2009). Our results indicate that differential monetary reward, when associated with a shape, had a similar effect to self-association, and that both reduced the effects of stimulus degradation seen when associations were formed between a familiar friend label and a shape. This qualitative similar is consistent with self-association being modulated by differential reward signals to the self versus others. We note, however, that this is only a first investigation of this issue. Not all brain imaging studies show overlap of self- and reward-related processing (see Berridge, Robinson, & Aldridge, 2009; de Greck et al., 2010, for differences in the insula and premotor cortex), and investigators have also pointed to a distinction between the processes involved in responding to monetary reward (as in Experiment 4B here) and social reward (perhaps linked to the self; see Behrens, Hunt, Woolrich, & Rushworth, 2008; however, see also Izuma et al., 2008, for the opposite view). Further experiments are required to specify the exact relations between reward and self-prioritized perception, although the current results do highlight the close similarity of the effects. One point to note here, however, is that the self-advantage appeared to differ qualitatively from the familiar other advantage in being more stable across the different experimental contexts. This suggests that there is some nonlinearity in the distinction between the self and other people, so that the self-advantage is not simply the same as a linearly increased reward value along a continuum of personal familiarity.

Other possible accounts of the effect are as follows. One suggestion is that, relative to their representation of other people, individuals have a well-developed self-template based on self-knowledge. Through matching of the shape–label pair to this template, "fast same" responses can be generated. This result is reminiscent of perceptual matching studies (e.g., Bamber, 1969; Krueger, 1978). For example, Krueger (1978) reported that, when participants judged whether a pair of letters was the same or not, same judgments were more rapid than different judgments, with different judgments being slowed by a rechecking process when stimuli fail to match the template. This could account for fast same matches and the enhanced d' data for self–shape associations.

A further possibility is that the results reflect the known finding that there is better memory for the stimuli we ourselves generate relative to stimuli generated by other people (Cunningham et al., 2008; Kesebir & Oishi, 2010; Klein et al., 1989; Rogers et al., 1977; Turk et al., 2007). The effects of self-generation have been well established on memory performance but not, to the best of our knowledge, on perceptual matching before. Nevertheless it could be that, when asked to make an association between a shape and the self, participants simulate the generation of that shape, and this then leads to faster matching performance.

Our results were consistent with prior studies examining the categorization of self and familiar and unfamiliar faces (Sui & Humphreys, 2011). Sui and Humphreys (2011) modeled face categorization using an ex-Gaussian fit for response latencies to capture the boundaries separating categorization of the self and familiar and unfamiliar others. The results revealed a changed response distribution for self and familiar and unfamiliar faces. In the present article, we have shown that these results generalize to the use of simple shape stimuli when effects of differential familiarity with the shapes themselves are overruled (unlike studies with self vs. others' faces).

The establishment of a reliable self-advantage, affecting the perceptual processing of shape–label pairs, opens the study of the self to experiments in which the shape properties can be used to probe perceptual processing (e.g., testing when shapes pop out in search, when they carry a singleton value, or whether they must be

[4] Effects of degradation on shapes linked to unfamiliar/neutral labels were small too, but this could reflect floor levels of performance.

ignored). From such studies we can learn whether self-associations capture attention in a bottom-up manner and whether (or not) they can be filtered efficiently. A new paradigm to study how self-associations affect perception is thus generated.

As well as having implications for understanding the factors that modulate self-prioritization, the current results have more general consequences on our understanding of perceptual processing. For example, one popular view of perception is that it reflects a largely bottom-up process, responding to structural regularities in our environment but unaffected by our expectancies or the social context in which we find ourselves (e.g., Fodor, 1983; Marr, 1983). However, both electrophysiological and brain imaging studies show that early stages of perception can be modified by expectancies (e.g., Chelazzi, Miller, Duncan, & Desimone, 1993; Kastner & Ungerleider, 2000), consistent with a view of perception as a predictive process (Spratling, 2008). In the vast majority of cases, experiments have addressed the effects of perceptual expectancies—having people predict where a stimulus might appear or what color it will take. In such cases, there are alterations of brain activity in perceptual regions registering these visual properties even prior to stimuli appearing, and, following their appearance, the processing of expected stimuli is enhanced (Kastner & Ungerleider, 2000; Soto, Wriglesworth, Bahrami-Balani, & Humphreys, 2010). These top-down effects are captured by accounts such as the biased competition model of attention (Duncan, Humphreys, & Ward, 1997), which holds that perception can be tuned to favor stimuli that match a participant's current goal. The current results suggest that top-down effects may be even more pervasive than this, however, and reflect prioritized processing of stimuli that have high personal relevance. In addition, these personal attachments can be set up rapidly (here after a small number of associative learning trials) and linked to stimuli that were neutral prior to the start of a short experiment. How this rapid modification of perception may operate is a topic now for important study.

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Appendix

Mean Criterion as a Function of Shape Category Across Experiments

Experiment	Self/high reward	Familiar/medium reward	Neutral/low reward
Experiment 1	−.47 (.37)	−.03 (.26)	.25 (.23)
Experiment 2A	−.08 (.27)	.31 (.35)	.59 (.30)
Experiment 2B	−.19 (.45)	.27 (.31)	.74 (.37)
Experiment 3C	−.19 (.49)	.36 (.24)	.51 (.38)
Experiment 3D	.02 (.20)	−.02 (.85)	.42 (.58)
Experiment 4A			
High contrast	.18 (.49)	.51 (.46)	.80 (.55)
Low contrast	.23 (.47)	.44 (.39)	.81 (.55)
Experiment 4B			
High contrast	.28 (.35)	.48 (.47)	.50 (.42)
Low contrast	.17 (.44)	.48 (.38)	.53 (.40)

Note. Criterion = $-0.5 \times (Z[\text{Hit}] + Z[\text{False Alarm}])$. Entries with negative scores mean that participants had a liberal response criterion. Entries with positive scores mean that participants' judgments were conservative. Entries with zero scores mean that participants were ideal observers. Standard deviations appear within parentheses.

Received March 2, 2011
Revision received April 13, 2012
Accepted April 16, 2012 ■