

The Power of the Self: Anchoring Information Processing Across Contexts

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Abstract

A stable self-representation has an intrinsically beneficial connotation for information processing: it allows the individual to flexibly adapt to different contexts, while prioritizing information that pertains to the own immediate survival. Indeed, many studies have shown how linking arbitrary information to physical or psychological aspects of the self leads to pervasive effects on our decision-making and even our perception. However, the evidence we have gained so far stems from isolated aspects of the self, and varying measures across studies and different levels of processing make results difficult to compare. The present study demonstrates that associating arbitrary information with the self rapidly leads to faster and more efficient processing of information, with stable performance benefits across different tasks (matching and categorization task) and stimulus domains. Focussing on specific processing levels, the findings firstly provide evidence regarding the involvement of self-relatedness in perception. Here, contrast processing interacted with self-relatedness, but only when complex stimuli were used. Secondly, they show that self-prioritization is flexible to decisional modulations, with processing benefits being adjusted to different social contexts. Thirdly, the present data provides evidence that performance benefits towards newly self-associated, abstract information are equivalent to those resulting from long-term established self-knowledge with personally owned objects. The results highlight mechanistic differences between the prioritization of information linked to the self and information linked to close others. Overall, the present findings suggest that the self acts as a stable anchor in information processing, allowing us to filter information by immediate relevance in order to facilitate optimal behavior.

Keywords: self-prioritization; perception; decision-making; integration; stability; flexibility

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Significance Statement

Self-biases are pervasive in our decision-making and even in the way we perceive the world. Evaluating the properties of these biases provides a critical way of understanding what we mean by the self. This paper defines the main properties of how the self affects information processing at the levels of perception and decision-making, and addresses whether these effects are stable across different forms of self-association and across tasks. We show that the individual, facilitative effects of self-association are stable across different stimuli and tasks, while allowing flexibility through decisional modulation. The findings suggest that a stable self-representation allows the brain to maintain high processing efficiency across different contexts by filtering information by its immediate relevance.

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1. Introduction

In order to maximize behavioral efficiency and to enhance survival, humans possess the ability to quickly and flexibly respond to information in their environment in a context-dependent way (Colunga & Smith, 2008; Coppens et al., 2010; Cunningham et al., 2013; Dosenbach et al., 2007; Dreisbach & Fröber, 2019). Here, different stages of information processing can be adapted such that the individual benefits through enhanced perception, memory, or quicker decision-making (Coutlee & Huettel, 2012; Dreisbach & Fröber, 2019; Hommel, 2015). In order to adapt information processing to a variable environment, however, the individual needs to rely on a stable anchor, that is, conceptual entities that unite properties of external stimuli, and channel behavioral flexibility towards the own needs. One such anchor may be provided by the social relation of external information to the self (Northoff et al., 2006; Sui & Humphreys, 2015b, 2017a). Indeed, self-relevance possesses measurable importance to our everyday life. It provides a convenient, amodal tag for information that has a direct impact on us and requires us to quickly and efficiently select appropriate behavior (Cunningham et al., 2013; Northoff, 2016; Schäfer et al., 2016, 2020). It is not surprising, therefore, that self-relevant information receives prioritization during behavioral selection.

There is now an extensive body of research demonstrating how self-relevance of external information modulates information processing across different contexts and stimuli (Alexopoulos et al., 2012; Cunningham & Turk, 2017; Northoff, 2011; Sui et al., 2012; Sui & Humphreys, 2017a). For example, individuals respond more quickly towards their own name (Alexopoulos et al., 2012; Moray, 1959), recognize their own face or body parts more quickly than those of others (Galigani et al., 2020; Keyes et al., 2010; Ma & Han, 2010; Sui et al., 2009; Sui & Humphreys, 2013a; Tong & Nakayama, 1999), or respond faster towards self-owned objects (Belk, 1988; Constable et al., 2011; Golubickis et al., 2019). Within the last decade, many studies demonstrated that the advantage of self-relevance, which has classically been considered to be a perquisite of information that has been associated with the self over long time and with frequent exposure (long-term established), can be rapidly “tagged” onto arbitrary information (newly-learned associations; Sui et al., 2012; Woźniak & Knoblich,

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2019). They showed that links between neutral stimuli and the self can be established within minutes, resulting in a prioritized processing of self-associated information, compared to information that has been associated with close others (e.g., friend, mother) or unfamiliar others (stranger), and, crucially, independently of stimulus familiarity (Desebrock et al., 2018; Hu et al., 2020; Macrae et al., 2018; Reuther & Chakravarthi, 2017; Schäfer et al., 2016, 2020; Siebold et al., 2015; Sui et al., 2012; Woźniak et al., 2018; Woźniak & Knoblich, 2019). The extension of the self-representation to flexibly incorporate arbitrary, external information has further been argued to explain phenomena such as the mere ownership effect (Golubickis et al., 2018; LeBarr & Shedden, 2017; Truong et al., 2017; Ye & Gawronski, 2016).

Despite the prevalence of self-prioritization effects (SPE) in isolated studies using long-term established or newly-learned self-associations, there is currently no evidence showing whether these effects are governed by the same underlying aspects of our self-representation, or whether they arise from different representational aspects that vary in their degrees of self-relatedness. In fact, some previous studies showed that behavioral performance enhancement underlies the degree of self-relatedness, with parts of the self-representation that show high personal significance leading to stronger self-prioritization benefits (Golubickis et al., 2020). Interestingly, the functional processing benefits also flexibly extend to close, familiar others, such as friends or the own mother (Golubickis et al., 2019; Schäfer et al., 2017; Sui et al., 2012; Sui & Humphreys, 2017b), affiliated groups such as the favorite sports team (Enock et al., 2018; Moradi et al., 2015), as well as different internal aspects of an individual, such as psychological and physical attributes that a person identifies with (Golubickis et al., 2020; McConnell, 2011; Symons & Johnson, 1997; Turk et al., 2008). These findings may be accounted for by shared representational aspects of the self and others (Araujo et al., 2013). However, there is increasing evidence suggesting that the SPE is governed by a stable, internal representation that is self-specific (Araujo et al., 2013; Northoff et al., 2006; Sui & Humphreys, 2015b, 2017a), and that processing advantages for close, familiar others are mediated by different representational aspects linked to the self (Denny et al., 2012; Greenwald & Banaji, 1989; Keyes & Brady, 2010; Sui et al., 2014; Sui & Humphreys, 2017b).

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This evidence has additionally been supported by neuropsychological data (e.g., Grilli & Glisky, 2010). For example, self-associations can boost memory performance in severely amnesic patients, while this is not the case for associations with close others (Sui & Humphreys, 2013b). Therefore, SPEs in the current study are considered in relation to close or distant others (i.e., friends or strangers).

Crucially, the idea of a stable internal self-representation that leads to performance enhancements towards self-related information would presuppose that the benefit that can be gained from self-association (i.e. the magnitude of the SPE) is (1) independent of the familiarity or frequency of exposure to the associated stimulus material, as well as (2) stable across time and contexts within individuals. Indeed, a recent study that used an implicit association task to assess the influence of ownership duration on self- (vs other-)owned object processing found no difference between short-term and long-term ownership on the degree to which self-owned objects were prioritized during categorization (LeBarr & Shedden, 2017). Secondly, if the SPE-mediating representation is self-specific, the benefit that can be gained from being associated with a close other (e.g. friend) would depend on further aspects, for instance the familiarity or degree to which that other individual is related to the self (social distance), or the strength of association between the other identity and the stimulus. Notably, the degree of psychological self-relatedness, or “closeness”, of other individuals often changes over the lifetime (e.g. Romund et al., 2017): Strangers can become friends, friends can become family, or acquaintances can lose touch over a heated argument. From an ecological perspective, it would therefore be adaptive if the processing advantage attributed to other individuals is more flexible to experience-dependent changes than that to the self, which typically remains at the center of our processing priority. Here, it should be noted that the above idea does not make any assumptions about the content of the representational aspects that overlap between self and others. These are much likely individually specific and influenced by the experiences an individual gains over their lifetime (Pfeifer & Peake, 2012; Romund et al., 2017; Scalabrini et al., 2020). In other words, while we cannot be certain which aspect of the self-representation (Golubickis et al., 2020) an individual uses to tag onto external information (Hu et al., 2020;

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Sui & Humphreys, 2015b), we can assess the stability of the benefit across and within individuals, which builds a necessary, albeit not exclusively sufficient, basis for the assumption that the same, stable aspect of the self-representation governs the SPE (relative to friends and strangers).

While neuroimaging and neuropsychological evidence supports the idea that enhanced processing of self-relevant information is governed by a common underlying processing source in cortical midline structures (e.g. Sui, Enock, et al., 2015 but see Araujo et al., 2013; Hu et al., 2016; Northoff et al., 2006 for meta-analyses), these findings converge from studies conducted across different individuals and tasks. Furthermore, while they offer insights into the overlap of processing substrates, they do not, in themselves, allow us to draw inferences about the functional characteristics and dependencies of the SPE (Sui, 2016). It therefore remains unclear whether an individually-specific, stable aspect of our self-representation leads to domain-independent functional processing facilitation within the same individuals.

One way of addressing this question is by assessing individual-specific self-related performance enhancements across stimulus domains (Humphreys & Sui, 2015). This borrows a similar approach as describing individual trait characteristics, such as personality traits, which rely on behavioral consistency across contexts and repeatability across time (Cobb-Clark & Schurer, 2012; MacKay & Haskell, 2015; Sih et al., 2004; Terracciano et al., 2010). In other words, if the SPE is mediated by the same, stable aspects of the internal self-representation, this would require the SPE to be (1) domain-invariant at group-level, as well as (2) stable within individuals.

The domain of self-reference can be understood as the type and experience of self-association an individual makes with a specific perceptual object. For example, one could distinguish between long-term established self-associations (e.g., names, faces, owned objects) and newly-learned self-associations (e.g., abstract shapes, Gabor patches). Despite lacking evidence for their direct comparability, both types of self-associations have been shown to enhance information processing across multiple hierarchical processing stages. That

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is, attaching self-relevance to external information facilitates the selection and integration of perceptual information (Macrae et al., 2017, 2018; Scheller & Sui, 2022; Sui, Yankouskaya, et al., 2015; Sui & Humphreys, 2015a; Truong et al., 2017), enhances the linking of attention and decision-making (Constable, Welsh, et al., 2019; Hu et al., 2020; Humphreys & Sui, 2016; Li et al., 2022; Liu et al., 2016), and leads to a more efficient binding of information in memory (Conway, 2005; Cunningham et al., 2008; Leshikar et al., 2015; Rogers et al., 1977; Yin et al., 2019). For example, in a previous study using the stimulus-label matching task, Sui and colleagues (2012, Experiment 4) manipulated the luminance contrast of abstract shape stimuli that have been associated with the self, a friend and a stranger. They observed that modulations of stimulus contrast affected participant's perceptual sensitivity differently, depending on the social identity that each shape was associated with. While self-associated stimuli were not affected by contrast degradation, responses to the friend-associated stimuli showed decreased sensitivity. Such interaction between contrast and social identity has been argued to arise from the interaction of social relevance with perceptual processing stages. Other recent studies employed hierarchical drift diffusion models (HDDM; Wiecki et al., 2013) to investigate how self-relevance affects perceptual decision-making through stimulus evaluation and response preparation. These models assume that decisions are the result of sequential evidence accumulation towards a decisional threshold, of which the starting position and difference magnitude between two opposing outcomes indicate decisional preoccupations. Behavioral performance towards self-relevant and self-irrelevant information is thereby dissected into perceptual and decisional components, pertaining to different underlying processes. The findings suggested that self-prioritization is underpinned by differences in both perceptual (rate of information uptake; Falbén et al., 2020; Golubickis et al., 2017; Hu et al., 2020) and decisional processes (starting point or threshold distance; Falbén, Golubickis, Wischerath, et al., 2020; Golubickis et al., 2018; Macrae et al., 2017) supporting the notion that self-prioritization unfolds across multiple processing stages.

The emergence of self-prioritization across different processing stages is in line with the theory of the integrative self, which states that the self acts as a central hub in binding

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information across processing levels and across different stimulus domains (Humphreys & Sui, 2016; Qin et al., 2020; Sui & Humphreys, 2015b). That is, by attaching social relevance to external stimuli, attentional capture leads to the prioritization of self-relevant information (Humphreys & Sui, 2016; Sui et al., 2012), similar to the enhanced processing of stimulus-driven perceptual saliency (termed social saliency Sui, Liu, et al., 2015), further affecting consecutive processing stages such as memory and decision-making (Sui & Humphreys, 2015b). However, while the influence of self-relevance on different levels of information processing has largely been assessed through computational models, applied across different groups of individuals and different manipulations, we still know little about how the process unfolds across the processing hierarchy within individuals.

1.1. Present study

To define the main properties of self-prioritization in how it affects hierarchical information processing, the first two objectives of the present study addressed how self-relevance modulates perception (first objective) and decision-making (second objective), two processes that are crucial for interpreting the contextual stability and flexibility of self-prioritization, within the same individuals and across stimuli and tasks. Effects of self-relevance on perception and decision-making were probed separately by associating social identities with different stimuli, and by manipulating external stimulus information (contrast: low vs. high) and internal decision boundary (classification boundary: self vs. other, familiar vs. unfamiliar), respectively. If self-relevance interacts with these processing stages, we would expect to find interactions between associated identity (self, friend, or stranger) and contrast (perception) or between associated identity decision boundaries (decision-making). Based on previous findings from Sui and colleagues (2012), we would expect that the interaction of stimulus contrast and social identity on perceptual sensitivity derives from a main effect of contrast on friend-related information, but no main effect of contrast on self-related information. Note that, in contrast to previous studies that assessed the relevance of decisional processes on self-prioritization by contrasting social and perceptual judgements (e.g. identity vs. location, Caughey et al., 2020; Constable, Welsh, et al., 2019; Falbén, Golubickis,

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Wischerath, et al., 2020), the present study varied the decisional boundaries within the social dimension (Sui & Humphreys, 2013a). That is, the decisional dimension was kept focussed on the feature of interest (relation between social identities), requiring participants to retrieve the social associations of each stimulus in order to make a decision across both decision boundaries. Making use of a full within-subject design, the present study allowed for internal replication to provide evidence for the robustness of self-association effects on perception and decision-making within the same individuals across tasks (stimulus-label matching, categorization) and across stimulus domains (newly-learned and long-term established self-knowledge).

As a third main objective, the present study investigated whether the beneficial effect of self-association can equally extend to different stimulus domains, while providing a benefit that is stable across contexts, i.e. across stimulus domains and tasks. To this end, the SPE, expressed as the performance advantage that is gained from associating external information with the self, compared to another person, was measured in two stimulus domains and two tasks. One stimulus domain consisted of newly-established associations with arbitrary geometrical shapes. The other one consisted of stimuli that have established robust self-associations over a long period of time. The two tasks were a stimulus-label matching task and a stimulus categorization task. These tasks have been frequently used to evidence the presence of self-prioritization (e.g., Golubickis et al., 2018; Hu et al., 2020; Sui et al., 2012; Woźniak & Knoblich, 2019), with the stimulus-label matching task generally producing longer absolute response times and larger relative effects of self-association. Both tasks rely partly on different sets of cognitive processes (Golubickis & Macrae, 2021; Janczyk et al., 2019), such as lexical processing, higher memory load and conceptual mapping in shape-label matching compared to categorization. Furthermore, as self-prioritization emerges across levels of processing (Desebrock & Spence, 2021; Janczyk et al., 2019; Sui, 2016) it is not clear whether the SPE measured via both tasks is directly comparable and derives from the influence of the same central self-representational aspects.

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Whether self-prioritization can equally extend to different stimulus domains was tested via mean-level comparisons (group-based) of SPE magnitude between newly-learned self-associations and long-term established self-associations. Furthermore, the internal stability of the SPE was assessed via intra-individual correlations of SPEs across stimulus domains and tasks (individual-based). Importantly, based on the idea that the same stable aspect of our self-representation mediates the functional SPE across different contexts (Northoff et al., 2006; Sui, 2016; Sui & Humphreys, 2015b, 2017a) one would expect to find trait-like stability in SPEs across stimulus domains and tasks. In other words, one would expect a similar strength in mean (group-based) SPE magnitude for both stimulus domains, as well as stable intra-individual correlations across stimulus domains and across tasks.

The domain-invariance and stability of self-prioritization was investigated across two experiments. Experiment 2 closely followed the design and procedure of Experiment 1, with two main differences. While Experiment 1 used pictures personally meaningful, owned objects as the stimulus that held a long-term established self-association, Experiment 2 used the participants' first name initials. Furthermore, based on the findings of Experiment 1, the contrast manipulation was removed in Experiment 2.

Experiment 1

2. Methods

2.1. Participants

43 healthy volunteers (23 female, aged 27 ± 6 years) participated in the first session of the study, while 38 of these (21 female, age: 26.7 ± 6.1 years) completed the second session. All participants were right handed, had normal or corrected-to-normal vision, and indicated to have no certified developmental or cognitive impairments.

Sample size estimation for generalized linear mixed-effect models was conducted via power calculations based on Monte Carlo simulation in R using the simR package (Green & Macleod, 2016). Based on data from 11 pilot participants we estimated an interaction effect size of 31.8ms for stimulus contrast and social identity for a generalized linear mixed effects

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model of reaction time data. In order to prevent effect overestimation, a more conservative interaction effect size of 25ms was assumed. Based on 1000 simulations with an alpha level of 0.05, it was determined that 38 participants would allow us to detect an effect of similar size with 92.7% [CI_{95%}:90.9-94.2%] power. A visualized power calculation curve and more details on recruitment and power analysis can be found in supplementary materials S3. The study received ethical approval from the University of Aberdeen Psychology Ethics Committee (PEC/4476/2020/3).

2.2. Design

The study was conducted online via the experimental platform Testable (Rezlescu et al., 2020). It consisted of two tasks, that participants repeated across two sessions, which took place one week apart (see Figure 1a). The first task was a perceptual matching task, introduced by Sui and colleagues (Sui et al., 2012). The second task was a social categorization task (Hu et al., 2020; Sui & Humphreys, 2013). In each session, a different type of stimulus material was used: newly-learned self-associations via abstract shape stimuli (session 1) and personally meaningful objects that hold a long-term established self-association (session 2). In order to assess the effects of self-association on perception and decision-making, each task and session was analysed separately. To allow analysing the domain-independent stability of SPEs across stimulus types the study employed a full within-participant design.

2.3. Stimuli:

In the first session, using newly-learned self-associations, stimuli consisted of three abstract shapes (circle/triangle/square or diamond/hexagon/trapezoid), and three words comprising the social identity-labels “You”, “Friend”, and “Stranger”. In the second session, three pictures of personally meaningful objects were used instead of abstract shapes. One of these objects was owned by the participant, one by their best friend. The pictures were taken by the participants and submitted to the experimenter prior to the second session. The third picture was selected by the experimenter to represent a stranger-owned object and was

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chosen to match the other two object images on different low- and high-level characteristics. All image and word-stimuli were presented at equal distance above and below a central fixation cross in an alternative, counterbalanced order. Contrast of image stimuli was adjusted to high ($LR_{high} = 6.89$) and low ($LR_{low} = 1.35$) luminance ratios against a dark gray background (see Figure 1d).

2.4. Procedure:

In the first phase of the experiment participants were instructed to associate a particular geometric shape with themselves, one with their best friend, and another one with a stranger. For example, they were told that they would be represented by a circle, their friend by a triangle, and a stranger by a square. The shape triplets and shape-identity-associations were counterbalanced across individuals. Participants next had to back-match each shape to their assigned identity to indicate they paid attention. When using personally owned objects, the associations were based on individual object ownership.

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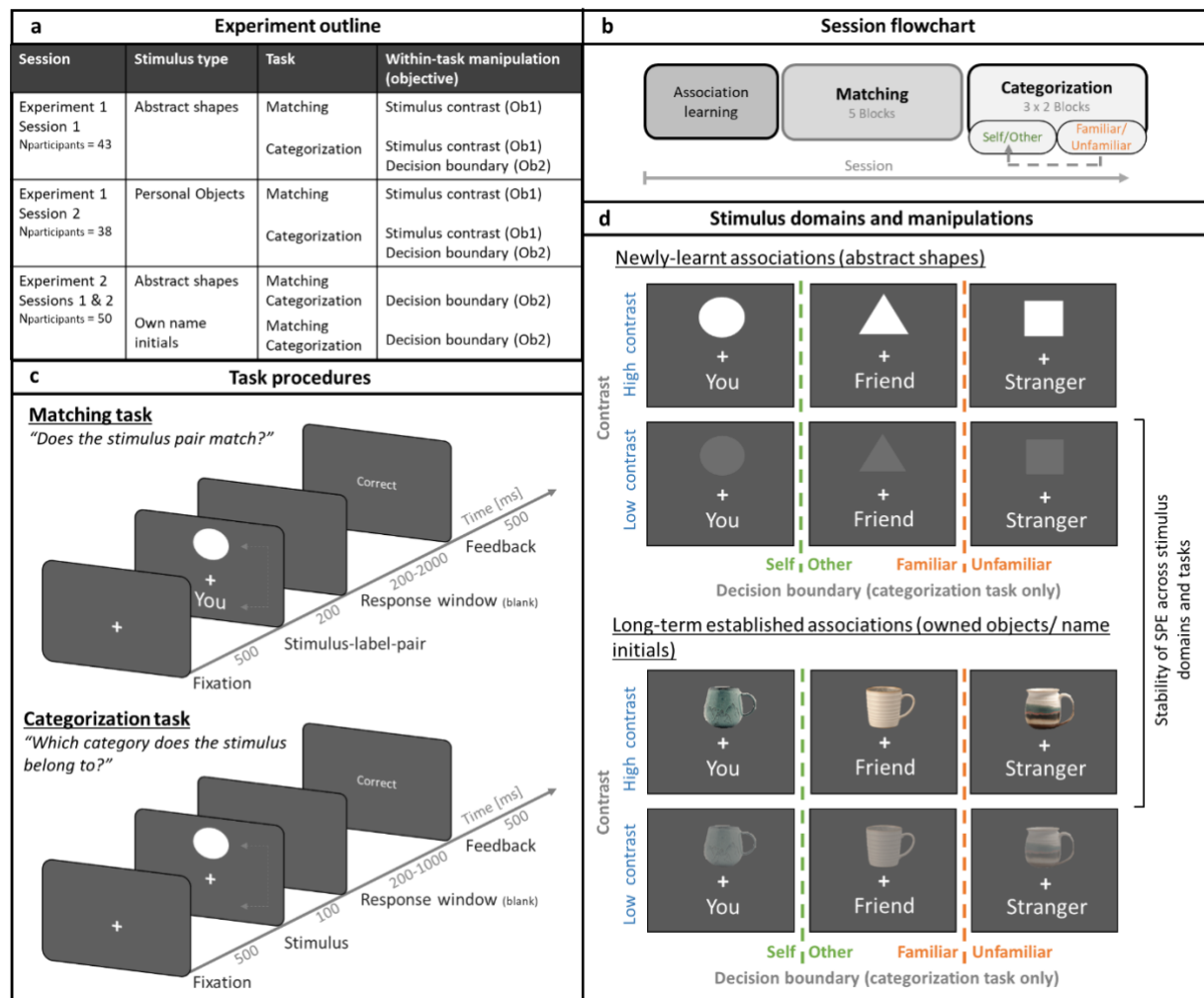


Figure 1. Experimental procedure overview:

Panel a outlines the specifics of the experiment, with two tasks being repeated with two different stimulus types across consecutive sessions, which were conducted one week apart with the same individuals. Within-task manipulations, as well as the objectives they address (Ob1: perception; Ob2: decision-making), are listed for each task, stimulus type and session. Objective 3 (stability) was addressed via between-session and between-task analyses. Experiment 2 was conducted with another 50 naïve participants, using a different stimulus type in session 2. Panel b shows the order of tasks for each of the two sessions, which consisted of an initial association phase, followed by the matching and categorization tasks. In the categorization task, different decision boundaries were assessed in separate blocks, presented in alternating order. Panel c shows example trial procedures for the matching task, in which an identity-associated stimulus and an identity-label had to be judged on their congruency (match/mismatch), and the categorization task, in which only an identity-associated stimulus had to be classified as either of two categories (self vs. other; familiar vs. unfamiliar). Panel d

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shows example stimuli from the matching task for both the newly-learned associations (abstract shapes) and long-term established associations (owned objects). It further illustrates the two experimental manipulations used to assess perceptual and decisional processes: contrast (high vs. low) and decision boundary, respectively.

In the matching task participants were asked to judge whether stimulus pairs that consisted of shapes/objects and an accompanying identity-label were matching the previously learned associations (Figure 1b). Image-label pairs were presented either as a match or a mismatch. Responses were given using the v or the b key on a computer keyboard. Previous studies have shown that SPEs are expressed by faster and more accurate performance towards matching stimuli that are associated with the self, compared to stimuli associated with close or distant others (Sui et al., 2012). To assess the influence of self-relevance on perception, image stimuli were presented with high or low contrast in a pseudorandomized order. The three factors (identity-association, pair-match, and contrast) were frequency-balanced across trials, while response keys were balanced across participants.

The categorization task also employed a 2-AFC design, and asked participants to judge whether a presented shape/object falls into either of two categories. Here, the image was presented without a label. To assess the influence of self-relevance on perception, stimulus contrast was varied in the same way as done in the matching task. To assess the influence of self-relevance on decision making, the decisional boundary was varied across blocks. That is, in one case, the presented stimulus had to be classified as representing the Self or representing Others [Self]/[Friend, Stranger]. In the other case, stimuli had to be categorized as representing someone familiar or unfamiliar [Self, Friend]/[Stranger] (Figure 1d). Stimulus category and stimulus contrast were frequency-balanced across trials, decision boundary was varied across blocks in an alternating order. In order to avoid forming associations between response keys and match-trials on the previous task, the categorization task used a different pair of response keys (F, J).

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Response key allocation was counterbalanced across participants and tasks. Practice trials were conducted before each session's tasks and for each decision boundary separately. Stimuli and further materials necessary to run the experiment are available in the repository of the Open Science Framework (Scheller & Sui, 2021, April 30).

2.5. Data Analysis:

All raw data were extracted and processed using R 4.0.1 (R Core Team, 2020). Trials during which participants failed to give a response within the specified response time window (matching task: 2000ms, categorization task: 1000ms) were classed as incorrect trials (session 1: 0.95%; session 2: 0.52% of all trials). Also, trials with RT below 200ms were excluded (session 1: 0.46%; session 2: 1.26% of all trials) as they are unlikely to reflect conscious decision-making processes. Based on previous research of the SPEs in matching tasks (Hu et al., 2020; Sui et al., 2012), response time (RT) analyses in the matching task was focussed on match-trials only, while RT analyses in both tasks was conducted on correct trials only. In order to reduce the effect of attentional lapses, trials with RTs that fell outside of 2.5 standard deviations of the mean were excluded from further analyses (session 1: 3.4%; session 2: 5.1% of correct trials). This was done for each condition and each participant separately.

The main study objectives were split into three analysis sections (Self-relevance in perception, self-relevance in decision-making, group-based and intra-individual SPE stability across stimulus domains).

2.5.1. Effects of self-relevance on different stages of hierarchical information processing

To assess the influence of self-relevance on perception and decision making, SPEs were analysed for each task and stimulus domain separately. SPEs are expressed by higher accuracy and/or shorter RTs towards self-associated, compared to friend- and stranger-associated stimuli (Golubickis et al., 2018; Sui et al., 2012; Woźniak & Knoblich, 2019). The design of the matching task allowed us to employ a signal detection approach. That is,

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enhanced performance accuracy can be achieved through higher sensitivity or a stronger a-priori bias towards a specific response (Bang & Rahnev, 2017; Kroll et al., 2002; Witt et al., 2015). In order to differentiate between these measures, sensitivity (d') and response criterion (C) were derived from individual accuracy measures for match- and mismatch-trials for each individual separately, based on Sui et al. (2012). Here, hits and false alarms were defined for each social stimulus identity (self, friend, stranger) separately. Hits reflected correct responses towards the identity-specific match-trials (i.e. shape/object and label matched), while false alarms reflected the incorrect responses towards identity-specific mismatch trials (e.g. self-shape/object shown with friend or stranger label). Hence, responding “match” towards self-associated stimuli, independently of the social identity category indicated by the label, would lead to an increased hit (H) but also an increased false (FA) alarm rate. Sensitivity and response criterion were calculated as $d' = z(H) - z(FA)$ and $C = -(z(H)+z(FA))/0.5$, respectively. Cases in which individual hit or false alarm rates in a specific condition were 0 or 1 they were approximated by 0.999 and 0.001 respectively. Hit and false alarm rates were z-transformed via an inverse cumulative Gaussian function. Negative values for C indicate the tendency to respond “match”, while positive values for C indicate the tendency to respond “mismatch”.

To assess whether self-relevance interacts with perceptual processing levels, the degree of self-prioritization was measured at two different levels of stimulus contrast (high contrast, low contrast) in both the matching task and the categorization task. A stronger degradation of perceptual sensitivity and longer RTs through decreased stimulus contrast that affect self- and other-associated information to different degrees (i.e. a significant interaction of social identity and stimulus contrast) would suggest that self-relevance affects information processing at perceptual processing stages.

To evaluate whether self-relevance affects decisional processes, the degree of self-prioritization was measured at two different social decisional boundaries. Here, as well, interactions of social identity and decisional boundary indicate self-relevance to affect

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decisional processes. This modulation was only possible in the categorization, but not the matching task.

Main effects of self-relevance, stimulus contrast and decision boundary on participants' performance measures (accuracy, sensitivity, response criterion, and RTs), as well as their interactions, were assessed via generalized linear mixed-effects models. Model generation, Tukey-adjusted post-hoc contrasts and data visualization were implemented in R (version 4.0.1; R Core Team, 2020) using packages lme4 (Bates, Mächler, et al., 2015), emmeans (Lenth, 2020) and sjplot (Lüdtke, 2017) as well as raincloud plots for robust data visualization of RT data (Allen et al., 2019). Given that we cannot assume that individual conceptions of social distance map linearly onto the three identities (i.e. no equal difference between self and friend as friend and stranger), social identity, as well as the other predictors, were treated as factorial rather than continuous predictors in each model. The self-associated stimulus was set as the reference level. Hence, results are reported for the friend and stranger identities (compared to the self-associated stimulus) as well as their interaction with the given experimental manipulation. The most parsimonious random effects structure with participant ID was chosen for each model to avoid over-parameterization (Bates, Kliegl, et al., 2015). Response key allocation was included as a nuisance variable to control for lateralization effects (see supplementary material S4). Task-matched model-specifications and parameter estimates are listed in supplementary material S1. Readers interested in the overall interaction effects of social identity and contrast, of social identity and decision boundary, or their three-way interactions, may refer to supplementary material S1.

2.5.2. SPE stability across stimulus domains: Newly-learned self-knowledge and long-term established self-knowledge

To determine the flexibility with which self-relevance allows to adjust to different stimulus contexts while providing a stable functional benefit, SPE magnitude was determined and contrasted across the different stimulus domains: newly-learned (arbitrary shape) and long-term established (personally meaningful objects). The latter can be suggested to be more strongly integrated into the self-concept over a longer period of time, and be more familiar to

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the participant (LeBarr & Shedden, 2017). Based on findings from the first analysis section, SPE magnitude was measured in RT enhancement towards self-associated stimuli relative to non-self-associated stimuli. SPE was calculated against both the close (friend) and distant (stranger) other, for each individual separately. Positive values indicate the self-related benefit in speeding of RTs.

To assess whether SPE strength varies as a function of stimulus domain, mean-level SPEs were contrasted between newly-learned associations with arbitrary shapes and long-term established associations with personally owned objects using two-sided, paired samples t-test. Multiple comparisons were FWE-controlled and reported p-values are Holm-Bonferroni corrected. This analysis was conducted separately for matching and categorization tasks. As outlined in the data analysis section, SPE magnitudes from participants that fell outside of 2.5 SD of the mean were excluded from analysis.

Along with frequentist test statistics, Bayes factors, generated in JASP (0.12.1.0) using the default prior with Cauchy distribution and scale parameter 0.707, are provided in favour of the more likely hypothesis. BF_{10} and BF_{01} , relating to each other via their respective inverse (i.e. $BF_{10} = 1/BF_{01}$), allow one to gauge the probability of finding the present data pattern given H_1 and H_0 , respectively, with H_0 assuming no difference between the two stimulus domains. Criteria for interpreting BFs was based on Lee and Wagenmakers (Lee & Wagenmakers, 2013; Wagenmakers et al., 2018), i.e. $1 < BF < 3$ indicates anecdotal evidence; $3 < BF < 10$ indicates moderate evidence; and $10 < BF < 30$ indicates strong evidence in favour of the respective hypothesis.

Next, to test a necessary assumption of the idea that the SPE that is present in different contexts is mediated by the same underlying aspect of an individual's internal self-representation we measured intra-individual stability of the SPE via differential correlations across stimulus domains and tasks. To that end, Pearson's correlation coefficients were established by correlating individual SPEs across stimulus domains for each task separately, as well as correlating individual SPEs across tasks. Intra-individual stability of SPEs across stimulus domains and tasks would suggest overlap in the individual-specific self-

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representations that mediate the SPE. Similar to the mean-level analysis outlined above, the SPE was established both in relation to the friend and the stranger. Readers interested in the prioritization of friend-associated information (i.e. friend vs stranger) are referred to supplementary material S5. In order to reduce the influence of influential outliers, individual data that showed large deviance from the group SPEs (>2.5 SD from mean) and were highly influential (Cook's distance $> 4/n$) were removed for this analysis, leading to the exclusion of 0-2 individual data points for each analysis. Multiple comparisons (i.e. for separate tasks) were FEW-controlled and reported p -values are Holm-Bonferroni corrected.

Due to response-key lateralization, an additional analysis was included in the supplementary material (supplementary material S4). This provides an exploratory account on response lateralization effects of self-processing-biases, comparing response performance when either left- or right-hand responses corresponded with different categories. Previous studies typically used unimanual responses (e.g. Sui et al., 2012); however, due to reduced experimenter control in online studies participants were allowed to use both hands.

The study has been pre-registered on the Open Science Framework (Scheller & Sui, 2021, February 22). See supplementary material S6 for full disclosure.

3 Results

3.1. Effects of Self-Relevance on Hierarchical Information Processing: Perception

3.1.1. Matching task

To investigate how self-relevance affects perceptual processing of newly-learned and long-term associations, the influence of shape identities (self, friend, stranger) and stimulus luminance (contrast low vs. high) on perceptual sensitivity, response criterion and RTs was assessed using mixed effect models. Before the interactions of stimulus identity and contrast were investigated, a full model including stimulus domain as a separate factor was implemented. This model indicated a significant three-way interaction of stimulus identity, contrast, and stimulus domain on RTs ($\beta = -10.33$, $CI[-18.35 -2.31]$, $p = .012$). There was no significant three-way interaction effect on sensitivity ($\beta = 0.06$, $CI[-0.33 0.45]$, $p = .765$) or

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response criterion ($\beta = 0.09$, $CI[-0.09\ 0.27]$, $p = .316$). Further analyses of stimulus identity and contrast are reported for each stimulus domain separately.

In order to ascertain whether self-prioritization effects (SPE) were present in each stimulus domain, main effects of social identity association are reported. Furthermore, to confirm whether the contrast manipulation worked as expected across different stimulus machines, that is, whether a decrease in contrast led to a deterioration in performance, main effects of stimulus contrast are reported as well.

Abstract shapes

A decrease in stimulus contrast did not significantly interact with self-relevance to influence perceptual sensitivity, neither when the self-associated shape was compared to the friend- ($\beta = -0.20$, $CI[-0.69\ 0.30]$, $p = .437$), nor stranger-associated shapes ($\beta = -0.03$, $CI[-0.53\ 0.46]$, $p = .905$). There was also no interaction between contrast and self-relevance in the response criterion, neither in relation to friend- ($\beta = -0.004$, $CI[-0.26\ 0.25]$, $p = .978$) nor stranger-shapes ($\beta = -0.053$, $CI[-0.30\ 0.20]$, $p = .682$). Lastly, RTs indicated no significant interactions between contrast and self-relevance (self-friend: $\beta = 5.8$, $CI[-8.79\ 20.47]$, $p = .434$; self-stranger: $\beta = -3.6$, $CI[-21.33\ 14.23]$, $p = .695$).

Perceptual sensitivity and response time (RT) measures indicated the presence of a self-prioritization effect (see Figure 2a), with self-associated shapes showing higher sensitivity compared to stimuli associated with a friend ($\beta = -0.44$, $CI[-0.79\ -0.09]$, $p = .015$) or a stranger ($\beta = -0.64$, $CI[-0.99\ -0.29]$, $p < .001$), as well as faster RTs (self-friend: $\beta = 87.1$, $CI[65.82\ 108.42]$, $p < .001$; self-stranger: $\beta = 134.9$, $CI[112.08\ 157.70]$, $p < .001$). Self-associated shapes also showed a more liberal response criterion (i.e. stronger tendency to report “match”) compared to stranger-shapes ($\beta = 0.34$, $CI[0.16\ 0.52]$, $p < .001$), but not compared to friend-shapes ($\beta = 0.08$, $CI[-0.10\ 0.25]$, $p = .407$).

Notably, there was no main effect of contrast on either sensitivity ($\beta = -0.02$, $CI[-0.37\ 0.33]$, $p = .902$) nor response criterion ($\beta = 0.11$, $CI[-0.07\ 0.29]$, $p = .231$), while RTs were slower when contrast was low ($\beta = 14.5$, $CI[3.70\ 25.31]$, $p = .009$). See supplementary material S1.0 for model specifications and parameter estimates.

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Personal objects

Similar to using abstract shapes, there were no significant interactions of stimulus identity and contrast on perceptual sensitivity (self-friend: $\beta < .01$, $CI[-0.51\ 0.52]$, $p = .991$; self-stranger: $\beta = -0.15$, $CI[-0.67\ 0.36]$, $p = .568$) nor on the response criterion (self-friend: $\beta = -0.03$, $CI[-0.28\ 0.22]$, $p = .808$) when using personally owned objects. Merely the self-stranger comparison showed some tentative indications of an identity-dependent contrast effect on the response criterion (self-stranger: $\beta = -0.24$, $CI[-0.49\ 0.01]$, $p = .066$). However, RTs showed a significant interaction, indicating a response slowing towards stranger-owned objects when stimulus contrast was reduced, that was not present in self-owned objects ($\beta = 14.6$, $CI[1.04\ 28.18]$, $p = .035$). Despite a similar tendency, there was no significant interaction with contrast and social identity for self- and friend-owned objects ($\beta = 9.75$, $CI[-3.27\ 22.78]$, $p = .142$).

Overall, self-relevant information was prioritized (Figure 2b), indicated by the self-owned objects showing higher sensitivity and faster RTs compared to objects belonging to the friend (d' : $\beta = -0.75$, $CI[-1.17\ -0.39]$, $p < .001$; RT: $\beta = 87.1$, $CI[65.82\ 108.42]$, $p < .001$) or to the stranger (d' : $\beta = -0.84$, $CI[-1.21\ -0.48]$, $p < .001$; RT: $\beta = 134.9$, $CI[112.08\ 157.70]$, $p < .001$). The response criterion of self-owned objects shifted towards more negative values (stronger tendency to report “match”) in contrast to the friend-owned objects ($\beta = 0.31$, $CI[0.13\ 0.49]$, $p < .001$), and the stranger-associated objects ($\beta = 0.86$, $CI[0.69\ 1.04]$, $p < .001$), which shifted towards more conservative values.

Again, there was no effect of stimulus contrast on perceptual sensitivity ($\beta = -0.07$, $CI[-0.43\ 0.29]$, $p = .709$). However the response criterion was significantly less negative for low-contrast compared to high-contrast stimuli ($\beta = 0.24$, $CI[0.06\ 0.41]$, $p = .01$).

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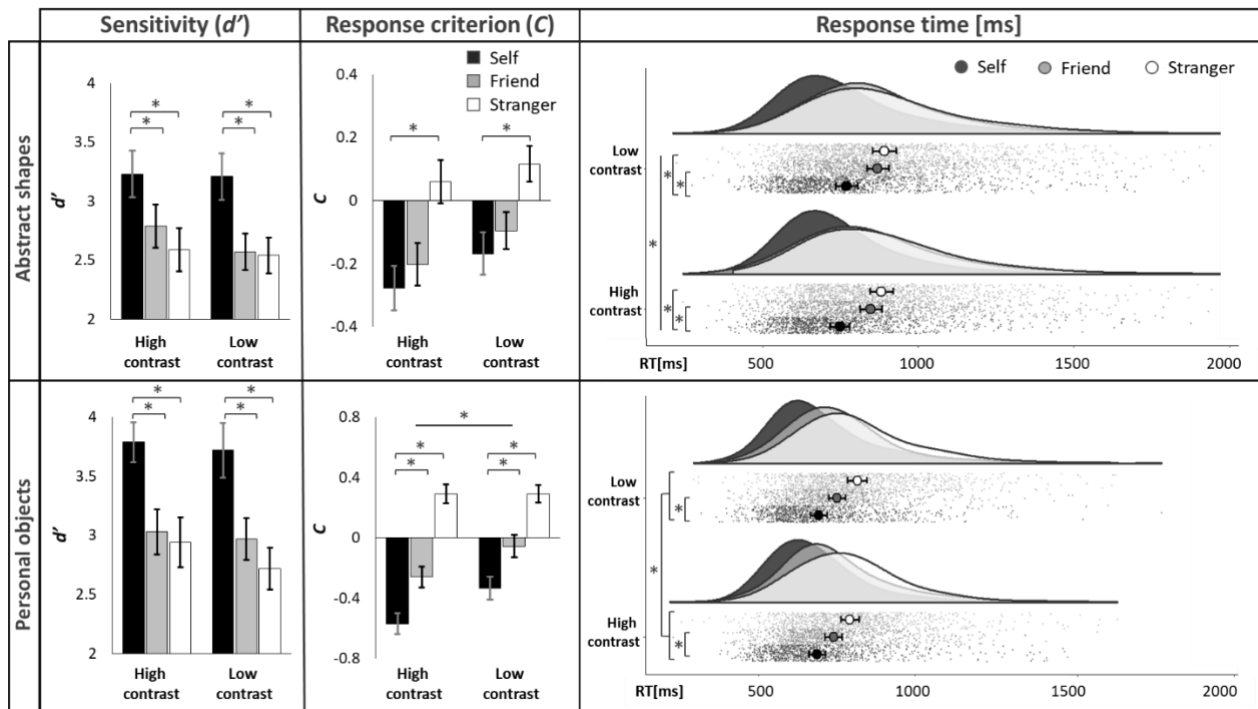


Figure 2. Effects of social association and stimulus contrast in the matching task.

Perceptual sensitivity d' , response criterion C , as well as RT distributions, means, and individual trial scatter points as a function of social identity-association and stimulus contrast (high vs. low), plotted separately for abstract shapes and personally meaningful, owned objects. Error bars indicate standard errors of the mean (SEM). $*p < .05$

3.1.2. Categorization task

To investigate how self-relevance affects perceptual processing of newly-learned and long-term associations, the influence of shape identities (self, stranger) and stimulus luminance (contrast low vs. high) on accuracy and RTs was assessed using mixed effect models. Similar to the matching task, a full model including identity and contrast, as well as stimulus domain and decision boundary was implemented. There was no significant four-way interaction between all factors (accuracy: $\beta = 0.6$, $CI[-0.52 \ 1.72]$, $p = .302$; RT: $\beta = 2.04$, $CI[-10.3 \ 14.38]$, $p = .746$), however, a three-way interaction of stimulus identity, contrast, and stimulus domain on RTs was significant ($\beta = 10.07$, $CI[0.25 \ 19.88]$, $p = .044$). Further analyses of stimulus identity and contrast are reported for each stimulus domain separately. Also, as the degree of self-prioritization differed for the two decision boundaries (see 3.2.), and to allow

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for comparability with the matching task, self-relevance effects on perceptual processing within the categorization task were assessed for each decision boundary separately. The friend-identity was excluded in this analysis as category and response-key association changed for this identity across the boundaries, while they were stable for the self and stranger.

Abstract shapes

There was an effect of contrast on performance accuracy, however, this was only significant in the self/other boundary ($\beta = -0.32$, $CI[-0.62 -0.01]$, $p = .042$), but not in the familiar/unfamiliar boundary ($\beta = -0.36$, $CI[-0.79 0.07]$, $p = .099$). There was no accuracy-benefit for either social identity in either decision boundary ($\beta > -0.23$, $p > .247$). Overall, accuracy was very high ($M \pm SD = 92.7 \pm 7.8\%$), suggesting ceiling effects left little room for performance enhancements. Hence, further analyses were focussed on RT measures.

Response time data suggested no interaction of stimulus identity and contrast in either decision boundary (self/other: $\beta = -6.74$, $CI[-18.16 4.68]$, $p = .246$; familiar/unfamiliar: $\beta = -4.20$, $CI[-15.98 7.58]$, $p = .484$). In the self/other decision boundary RT models indicated both main effects of stimulus identity and of contrast, with self-shapes being responded to faster than stranger-shapes ($\beta = 20.51$, $CI[12.52 28.49]$, $p < .001$), and responses being slower towards low-contrast shapes ($\beta = 12.37$, $CI[6.00 18.74]$, $p < .001$). There was a weak but non-significant effect of contrast in the familiar/unfamiliar boundary ($\beta = 8.93$, $CI[-0.75 18.61]$, $p = .071$) but no effect of stimulus identity ($\beta = -5.00$, $CI[-13.28 3.28]$, $p = .237$).

Personal objects

To investigate whether self-relevance interacts with perceptual processing of personally owned objects, the effect of owner identity and contrast on RTs were analysed for each decision boundary separately.

There was no accuracy-benefit for either social identity in either decision boundary ($\beta > -0.12$, $p > .567$). However, there was again an effect of contrast on performance accuracy, which was only present in the self/other boundary ($\beta = 0.38$, $CI[-0.73 0.02]$, $p = .037$), but not

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in the familiar/unfamiliar boundary ($\beta = -0.07$, $CI[-0.55 \ 0.42]$, $p = .786$). Interestingly, this effect showed an opposite directionality to the one present in abstract shapes, indicating enhanced accuracy towards low contrast objects. This suggests that stimulus contrast may have influenced more and less complex stimuli differently. Again, accuracy was almost at ceiling ($M \pm SD = 93.8 \pm 6.9\%$).

Within both decision boundaries, there were significant main effects of stimulus identity and of contrast on RTs (see Table 1). Furthermore, there were significant interactions of social identity and contrast on RTs in both boundaries, with self-owned objects being more strongly modulated by stimulus contrast compared to stranger-owned objects (self/other: $\beta = -16.21$, $CI[-27.88 \ -4.55]$, $p = .007$; familiar/unfamiliar $\beta = -14.82$, $CI[-26.04 \ -3.60]$, $p = .01$).

Table 1. Effect estimates and test statistics for social identity and stimulus contrast in the matching and categorization tasks. Note that effect estimates for the matching task, derived from one model, are reported for each identity level separately. Hence, contrast estimates are identical across both comparisons. Effects with $p < .05$ are highlighted in bold.

			Identity			Contrast			Identity:Contrast		
Matching task	Measure	Stimulus	β	t	p	β	t	p	β	t	p
Self vs Friend	Sensitivity	Shape	-0.439	2.441	0.015	-0.068	0.245	0.806	-0.198	0.778	0.437
		Object	-0.755	4.038	< 0.001	0.032	0.111	0.912	0.003	0.012	0.991
	Criterion	Shape	0.076	0.829	0.407	0.148	1.029	0.303	-0.004	0.410	0.978
		Object	0.309	3.387	< 0.001	0.383	2.749	0.006	-0.031	0.243	0.808
	RT	Shape	87.13	8.015	< 0.001	17.36	2.137	0.033	5.84	0.783	0.434
		Object	49.46	6.483	< 0.001	-0.69	0.091	0.928	9.75	1.467	0.142
Self vs Stranger	Sensitivity	Shape	-0.637	3.543	< 0.001	-0.068	0.245	0.806	-0.030	0.119	0.905
		Object	-0.845	4.521	< 0.001	0.032	0.111	0.912	-0.151	0.572	0.568
	Criterion	Shape	0.337	3.687	< 0.001	0.148	1.029	0.303	-0.053	0.027	0.682
		Object	0.862	9.460	< 0.001	0.383	2.749	0.006	-0.237	1.839	0.066
	RT	Shape	134.89	11.591	< 0.001	17.36	2.137	0.033	-3.55	0.392	0.695
		Object	103.81	7.338	< 0.001	-0.69	0.091	0.928	14.61	2.11	0.035
Categorization task			β	z/t	p	β	z/t	p	β	z/t	p
Decision boundary: Self/Others	Accuracy	Shape	-0.13	0.659	0.510	-0.32	2.032	0.042	-0.78	1.647	0.100
		Object	0.12	0.573	0.567	0.38	2.091	0.037	-0.31	1.020	0.308
	RT	Shape	20.51	5.033	< 0.001	12.371	3.807	< 0.001	-6.74	1.157	0.247
		Object	23.42	5.526	< 0.001	16.65	4.936	< 0.001	-16.21	2.724	0.007
Decision boundary: Familiar/Unfamiliar	Accuracy	Shape	-0.23	1.156	0.248	-0.36	1.650	0.099	0.15	0.555	0.579
		Object	-0.12	0.555	0.579	-0.07	0.272	0.786	-0.02	0.067	0.947
	RT	Shape	-5.00	1.183	0.237	8.93	1.809	0.071	-4.20	0.699	0.484
		Object	7.78	1.971	0.049	26.20	5.632	< 0.001	-14.82	2.589	0.010

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3.2. Effects of Self-Relevance on Hierarchical Information Processing: Decision-making

3.2.1. Categorization task

In order to assess whether self-relevance leads to prioritized processing in decision-making, each task and session was analysed in regard to interactions of social association with the decision boundary. Trials from high- and low-contrast conditions were combined as decisional effects did not differ across these conditions. The interested reader can find separate model results for each contrast condition and for accuracy values in the supplementary material S1.2. In order to reduce response bias and effects of frequency expectation on response performance, each response category was frequency-balanced. Note that this leads to frequency differences with which each individual identity is shown within each decision boundary. In the self/other boundary, the self-associated stimulus was presented on half of the trials, while the friend- and stranger-associated stimuli were each shown on a quarter of the trials each. In the familiar/unfamiliar boundary, the stranger-associated stimulus was shown on half of all trials, while self- and friend-associated stimuli were shown on a quarter of the trials. The friend-identity was excluded from this task's analysis as category and response-key association changed for this shape across the boundaries, while they were stable for the self and stranger.

Abstract shapes

RT models indicated a significant interaction of shape-associated identity and decision boundary ($\beta = 24.17$, $CI[16.01\ 32.34]$, $p < .001$, Figure 3). Here, self-associated shapes were responded to faster when participants had to discriminate between the self and others ($\beta = 17.39$; $p_{adj} < .001$), but no advantage of either the self- or stranger-associated shapes emerged when discriminating between familiar and unfamiliar identities ($\beta = -6.78$; $p_{adj} = .112$).

Personal objects

Similar to abstract shapes, the influence of internal decision boundary on RTs in the object-categorization task revealed a significant interaction of decision boundary and self-

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relevance ($\beta = 15.94$, $C[7.63\ 24.25]$, $p < .001$, Figure 3). Self-owned objects showed a stronger RT advantage when participants discriminated between the self and stranger ($\beta = 15.88$; $p_{adj} < .001$), while no advantage for either the self- or stranger-owned objects was observed when participants discriminated between familiar and unfamiliar objects ($\beta = 0.06$; $p_{adj} > .999$). Notably, the increased frequency with which stranger-stimuli were presented within the latter decision boundary reduced the SPE, but did not reverse it to a stranger-prioritization effect. This was the equally case in both stimulus domains.

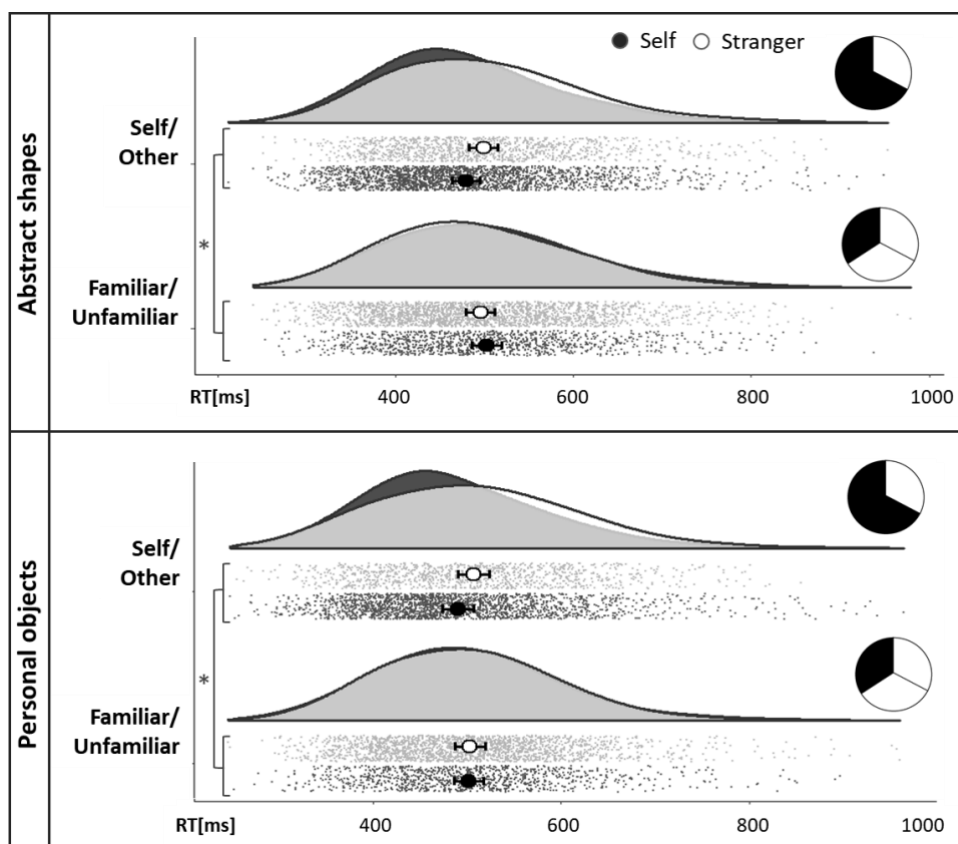


Figure 3. Effects of social association and decision boundary in the categorization task.

Response time distributions, means, and individual trial scatter points, plotted as a function of identity-association (self, stranger) and decision boundary, split for each stimulus type. Error bars indicate SEM.

* $p < .05$. Pie charts adjacent to the response time distributions indicate the frequency with which each of the two included identity-associations was shown within each decision boundary (note: the friend-associated stimulus was excluded for the analysis).

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Table 2. Effect estimates and test statistics for social identity and decision boundary in the categorization tasks. Effects with $p < .05$ are highlighted in bold.

All contrasts	Measure	Stimulus	Identity			Decision boundary			Identity:Decision boundary		
			β	z/t	p	β	z/t	p	β	z/t	p
	Accuracy	Shape	-0.148	1.127	0.260	0.023	0.168	0.867	0.255	1.338	0.181
		Object	-0.128	0.857	0.392	0.051	0.334	0.739	0.106	0.495	0.62
	Resp Time	Shape	-6.78	2.234	0.026	-22.94	7.736	<0.001	24.17	5.803	<0.001
		Object	-0.06	0.020	0.984	-13.92	4.691	<0.001	15.94	3.758	<0.001

Effect estimates for the social identity and decision boundary predictors are given in Table 2. The above effects of decisional boundary on self-related processing were replicated in a second, naïve sample in Experiment 2 (see Supplement S1.3).

3.3. Flexibility and stability of self-prioritization effects across contexts

3.3.1. Effects of stimulus domain on self-prioritization strength – Experiment 1

To test the flexibility with which self-relevance can be tagged onto different external information while providing a consistent, functional benefit, SPE strength was contrasted between newly-learned associations (arbitrary shapes) and long-term established associations (personally owned objects). The SPE was calculated relative to the distant other – i.e., stranger-associated stimulus – as well as the close other – i.e., friend-associated stimulus. In both of the above cases, the self-associated stimulus is treated as an anchor against which the stability of processing advantages relative to other identities can be compared. The interested reader can find information about friend-prioritization (relative to the stranger-associated stimulus) in the supplementary material S5. Positive SPE values indicate faster responses towards self-associated information. If self-relevance can equally extend to different stimulus domains one would expect no difference in SPE magnitude between stimulus domains.

Matching task

Relative to the stranger-associated stimulus, the processing advantage for the self-associated stimulus did not differ between newly-learned associations and long-term

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established associations ($t(32) = 1.21$, $p_{adj} = .469$, $BF_{01} = 3.12$; see Figure 4a). When the SPE was measured in relation to the friend-associated stimulus the magnitude of the processing advantage showed a significant effect of stimulus domain ($t(32) = 3.76$, $p_{adj} = .001$; see Figure 4b). Bayes factor indicated that the hypothesis suggesting a true difference between stimulus domains (H_1) was 45 times more likely than the null ($BF_{10} = 45.01$). Importantly though, this effect was driven by a larger stimulus-dependent change in the friend stimulus. RT slowing towards friend-associated abstract shapes, compared to friend-associated objects, was almost twice as large as towards self-associated information (mean RT difference between stimulus domains for each identity: Self: $\Delta_{RT} = -52.8\text{ms}$; Friend: $\Delta_{RT} = -105.78\text{ms}$; Stranger: $\Delta_{RT} = -72.01\text{ms}$), suggesting that friend-associated objects received a stronger processing benefit compared to friend-associated abstract shapes, while the SPE relative to the stranger was more stable. Investigations of the friend-prioritization effect (friend vs stranger) supports this observation (see supplementary material S5).

Categorization task

As shown in the analysis on social identity and decisional boundary, a prominent self-prioritization effect was only evident when participants had to categorize stimuli into self or others. Hence, SPE-based analyses were focussed on this decision boundary.

First, SPE magnitude was calculated relative to stranger-associated stimuli and contrasted between both stimulus domains. Similar to the matching task, there was no difference in SPE between stimuli with newly-learned or long-term established self-associations ($t(32) = 0.828$, $p_{adj} = .828$; see Figure 4a). Bayes factor indicated that this hypothesis (H_0) was 3.9 times more likely than the alternative ($BF_{01} = 3.9$). Similar to the matching task, a significant difference between stimulus domains was apparent when the self-advantage was measured relative to the friend-associated stimulus ($t(31) = 3.275$, $p_{adj} = .005$, $BF_{10} = 14.06$; see Figure 4b). This, again, was driven by a change in response performance towards different stimulus materials associated with the friend (mean RT difference between stimulus domains for each identity: Self: $\Delta_{RT} = 10.99\text{ms}$; Friend: $\Delta_{RT} = -14.31\text{ms}$; Stranger: Δ_{RT}

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= 12.96ms), suggesting that friend-owned objects were processed faster than friend-associated abstract shapes.

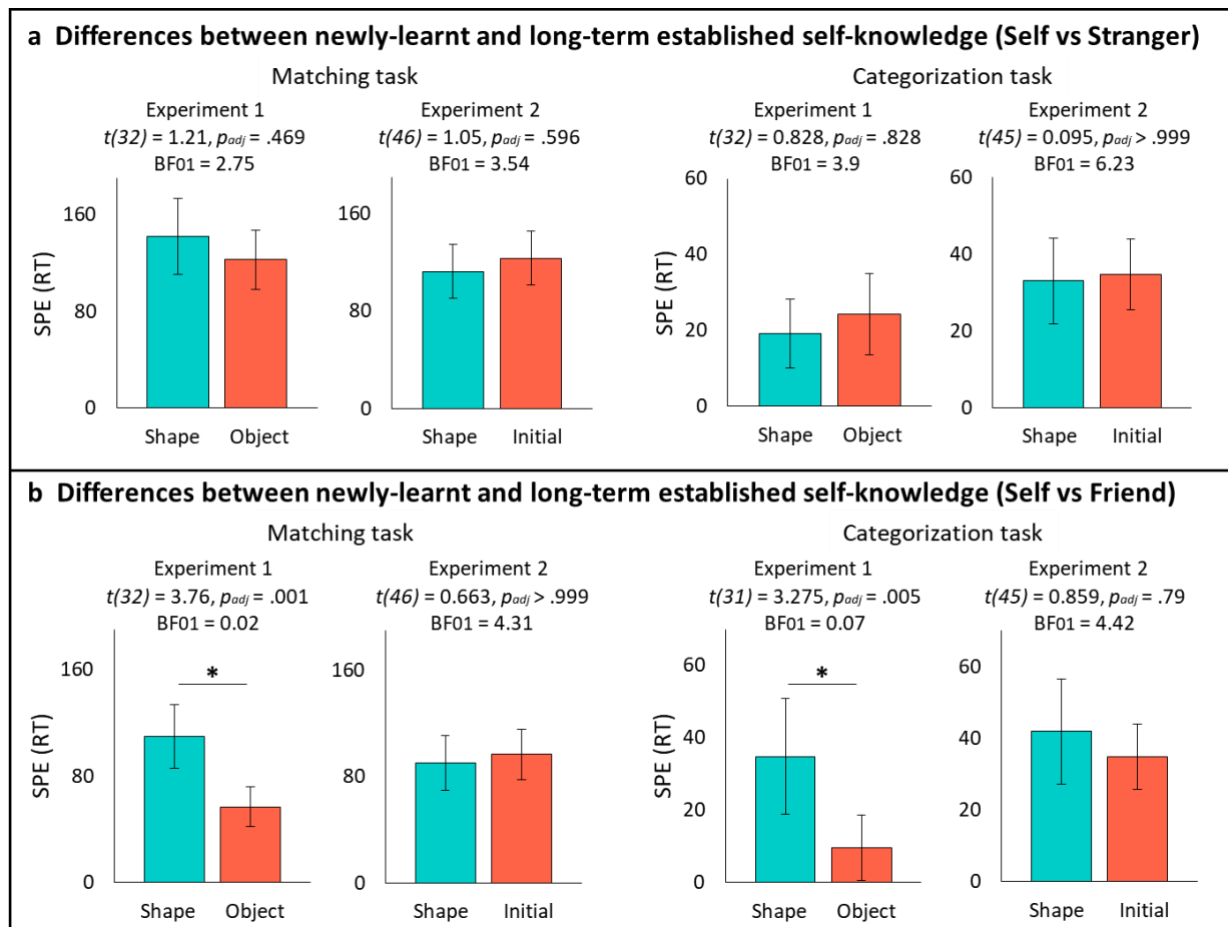


Figure 4. Stimulus-dependency of self-prioritization effects.

Group-averaged self-prioritization effects, measured in RT shortening for self-associated stimuli compared to (a) stranger-associated stimuli and compared to (b) friend-associated stimuli, as a function of stimulus domain (newly-learned associations, long-term established associations), plotted for each task and experiment separately. Higher values indicate faster RTs to the self-associated stimulus. In Experiment 1, images of personally-owned objects were used to represent long-term established associations, while in Experiment 2 participant's first name initials were used. Error bars represent 95%CI. Paired-test statistics, Bonferroni-Holm adjusted p-values, and Bayes factors for the Null Hypothesis are given above each graph. * $p_{adj} < 0.05$

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3.3.2. Stability of self-prioritization effects across stimulus domains and tasks –

Experiment 1

Based on the idea that a stable core aspect of our self-representation mediates the functional SPE one would expect trait-like stability in SPE magnitude across stimulus domains and tasks, not only at group-level, but crucially, at the individual level as well. To that end, we determined the intra-individual stability of SPEs across the two stimulus domains, as well as across tasks.

Relative to the stranger-associated stimulus, differential correlation of individual SPEs in the matching task indicated a positive correlation across stimulus domains ($r(35) = 0.434$, $p_{adj} = .019$, $BF_{10} = 5.43$; see Figure 5a, dark data points). In the categorization task, individual measures of SPE showed a positive trend as well, but were not significantly correlated ($r(34) = 0.252$, $p_{adj} = .299$, $BF_{10} = 0.58$). Furthermore, there was a significant intra-individual correlation across tasks ($r(36) = 0.342$, $p = .041$, $BF_{10} = 1.53$). When individual SPEs were calculated relative to the friend-associated stimulus, significant correlations were evident for the categorization task ($r(35) = 0.459$, $p_{adj} = .011$, $BF_{10} = 8.39$; see Figure 5b, dark data points), but not for the matching task ($r(35) = 0.140$, $p_{adj} = .846$, $BF_{10} = 0.29$). There was also no correlation of individual SPEs across tasks when measured relative to the friend ($r(36) = 0.071$, $p = .681$, $BF_{10} = 0.23$).

Experiment 2

In order to assess whether the above reported effects of flexibility and stability replicate with a different type of long-term established stimulus, a second experiment was conducted that measured self-prioritization effects in a further, naïve sample of 50 healthy volunteers (36 female, aged 27.9 ± 5.7 years). Inclusion criteria were the same as in Experiment 1. Two participants indicated response accuracy below 60%, one in the matching task and the other in the categorization task. Data from these participants was excluded from further analyses in the respective tasks.

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Experiment 2 closely followed the design and procedure of Experiment 1, with two main differences: The stimulus that held a long-term established self-association (session 2) consisted of the participant's, their friend's and a stranger's first name initials, rather than images of personally meaningful, owned objects. Further, the contrast manipulation was not included in Experiment 2 due to limited contrast control in the online setting, which was further supported by the outcomes of the first objective. Similar to Experiment 1, the study employed a full within-participant design to allow analysing the domain-independent stability of SPEs across stimulus types and tasks.

Again, trials with RTs below 200ms were excluded (0.11% across all trials) as they were unlikely to reflect conscious decision-making processes. In order to reduce the effect of attentional lapses, trials with RTs that fell outside of 2.5 standard deviations of the mean were excluded from further analyses (6.3% of all trials).

3.4. Flexibility and stability of self-prioritization effects across contexts

3.4.1. Effects of stimulus domain on self-prioritization strength – Experiment 2

SPE strength was contrasted between newly-learned associations (arbitrary shapes) and long-term established associations (first name initials) to test the flexibility with which self-relevance can be tagged onto different types of external information while providing a consistent, functional benefit. Positive SPE values indicate faster responses towards self-associated information. If self-relevance can equally extend to different stimulus domains one would expect no difference in SPE magnitude between stimulus domains.

Matching task

Similar to Experiment 1, relative to the stranger-associated stimulus, the processing advantages for the self-associated stimulus did not differ between newly-learned associations and long-term established associations ($t(46) = 1.053$, $p_{adj} = .596$; see Figure 4a). Bayes factor indicated moderate evidence for the null hypothesis ($BF_{01} = 3.45$). However, in contrast to Experiment 1, when the SPE was measured in relation to the friend-associated stimulus the magnitude of the processing advantage also showed no difference between stimulus domains

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($t(46) = 0.663$, $p_{adj} > .999$; see Figure 4b), with moderately strong evidence for the null hypothesis ($BF_{01} = 4.31$). Indeed, compared to Experiment 1, the difference in response performance towards different stimulus materials did not differ strongly between the friend-associated stimuli and the others (mean RT difference between stimulus domains for each identity: Self: $\Delta_{RT} = 59.38\text{ms}$; Friend: $\Delta_{RT} = 53.13\text{ms}$; Stranger: $\Delta_{RT} = 54.71\text{ms}$).

Categorization task

There was no significant difference in SPE strength between stimuli with newly-learned or long-term established associations, both when the SPE was calculated in relation to the stranger ($t(45) = 0.095$, $p_{adj} > .999$; see Figure 4a) or to the friend ($t(45) = 0.859$, $p_{adj} = .79$; see Figure 4b). In both cases, the Bayes factor indicated moderately strong evidence for the null hypothesis (stranger: $BF_{01} = 6.23$; Friend $BF_{01} = 4.42$). Here, too, the difference in response performance towards different stimulus materials was comparable for all three identity-associations (Self: $\Delta_{RT} = 39.32\text{ms}$; Friend: $\Delta_{RT} = 46.37\text{ms}$; Stranger: $\Delta_{RT} = 38.77\text{ms}$).

3.4.2. Stability of self-prioritization effects across stimulus domains and tasks –

Experiment 2

The stability of the SPE across different stimulus domains and tasks was probed by correlating individual SPE magnitudes across those contexts. Similar to Experiment 1, when the SPE was calculated relative to the stranger-associated stimulus, differential correlation indicated a positive correlation across stimulus domains in the matching task ($r(48) = 0.598$, $p_{adj} < .001$, $BF_{10} = 32865$; see Figure 5a, light data points) and also in the categorization task ($r(48) = 0.351$, $p_{adj} = .029$, $BF_{10} = 3.29$). Across tasks, individual SPEs showed a trend to correlate ($r(48) = 0.253$, $p = .083$, $BF_{10} = 0.78$). In contrast to Experiment 1, when individual SPEs were calculated relative to the friend-associated stimulus, a strong significant correlation was evident for the matching task ($r(49) = 0.647$, $p_{adj} < .001$, $BF_{10} = 8431$; see Figure 5b), but not for the categorization task ($r(48) = 0.132$, $p_{adj} = .739$, $BF_{10} = 0.27$). Furthermore, SPEs were significantly correlated across tasks ($r(48) = 0.349$, $p = .02$, $BF_{10} = 2.49$).

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3.5. Stability of self-prioritization effects across stimulus domains and tasks –

Experiments 1 & 2

As the initial power estimation was based on the effect size of identity and contrast interactions, while no effect size estimates for correlation analyses were available, it was likely that the individual experiments did not provide sufficient power to detect true effects. For instance, detecting a true effect at $r = 0.335$ (average coefficient across Experiments 1 and 2) with 80% power would require a sample of 68 participants. Furthermore, as correlations in Experiment 1 and 2 showed the same effect pattern for the SPE, especially when treated in relation to the stranger, the samples from both experiments were pooled for a final mega-analysis, to allow testing the stability of SPEs across stimulus domains and tasks with maximal power.

Stability across stimulus domains

When individual SPEs were calculated relative to the stranger-associated stimulus, differential correlation of individual SPEs in the matching task indicated a strong positive correlation across stimulus domains ($r(82) = 0.523$, $p_{adj} < .001$, $BF_{10} = 35258$; see Figure 5a). Similarly, in the categorization task, individual measures of SPE were significantly correlated across stimulus domains ($r(83) = 0.313$, $p_{adj} = .004$, $BF_{10} = 8$). As can be seen from the experiment-specific trend lines, both experiments showed the same relationship pattern, while the effects were more pronounced in Experiment 2. When individual SPEs were calculated relative to the friend-associated stimulus, significant correlations were evident, both in the matching task ($r(83) = 0.396$, $p_{adj} < .001$, $BF_{10} = 118$; see Figure 5b) as well as the categorization task ($r(83) = 0.227$, $p_{adj} = .04$, $BF_{10} = 1.09$). As can be seen from the experiment-dependent trend lines, however, the correlation in the matching task was less consistent across Experiments 1 (objects) and 2 (initials) when the self was treated relative to the friend, in line with results from the mean-level analysis.

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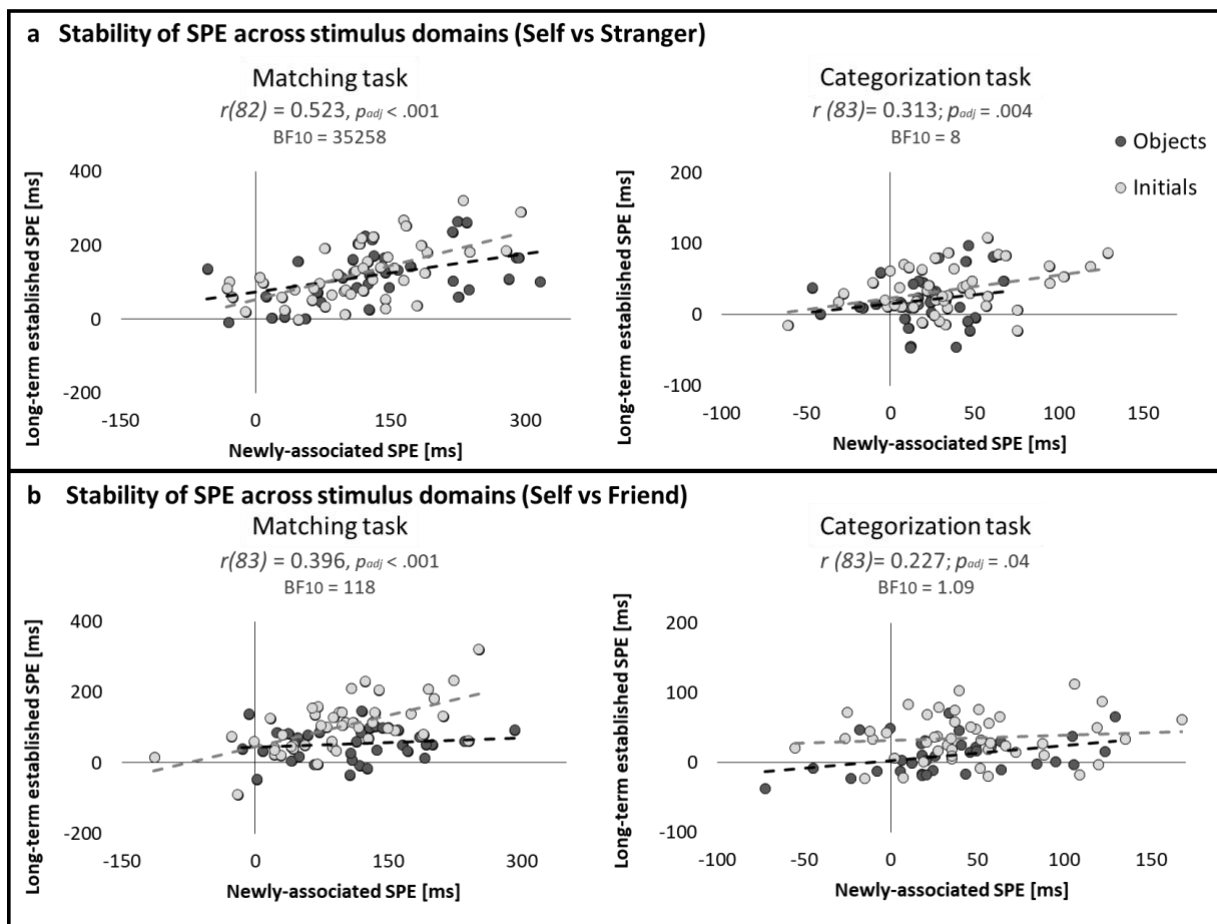


Figure 5. Intra-individual stability of self-prioritization across stimulus domains.

SPEs were extracted, for each participant and task, by contrasting the self with (a) a distant other or (b) with a close other. Each point represents data from one individual. Dark gray circles indicate SPEs from Experiment 1, in which shapes and personally owned objects were used, while light gray circles indicate SPEs from Experiment 2, in which shapes and first name initials were used. Light and dark gray dashed lines indicate lines of best fit, plotted for each sample separately. Pearson's correlation coefficients, Bonferroni-Holm adjusted p-values, as well as Bayes Factors for the combined sample are given above each graph.

Stability across tasks

The above correlation analyses across stimulus domains showed intra-individual stability of the SPE in both the matching task and the categorization task, independently of the identity against which the self-advantage was measured. As the two tasks involve different

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levels of processing, further leading to different overall SPE strengths (see Figure 4, see also Hu et al., 2020) these analyses were conducted for each task separately. As a further step, cross-task correlational analyses were implemented to test whether the individual SPEs measured in matching and categorization are directly comparable and derive from the influence of the same self-representational aspects on different levels of information processing. Individual SPEs showed significant positive correlations across tasks, both when the SPE was measured relative to the stranger ($r(84) = 0.283, p = .009, BF_{10} = 3.9$; Figure 6a) and when measured relative to the friend ($r(82) = 0.249, p = .024, BF_{10} = 1.69$; Figure 6b).

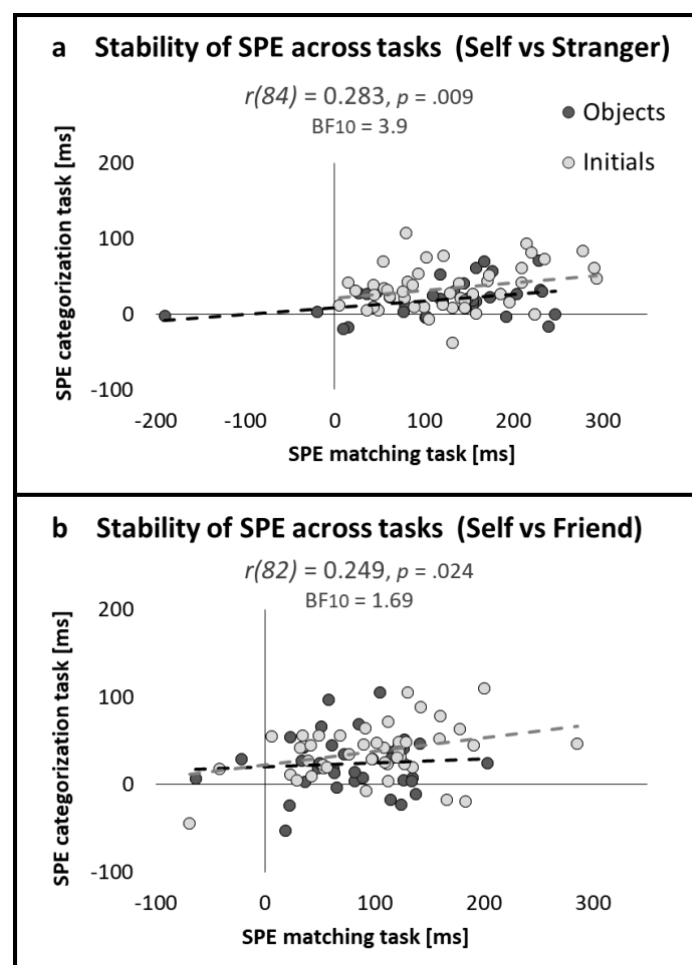


Figure 6. Intra-individual stability of self-prioritization across tasks.

SPEs were extracted, for each participant, by contrasting the self with (a) a socially distant other or (b) with a socially close other. Each point represents data from one individual. Dark gray circles indicate SPEs from Experiment 1, in which shapes and personally owned objects were used, while light gray circles indicate SPEs from Experiment 2, in which shapes and first name initials were used. Light and

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dark gray dashed lines indicate lines of best fit, plotted for each sample separately. Pearson's correlation coefficients, p-values, as well as Bayes Factors are given above each graph.

4. Discussion

Despite the consistently reported behavioral advantages that self-association brings about, the underlying mechanisms remain elusive. Previous work suggests that self-reference renders the perceptual saliency of information, thereby integrating different levels of processing and leading to a prioritization of self-related information (Sui, 2016; Sui, Enock, et al., 2015; Sui, Yankouskaya, et al., 2015; Sui & Humphreys, 2015b). However, this account of the integrative self has not yet been formally tested. The present study therefore set out to define the main properties of how the self affects hierarchical information processing by outlining how self-reference modulates perception and decision making within the same individuals, and to what extent these self-biases depend on the stimulus domain (newly gained self-knowledge vs. long-term established knowledge) and tasks via which they are measured.

Firstly, across the two experiments our results consistently replicated and extended previous findings of pervasive self-prioritization effects (SPEs; Golubickis et al., 2020; Hu et al., 2020; Lee et al., 2021; Sui et al., 2012; Woźniak & Knoblich, 2019), persisting across different tasks and sessions within the same individuals, with self-associated stimuli being responded to faster than other-associated stimuli. Furthermore, sensitivity and response bias were modulated by social relevance, with self-associated stimuli showing higher sensitivity and a more liberal response criterion than stranger-associated stimuli, supporting findings from mathematical modelling studies that demonstrated changes in the rate of information uptake (Falbén et al., 2020; Golubickis et al., 2017; Hu et al., 2020) and decisional preoccupations (Golubickis et al., 2018; Macrae et al., 2017).

In order to unravel influences of self-reference on different hierarchical levels of information processing we manipulated perceptual (contrast in Experiment 1 only) and decisional task features (decision boundary) within two tasks and with two different stimulus

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types, thereby providing the opportunity for internal replication of effects across contexts. Altering stimulus contrast revealed little consistent evidence for self-relevance effects on perceptual sensitivity d' . Using the stimulus-label matching task with abstract shapes, Sui et al. (2012) reported self-relevance to interact with stimulus contrast by decreasing perceptual sensitivity towards friend-associated, but not self-associated information (see Experiment 4A in Sui et al., 2012). Albeit sensitivity estimates in the present task suggested a trend in the same direction (see upper left panel of Figure 2 and supplement S1.1.1.), we did not find significant interactions between contrast and social association on perceptual sensitivity that were robustly present across tasks and sessions. Main effects of contrast degradation on perceptual sensitivity were not present either ($p > .709$). Such a main effect, however, would be expected if the contrast manipulation worked robustly across different monitors. In order to assess potential reasons for the absence of effects such as those observed in Sui et al. (2012), we carried out additional, exploratory analyses, and discussed potential reasons for the differences in findings (see section S2 and S4 in the supplementary material). In brief, we observed that response laterality affected not only the response measures as a main effect, but also the interaction of stimulus contrast with social identities. When match-responses were given with the right hand, similar to the study of Sui and colleagues (2012), we observed a significant interaction of contrast and social identity in the same direction as the reported effect in the given study. This effect was not present in left-lateralized responses.

Effects of stimulus contrast and social identity on response times provided some evidence for self-relevance modulating perceptual processing stages, as indicated by significant interaction effects. These effects, however, varied with the stimulus domain and task being used. That is, when personally owned objects were used as stimuli, contrast and social identity interacted both within the matching task and in the categorization task. The absolute effect directionality, however, differed between the tasks, suggesting that the contribution of perceptual processes to the generation of SPEs differed between the tasks, and was enhanced when more complex stimuli with long-term established associations were used. Given the vast differences in low-level perceptual complexity between simple, abstract

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shapes and real-life objects, it is likely that the degradation of stimulus contrast impacted both stimulus types to different extents. While the findings of the present study align with the mixed evidence of SPE arising at perceptual levels of information processing (Constable, Rajsic, et al., 2019; Golubickis et al., 2018; Macrae et al., 2017; Reuther & Chakravarthi, 2017; Sui et al., 2012; Stein et al., 2016), they suggest that part of the mixed findings regarding perceptual effects on self-prioritization may hinge on use of specific stimuli. At the same time, due to the online nature of the study, variability of contrast influences across different individuals/machines limits our ability to draw definitive conclusions, and warrants future studies that allow for better contrast control in lab-based environments, as well as extending the commonly used matching and categorization paradigms to probe for more specific perceptual processes such as sensory integration (Scheller & Sui, 2022) or early visual, temporal filtering (Constable, Welsh, et al., 2019; Truong et al., 2017).

Furthermore, the results confirmed a robust effect of self-relevance on the decisional stages of information processing, independently of stimulus domain. Here, a stable SPE was observed when participants were asked to distinguish between the self and others. This effect was reduced when the friend was included in the same category as the self. One may interpret the finding in such a way that generation of an SPE would require the 'self' to be a possible decisional category in order to draw attention to the self-relevant stimulus (e.g. see (Caughey et al., 2020; Constable, Welsh, et al., 2019; Falbén, Golubickis, Wischerath, et al., 2020)). However, in contrast to previous studies that support this notion, showing that the SPE is absent when switching from a social to a perceptual decision about the stimulus, the present decisional manipulation required participants to retrieve the social associations of each stimulus across both decisional boundaries. Social association retrieval biases attention towards the more socially salient category (Liu & Sui, 2016). This is also supported by other studies showing that self-prioritization is still present when the self is not a relevant decisional category (Jublie & Kumar, 2021; Sui & Humphreys, 2013a). Importantly, if self-association had no effect on stimulus categorization in the familiar/unfamiliar decision boundary condition, one would expect to find an enhancement of task performance towards stranger-associated stimuli

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(Falbén, Golubickis, Wischerath, et al., 2020; Svensson et al., 2021), which, however, was not present. The results seem to support the notion that the SPE advantage is self-specific (Northoff, 2016). That is, previous research demonstrated that the self can flexibly adapt to include close, familiar others such as friends (Sui et al., 2012, 2013), the mother (Frings & Wentura, 2014; Schäfer et al., 2016; Sui et al., 2014), or affiliated groups, such as the favourite sports team (Enock et al., 2018) in an extended self-representation (Swann et al., 2012), leading to prioritized processing of these familiar others. While our results from the matching task further reiterate this enhanced processing of close others, the results from the categorization task suggest that processing advantages of familiar others may not be mediated by the same representation that facilitates processing of self-relevant stimuli. This may further explain why the magnitude of prioritization is typically smaller and less stable for familiar others than for the self (Enock et al., 2018; Frings & Wentura, 2014; Keyes & Brady, 2010; Sui et al., 2012, 2014; Woźniak & Knoblich, 2019), an observation in the literature that is further confirmed by our stability analyses.

Mean-level, cross-session analyses showed that the self-processing-advantage is flexible in that it equally extends to different stimulus domains and even across tasks. In both tasks, matching and categorization, the magnitude of self-related behavioral facilitation was equally strong across identity-associations that have been newly-formed and those that have been shaped and reinforced over a long period of time. However, reiterating the above point that friend-associations may not be mediated by the same self-representation that leads to an SPE, friend-associated stimuli showed to benefit more from the encoding into an extended, social self-representation over time. That is, while equal SPE magnitudes were found across stimulus domains when the self-related processing advantage was measured relative to the stranger in both experiments, the friend-associated stimulus differed from the self- and other-associated stimuli in that processing of personally owned objects was enhanced relative to shapes (see sections 3.3.1, and supplement S5). This may suggest that, in contrast to self-associated information, friend-associated information is more prone to contextual modulations. In line with this suggestion, previous research showed that other

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factors such as the concreteness of the association and the friend-knowledge related to it (Lee et al., 2021; Woźniak & Knoblich, 2019), or the predictability of their appearance (Keyes & Brady, 2010; Sui et al., 2014) largely affect the processing of friend-, but not self-related information. Interestingly, however, this modulation of the friend-associated stimulus was only present when using personally owned objects but not when using first name initials (see sections 3.4.1, and supplement S5). While both types of stimuli hold long-term associations with the self and the friend, these stimuli differ in their perceptual complexity. Combining this with our findings from the perceptual level analysis (section 3.1), which showed that luminance contrast and stimulus identity interacted when complex object-stimuli were used, but not when simple shape-stimuli were used, this may suggest that enhanced stimulus complexity, which requires greater attentional engagement and evidence accumulation (Perri et al., 2019), increases the involvement of early attentional and perceptual effects on social prioritization effect generation. In other words, when more sensory information needs to be collected in order to distinguish the stimuli from each other and retrieve the correct social association, perceptual sub-processes that are prone to bottom-up (e.g., contrast) and top-down modulations will have a greater contribution to the overall processing time. As this complexity-modulation was present for the friend-associated stimulus, but not for the self-associated stimulus, this may explain why previous studies that used more complex stimuli such as faces found self-association to alter early attentional and perceptual processes in a more automatic fashion, while the effects of friend-association on these processes were less evident (Jublie & Kumar, 2021; Liu et al., 2016; Sui, Liu, et al., 2015).

To test whether the SPE is not only stimulus-independent at group-level, but also stable within individuals, we assessed the intra-individual correlations of SPEs across contexts, that is, across the two stimulus domains and tasks. Differential correlation did not only show that individual SPEs are stable across time, but also suggested that the extent to which stimulus material is associated with the self does not affect the extent to which information processing is facilitated, as long as it is related to the self. The individual SPE magnitude was stable when measured relative to a distant other. This effect was more

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pronounced in Experiment 2, in which participant name initials were used. This is not too surprising though, given that data in Experiment 1 was pooled across different contrast levels, while no contrast manipulation was included in Experiment 2, thereby reducing the variance induced by different luminance contrasts on the processing of different stimulus domains. As shown in the perceptual level analysis, stimulus contrast influenced RTs across stimulus domains and identities differently. Interestingly, despite the involvement of different processing stages in matching and categorization tasks, we observed that SPE magnitude was stable across tasks. This suggests that the SPE measured via both tasks is directly comparable and likely derives from the influence of the same central self-representational aspects on different levels of information processing.

Taken together, the present findings of stability at both group- and individual level support the idea that the SPE is mediated by the same aspect of an individual's internal self-representation, which is accessible across different contexts. In other words, it supports the notion that the self acts as an anchor in information processing (Sui, 2016), leading to a trait-like stability of its facilitative effects regardless of the stimulus material and task type, as long as attention is drawn to the stimulus-associated social identities. Such stability of the SPE adds to previous experimental and neuroimaging studies outlining the account of the 'integrative self' (Hu et al., 2016; Sui & Humphreys, 2015b; Woźniak & Knoblich, 2019), which assumes that external information is bound to a common, stable self-representation that can be flexibly accessed across different contexts.

Given the nature of correlation analysis, this stability of the SPE can always only provide suggestive, albeit not conclusive evidence for the mediation by a common underlying self-representation. It is therefore crucial to consider possible alternative mechanisms that might lead to the observed stability across stimulus domains and time. For instance, it may be possible that the familiar labels in the matching task, which were present across both sessions and possess an established meaning, might mediate the SPE in both stimulus domains. However, recent studies provide little support for this claim (Lee et al., 2021; Schäfer et al., 2017; Woźniak & Knoblich, 2019). For example, Schäfer, Wentura and Frings (2017)

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assessed to what extent the concreteness of the labels affects information-prioritization. The authors found that increasing label concreteness led to a measurable performance enhancement, suggesting that the label has an effect on information prioritization, however, this effect was both smaller in magnitude and did not correlate with the SPE. Furthermore, if part of the SPE that shows stability across stimulus domains was driven by the label, this internal stability in the SPEs would be absent in the categorization task, in which no labels were used. Instead, intra-individual stability was observed in both tasks, making it unlikely that the stability of the SPE results solely from the labels.

A second alternative that may be considered is that the magnitude of SPE in both sessions indicates a differential ability to encode external information into memory. Indeed, self-reference effects in memory have been consistently evidenced in the literature, with self-associated information being remembered better than non-self-associated information (Cunningham et al., 2008; Rogers et al., 1977; Symons & Johnson, 1997). However, while it may seem plausible that SPE stability results from memory encoding ability, previous studies have shown that memory encoding alone cannot account for the magnitude of self-prioritization. For example, in a recent study Reuther and Chakravarthi (2017) assessed whether differences in memory encoding, rather than perceptual processing, might account for the self-bias in information processing. Despite extensive training, resulting in error-free memory performance for all associations, self-related information was still prioritized over friend- and stranger-related information. Additionally, increasing evidence from the neuroscience literature and lesion-patient studies suggests that self-reference advantages arise independently of the depth of semantic encoding and semantic classification ability (Grilli & Glisky, 2013; Grilli & McFarland, 2011; Rathbone et al., 2011; Sui & Humphreys, 2013b). Lastly, our results in the first analysis demonstrate that the SPE we observe in the present sample affects both perceptual and decisional levels of information processing, supporting the suggestion that SPEs arise at several levels of information processing (Cunningham & Turk, 2017; Desebrock & Spence, 2021; Golubickis et al., 2018; Hu et al., 2020; Sui & Humphreys, 2017a). However, given that self-prioritization influences various levels of information

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processing, the present results do not allow us to draw certain conclusions about whether the intra-individually stable SPE relates to individual-specific, trait-like differences in a single processing level (e.g. perception, memory), or whether it results from the integrated processing across different hierarchical levels.

Taken together, the present results provide evidence for the idea that the self acts as a stable anchor in binding information across contexts, which constitutes a major question in self research (Molnar-Szakacs & Arzy, 2009; Sui & Humphreys, 2015b, 2017a). While our results provide evidence for self-prioritization to interact with perceptual processing when complex stimuli are used, they show that self-prioritization is influenced by decisional processes independently of the stimulus material. The present findings further show that self-association leads to similar performance enhancement across newly-learned as well as long-term established self-associations. By comparing self-, friend- and stranger-associations the present results further strengthen the hypothesis that prioritization of self- and friend-related information is mediated by different underlying representations and suggest that a self-specific reference provides a stable processing basis that can be applied to different types of information, while friend-reference may be more strongly modulated by the stimulus domain or the type of association it holds to the self.

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The Power of the Self: Anchoring Information Processing Across Contexts

- Supplementary Material -

Supplementary material

S1: Probing self-prioritization effects across different stages of information

processing: model-specifications and parameter estimates.

To avoid overparameterization of generalized linear mixed effect models the most parsimonious random effects structure was selected for each model (Bates, Kliegl, et al., 2015). Participant ID was treated as a random factor across all models to account for inter-individual variance in response intercept. Random factor crossing of participant and stimulus shape was considered for Experiment 1 and 3 (Judd et al., 2012), in which abstract shapes were paired with identities. However, random factor crossing with stimulus shape did not add sufficient explanatory power and was therefore dropped from these models.

Matching task: Individual perceptual sensitivity and response criterion were modelled using linear mixed effect models with stimulus identity and contrast as interacting fixed factors and response key added as nuisance variable. Random effects structure was session-dependent as outlined above. Untransformed response time (RT) data was modelled on a trial-basis using generalized mixed effect models fitted for an inverse Gaussian distribution with identity link (Lo & Andrews, 2015; Schwarz, 2001). This was preferred over log-transforming RT data as both the left-end Gaussian and well as right-ward skew have been shown to be affected differently by self-relevance and decisional context (Sui & Humphreys, 2013a).

Categorization task: response accuracy and RTs were modelled using generalized linear mixed effect models, using the same random structure as outlined in the matching task. Here, we only included self- and stranger-associated stimuli in the analysis as reassignment of friend-associated stimuli to different categories and response keys across different blocks would affect friend-associated performance. A mixed effects model with binomial error distribution was implemented to assess trial-based performance accuracy, while the RT model was generated using the same characteristics as in the matching task. A first model assessed a three-way interaction of stimulus identity, contrast, and decision boundary. Given the

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absence of a three-way interaction, simpler models with identity-contrast and identity-boundary interactions were modelled for each contrast level or decisional boundary separately. P-values are estimated from likelihood ratio test and are reported in conjunction with their 95%-CIs. For generalized mixed models with inverse Gaussian error distributions Wald confidence intervals are reported. To allow for direct comparison and interpretability of the results we report unstandardized coefficients.

S1.1: Matching task

Table S1.1. Model specifications for the perceptual matching tasks with abstract shapes and personal objects

Parameter	Stimulus	n_{part}	n_{obsv}	$SD_{participant}$	Family	Formula
Sensitivity	Shape	43	258	0.819	gauss	$d' \sim \text{shape} * \text{contrast} + \text{rspkey} + (1 + \text{rspkey} \text{subject})$
	Object	38	228	0.882	gauss	
Criterion	Shape	43	258	0.042	gauss	$C \sim \text{shape} * \text{contrast} + \text{rspkey} + (1 + \text{rspkey} \text{subject})$
	Object	38	228	0.136	gauss	
Resp Time	Shape	43	6701	57.30	inv.gauss	$RT \sim \text{shape} * \text{contrast} + \text{rspkey} + (1 + \text{rspkey} + \text{shape} \text{subject})$
	Object	38	5823	45.41	inv.gauss	

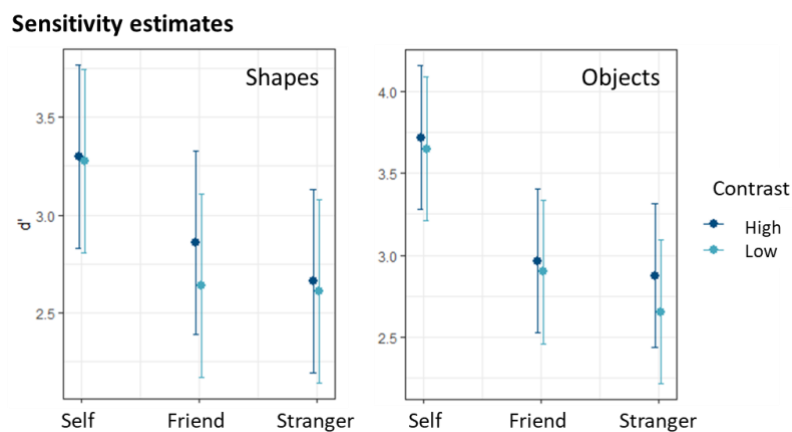


Figure S1.1.1. Perception. Model estimates of perceptual sensitivity for factor interaction of identity and contrast. Left panel shows estimates for abstract shape stimuli (similar to Sui, He & Humphreys, 2012), right panel shows estimates for personally-owned objects.

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Table S1.1.1. Perception. Model estimates for perceptual sensitivity (d') using abstract shapes and personal objects

	Intercept	Friend	Stranger	Contrast	Friend: Contrast	Stranger: Contrast	RespKey
<i>Shapes</i>							
β	3.30	-0.44	-0.64	-0.02	-0.20	-0.03	-0.11
SE	0.237	0.180	0.180	0.180	0.254	0.254	0.274
t	13.899	2.441	3.543	0.123	0.778	0.119	0.413
$CI+$	3.76	-0.09	-0.29	0.33	0.30	0.46	0.42
$CI-$	2.83	-0.79	-0.99	-0.37	-0.69	-0.53	-0.65
p		0.015	<0.001	0.902	0.437	0.905	0.681
<i>Objects</i>							
β	3.72	-0.75	-0.84	-0.07	0.00	-0.15	0.20
SE	0.224	0.187	0.187	0.187	0.264	0.264	0.322
t	16.617	4.038	4.521	0.373	0.012	0.572	0.630
$CI+$	4.15	-0.39	-0.48	0.29	0.52	0.36	0.83
$CI-$	3.29	-1.12	-1.21	-0.43	-0.51	-0.67	-0.43
p		<0.001	<0.001	0.709	0.991	0.568	0.529

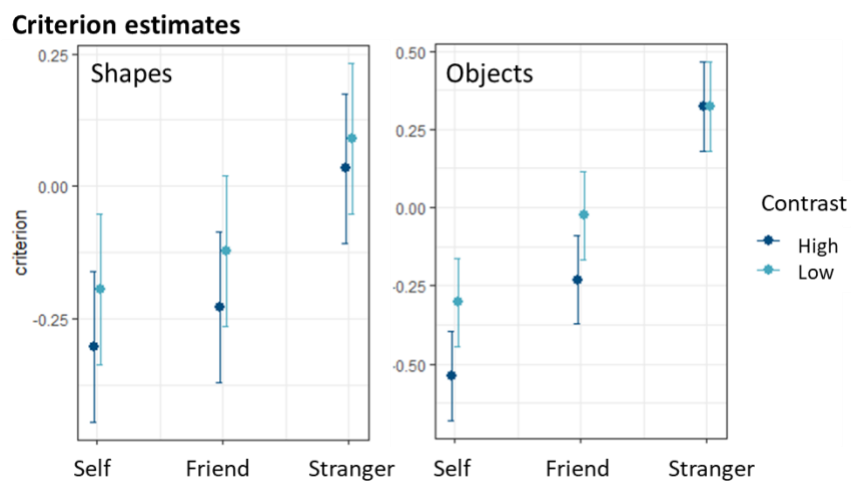
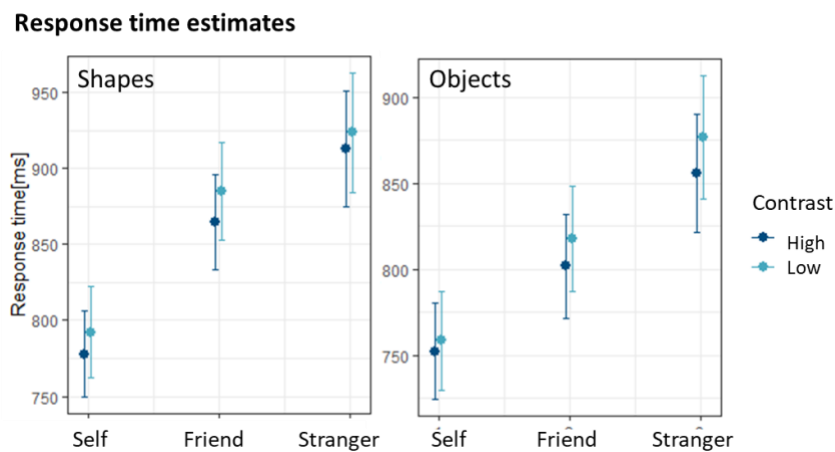


Figure S1.1.2. Perception. Model response criterion estimates for factor interaction of identity and contrast. Left panel shows estimates for abstract shape stimuli, right panel shows estimates for personally-owned object stimuli.

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Table S1.1.2. Perception. Model estimates for response criterion (C) using shapes and object stimuli.

	Intercept	Friend	Stranger	Contrast	Friend: Contrast	Stranger: Contrast	RespKey
<i>Shapes</i>							
β	-0.30	0.08	0.34	0.11	-0.004	-0.05	0.05
<i>SE</i>	0.072	0.091	0.091	0.091	0.129	0.129	0.055
<i>t</i>	4.197	0.829	3.687	1.199	0.410	0.027	0.831
<i>CI+</i>	-0.16	0.25	0.52	0.29	0.25	0.20	0.15
<i>CI-</i>	-0.44	-0.10	0.16	-0.07	-0.26	-0.30	-0.06
<i>p</i>		0.407	<0.001	0.231	0.978	0.682	0.406
<i>Objects</i>							
β	-0.54	0.31	0.86	0.24	-0.03	-0.24	-0.09
<i>SE</i>	0.072	0.091	0.091	0.091	0.129	0.129	0.072
<i>t</i>	7.438	3.387	9.460	2.588	0.243	1.839	1.214
<i>CI+</i>	-0.40	0.49	1.04	0.41	0.22	0.01	0.05
<i>CI-</i>	-0.68	0.13	0.68	0.06	-0.28	-0.49	-0.23
<i>p</i>		<0.001	<0.001	0.010	0.808	0.066	0.225

**Figure S1.1.3. Perception.** Model RT estimates for factor interaction of identity and contrast. Left panel shows estimates for abstract shape stimuli, right panel shows estimates for personally-owned object stimuli. Error bars indicate SEM.

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Table S1.1.3. Perception. Model estimates for RTs using shapes and object stimuli.

	Intercept	Friend	Stranger	Contrast	Friend: Contrast	Stranger: Contrast	RespKey
<i>Shapes</i>							
β	777.71	87.13	134.89	14.50	5.84	-3.55	48.90
SE	14.470	10.870	11.638	5.514	7.464	9.073	24.600
t	53.746	8.015	11.591	2.630	0.783	0.392	1.989
CI+	806.07	108.42	157.70	25.31	20.47	14.23	97.13
CI-	749.35	65.82	112.08	3.70	-8.79	-21.33	0.72
p		< 0.001	< 0.001	0.009	0.434	0.695	0.047
<i>Objects</i>							
β	752.14	49.462	103.814	6.198	9.75	14.61	97.056
SE	14.310	7.630	14.150	4.290	6.646	6.923	16.468
t	52.530	6.483	7.338	1.445	1.467	2.110	5.890
CI+	780.20	64.41	131.54	14.61	22.78	28.18	129.30
CI-	724.08	34.51	76.08	-2.21	-3.27	1.04	64.78
p		< 0.001	< 0.001	0.149	0.142	0.035	<.001

Summary – Matching task

Abstract shapes: In summary, there was a robust self-prioritization effect within the matching task using abstract shapes. This was expressed by a heightened perceptual sensitivity as well as faster RTs times towards self-associated shapes compared to friend- and stranger-associated shapes. The response criterion showed a more liberal response bias for self- and friend-shapes compared to stranger-shapes, for which the response criterion was more conservative. There was no consistent effect of stimulus contrast on response performance and no evidence of contrast interacting with self-relevance.

Personal objects: In summary, we observed a robust self-prioritization effect within the matching task using personally-owned objects. This was evidenced by heightened perceptual sensitivity and faster RTs towards self-owned objects compared to friend- and stranger-owned objects. The response criterion showed a strong negative bias for self-owned objects and, albeit to a lesser degree, for friend-owned objects, but not for stranger-owned objects. Contrast-effects were not consistent across performance measures, however, RTs indicated that contrast degradation affected stranger-owned objects more strongly compared to self-owned objects.

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S1.2: Categorization task

To investigate how self-relevance affects perceptual and decisional processing of newly-learned associations, the influence of shape identities (self, friend, stranger), stimulus luminance (contrast low vs. high), and decisional boundaries (classification: self vs. other, familiar vs. unfamiliar) on response accuracy and RTs was assessed using mixed effect models. Before the interactions of stimulus identity with contrast and of stimulus identity with decision boundary were investigated, a full model with all factors was implemented. When using abstract shapes, this model indicated that there was no three-way interaction for neither accuracy ($\beta = 0.31$, $CI[-0.44 \ 1.06]$; $p = .422$) nor RTs ($\beta = -1.82$, $CI[-15.26 \ 11.63]$; $p = .791$), showing that potential effects of stimulus degradation on the SPE did not differ depending on the decisional boundary. When using personally owned objects, there was also no three-way interaction of owner identity, contrast, and decision boundary for either accuracy ($\beta = -0.29$, $CI[-1.14 \ 0.55]$; $p = .494$) nor RT measures ($\beta = -1.61$, $CI[-17.13 \ 13.91]$; $p = .839$).

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Table S1.2: Model specifications for the categorization tasks (experiment 3 and 4)

Parameter	Stimulus	Boundary	n_{obsv}	n_{part}	$SD_{participant}$	Family	Formula
Perception							
Accuracy	Shape	Self/Others	3854	43	0.790	binomial	$Acc \sim shape * contrast + rspkey + (1+rspkey subject)$
		Familiar/Unfamiliar	3833		0.654		
	Object	Self/Others	3408	38	0.777		
		Familiar/Unfamiliar	3407		0.601		
Resp Time	Shape	Self/Others	3445	43	27.51	nverse gaussian	$RT \sim shape * contrast + rspkey + (1+rspkey subject)$
		Familiar/Unfamiliar	3407		25.55		
	Object	Self/Others	3125	38	26.39		
		Familiar/Unfamiliar	3056		27.78		
Decision making							
Accuracy	Shape	High	3835	43	0.694	binomial	$Acc \sim shape * boundary + rspkey + (1+rspkey+shape subject)$
		Low	3852		0.546		
	Object	High	3409	38	0.780		
		Low	3406		0.618		
Resp Time	Shape	High	3456	43	27.13	nverse gaussian	$RT \sim shape * boundary + rspkey + (1+rspkey+shape subject)$
		Low	3396		27.28		
	Object	High	3082	38	25.50		
		Low	3099		25.13		

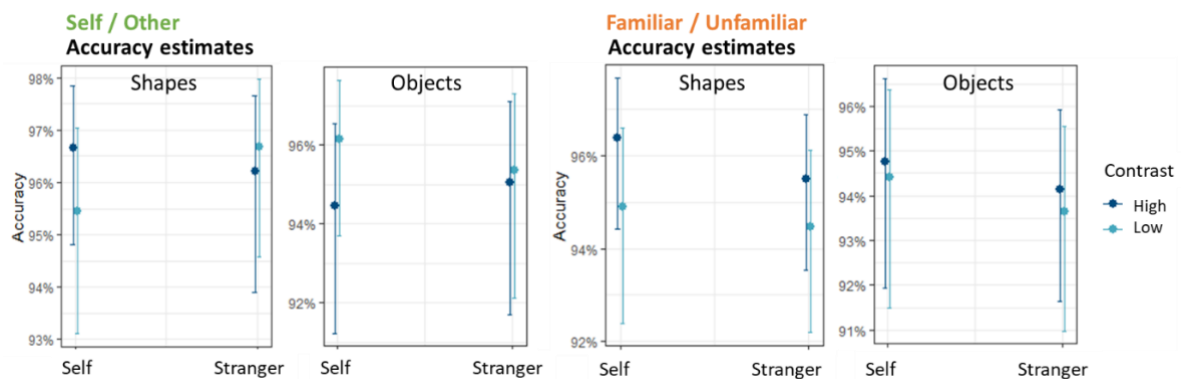
1.2.1. Perception: Effects of contrast and social saliency

Figure S1.2.1.1. Perception. Model accuracy estimates for identity and contrast interactions when using abstract shapes and personally-owned objects as stimuli. Left two panels show estimates for categorization task using the Self/Other decision boundary, right panels show estimates within the Familiar/Unfamiliar boundary. Error bars indicate SEM.

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Table S1.2.1.1. Perception. Accuracy estimates in the categorization task, using shapes and object stimuli across two decision boundaries.

Self/Other						Familiar/Unfamiliar					
	Intercept	Stranger	Contrast	Stranger: Contrast	RespKey f		Intercept	Stranger	Contrast	Stranger: Contrast	RespKey f
<i>Shapes</i>						<i>Shapes</i>					
β	3.36	-0.13	-0.32	-0.78	0.45	β	3.28	-0.23	-0.36	0.15	-0.67
SE	0.233	0.196	0.156	0.276	0.268	SE	0.228	0.199	0.220	0.265	0.245
z	14.418	0.659	2.032	1.647	2.926	t	14.301	1.156	1.650	0.555	2.630
CI+	3.82	0.25	-0.01	1.00	-0.26	CI+	3.74	0.16	0.07	0.67	-0.20
CI-	2.91	-0.51	-0.62	-0.09	-1.31	CI-	2.83	-0.62	-0.79	-0.37	-1.14
p		0.510	0.042	0.100	0.003	p		0.2477	0.09889	0.5792	0.0086
<i>Objects</i>						<i>Objects</i>					
β	2.84	0.12	0.38	-0.31	0.10	β	2.89	-0.12	-0.07	-0.02	0.06
SE	0.253	0.210	0.181	0.308	0.332	SE	0.235	0.213	0.247	0.297	0.245
z	11.210	0.573	2.091	1.020	0.308	t	12.306	0.555	0.272	0.067	0.242
CI+	3.34	0.53	0.73	0.29	0.75	CI+	3.36	0.30	0.42	0.56	0.54
CI-	2.34	-0.29	0.02	-0.92	-0.55	CI-	2.43	-0.54	-0.55	-0.60	-0.42
p		0.567	0.037	0.308	0.758	p		0.579	0.786	0.947	0.808

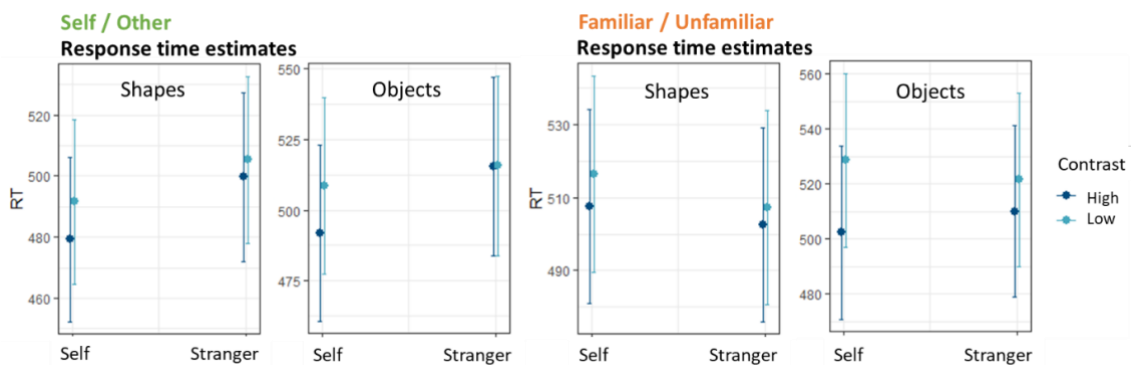


Figure S1.2.1.2. Perception. Model RT estimates for identity and contrast interactions when using abstract shapes and personally-owned objects as stimuli. Left two panels show estimates for categorization task using the Self/Other decision boundary, right panels show estimates within the Familiar/Unfamiliar boundary. Error bars indicate SEM.

SELF-PRIORITIZATION IN INFORMATION PROCESSING

Table S1.2.1.2. Perception. RT estimates in the categorization task, using shapes and object stimuli across two decision boundaries.

Self/Other						Familiar/Unfamiliar					
	Intercept	Stranger	Contrast	Stranger: Contrast	RespKey f		Intercept	Stranger	Contrast	Stranger: Contrast	RespKey f
<i>Shapes</i>						<i>Shapes</i>					
β	479.21	20.51	12.371	-6.74	16.61	β	507.54	-5.00	8.93	-4.20	3.30
SE	13.702	4.075	3.249	5.827	20.382	SE	13.577	4.225	4.938	6.010	23.169
<i>t</i>	34.973	5.033	3.807	1.157	0.815	<i>t</i>	37.382	1.183	1.809	0.699	0.143
<i>Cl+</i>	506.06	28.49	18.74	4.68	56.56	<i>Cl+</i>	534.15	3.28	18.61	7.58	48.71
<i>Cl-</i>	452.35	12.52	6.00	-18.16	-23.34	<i>Cl-</i>	480.93	-13.28	-0.75	-15.98	-42.11
<i>p</i>		<0.001	<0.001	0.2474	0.415	<i>p</i>		0.237	0.071	0.484	0.887
<i>Objects</i>						<i>Objects</i>					
β	491.95	23.42	16.65	-16.21	5.57	β	502.29	7.78	26.20	-14.82	-1.02
SE	15.900	4.238	3.373	5.952	22.641	SE	16.011	3.947	4.652	5.725	18.623
<i>t</i>	30.941	5.526	4.936	2.724	0.246	<i>t</i>	31.371	1.971	5.632	2.589	0.055
<i>Cl+</i>	523.12	31.73	23.26	-4.55	49.95	<i>Cl+</i>	533.67	15.51	35.32	-3.60	35.48
<i>Cl-</i>	460.79	15.11	10.04	-27.88	-38.80	<i>Cl-</i>	470.91	0.04	17.08	-26.04	-37.52
<i>p</i>		<0.001	<0.001	0.007	0.806	<i>p</i>		0.049	<0.001	0.010	0.956

1.2.2. Decision-making: Effects of decision boundary and social salience

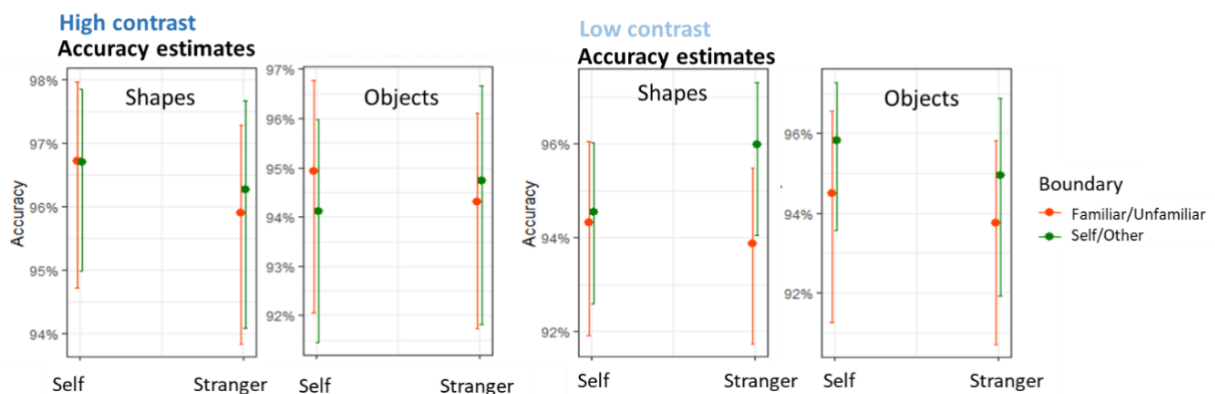


Figure S1.2.2.1. Decision-making. Accuracy estimates for identity and decision boundary interactions when using abstract shapes and personally-owned objects as stimuli. Left two panels show estimates for high contrast stimuli, right panels show estimates for low contrast stimuli. Error bars indicate SEM.

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Table S1.2.2.1. Decision-making. Accuracy estimates in the categorization task, using shapes and object stimuli across two decision boundaries.

High contrast						Low contrast					
	Intercept	Stranger	Boundary	Stranger: Boundary	RespKey f		Intercept	Stranger	Boundary	Stranger: Boundary	RespKey f
<i>Shapes</i>						<i>Shapes</i>					
β	3.38	-0.23	-0.004	0.10	-0.80	β	2.81	-0.08	0.04	0.40	-0.57
SE	0.253	0.198	0.203	0.279	0.267	SE	0.195	0.174	0.177	0.262	0.217
z	13.395	1.166	0.018	0.37	3.011	z	14.416	0.465	0.241	1.539	-2.630
CI+	3.88	0.16	0.40	0.65	-0.28	CI+	3.19	0.26	0.39	0.92	-0.15
CI-	2.89	-0.62	-0.40	-0.44	-1.33	CI-	2.43	-0.42	-0.30	-0.11	-1.00
p		0.244	0.986	0.712	0.003	p		0.642	0.809	0.124	0.009
<i>Objects</i>						<i>Objects</i>					
β	2.93	-0.12	-0.16	0.24	0.19	β	2.84	-0.14	0.29	-0.056	0.05
SE	0.243	0.214	0.213	0.300	0.316	SE	0.253	0.207	0.220	0.307	0.264
z	12.033	0.562	0.735	0.804	0.613	z	11.226	0.650	1.308	0.194	0.201
CI+	3.404	0.299	0.260	0.829	0.812	CI+	3.34	0.27	0.72	0.54	0.57
CI-	2.450	-0.539	-0.573	-0.347	-0.425	CI-	2.35	-0.54	-0.14	-0.66	-0.46
p		0.574	0.462	0.422	0.54	p		0.515	0.191	0.846	0.841

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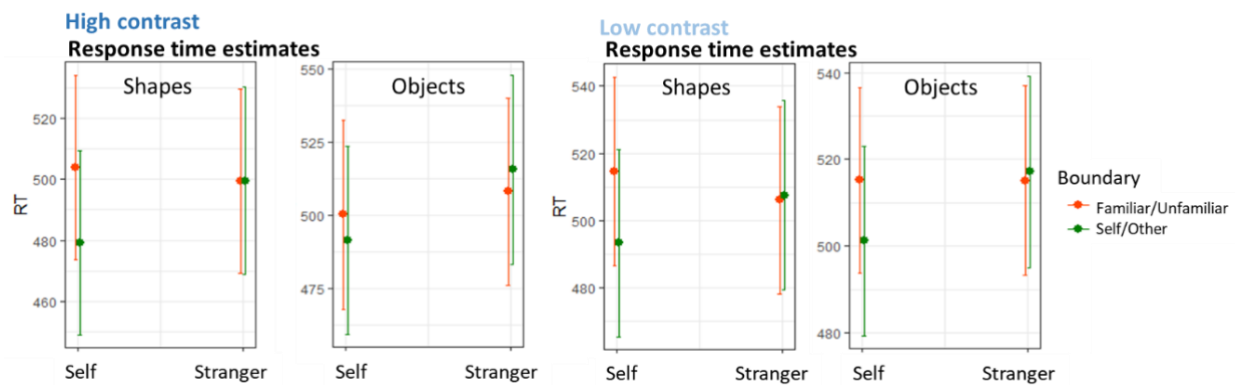


Figure S1.2.2.2. Decision-making. RT estimates for identity and decision boundary interactions when using abstract shapes and personally-owned objects as stimuli. Left two panels show estimates for high contrast stimuli, right panels show estimates for low contrast stimuli. Error bars indicate SEM.

Table S1.2.2.2. Decision-making. RT estimates in the categorization task, using shapes and object stimuli across two decision boundaries.

High contrast						Low contrast					
	Intercept	Stranger	Boundary	Stranger: Boundary	RespKey f		Intercept	Stranger	Boundary	Stranger: Boundary	RespKey f
<i>Shapes</i>						<i>Shapes</i>					
β	502.39	-4.54	-24.79	24.83	14.06	β	514.68	-8.58	-21.37	22.80	7.12
SE	12.785	3.914	3.948	5.113	19.049	SE	14.325	4.348	4.255	6.004	23.075
t	39.295	1.159	6.277	4.856	0.738	t	35.929	1.97	4.255	3.798	0.308
CI+	534.18	3.99	-16.42	36.69	53.65	CI+	542.75	-0.05	-13.02	52.35	34.57
CI-	476.82	-13.07	-33.13	12.95	-33.19	CI-	486.60	-17.10	-29.70	-38.11	11.04
p		0.246	<0.001	<0.001	0.461	p		0.049	<0.001	<0.001	0.758
<i>Objects</i>						<i>Objects</i>					
β	500.12	7.94	-8.76	16.29	2.44	β	526.24	-7.84	-18.94	15.78	2.44
SE	16.450	4.173	4.092	5.908	19.932	SE	15.925	4.342	4.288	5.993	19.720
t	30.401	1.904	2.141	2.758	0.123	t	33.046	1.807	-4.416	2.632	0.124
CI+	532.37	16.12	-0.74	27.87	41.51	CI+	557.45	0.67	-10.53	27.52	41.09
CI-	467.88	-0.24	-16.78	4.71	-36.62	CI-	495.03	-16.35	-27.34	4.03	-36.22
p		0.057	0.032	0.006	0.902	p		0.071	<0.001	0.001	0.902

Summary – Categorization task

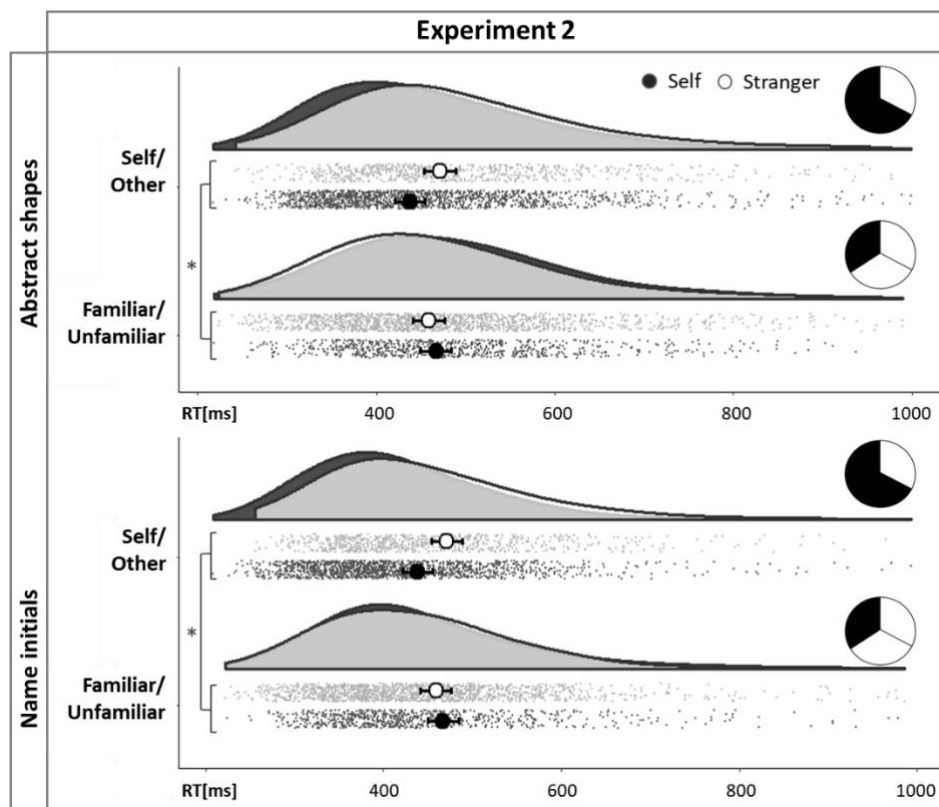
Abstract shapes: In summary, RTs failed to indicate an effect of self-relevance on perceptual processing via a contrast-modulation, however, there was a robust interaction of self-relevance with decision boundary. Here, self-relevant information was responded to faster when participants had to discriminate self-shapes from friend- and stranger-shapes, but not when self- and friend-shapes were discriminated from stranger-shapes.

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Personal objects: In summary, RT showed significant robust interactions of self-relevance with perceptual processing, as well as with decisional boundaries. At the perceptual level, self-owned objects were responded to faster when presented in high contrast, while stranger-owned objects were not affected by stimulus contrast. At the level of decision making, categorization into self- and other-owned stimuli led to a robust self-prioritization effect that was absent when participants had to categorize stimuli into familiar and unfamiliar objects.

1.3. Decision-making: Effects of decision boundary and social salience - Experiment 2

Experiment 2 included the decisional manipulation and replicated the findings of Experiment 1 (section 3.2. in the main text), showing significant interactions of decision boundary and social associations on response times. This was the case both when using abstract shapes ($\beta = 46.48$, $C[34.79\ 58.19]$, $p < .001$), as well as when using first name initials ($\beta = 35.36$, $C[24.64\ 46.07]$, $p < .001$), with the self-associated stimulus showing a larger benefit in the boundary in which self and other had to be discriminated (shapes: $\beta = -31.62$, $p < .001$; initials: $\beta = -32.21$, $p < .001$).



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Figure S1.3. Effects of social association and decision boundary - categorization task. Response time distributions, means, and individual trial scatter points, plotted as a function of identity-association (self, stranger) and decision boundary, split for each stimulus type. Error bars indicate SEM. $*p < .05$. Pie charts adjacent to the response time distributions indicate the frequency with which each of the two included identity-associations was shown within each decision boundary (note: the friend- associated stimulus was excluded for the

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S2: Effects of self-relevance on perceptual processing – Experiment 1

The present study only provides little evidence for SPEs interacting with perceptual processes. Firstly, we did not observe significant interactions of stimulus identity and contrast when using abstract shapes, as has been reported by Sui and colleagues (Sui, He, et al., 2012), even though there was a tendency towards similar patterns. In their study the authors reported that a reduction in stimulus contrast lead to a degradation of perceptual sensitivity towards friend-shapes, while self-shapes were more stable across contrasts. Potential explanations for the absence of such effect was the influence of task specifications, such as response lateralization, the use of different display screens, or the difference in RT duration. In their 2012 study, Sui and colleagues conducted a lab-based study where screen contrast and viewing distance was standardized across all participants, and where participants were restricted to only using the right hand to respond. Such standardization is not possible in an online setting. Exploratory analyses of response lateralization indicated that similar patterns of perceptual sensitivity decreases for friend-stimuli following contrast degradation were present only for right-hand but not left-hand responses, and only for shapes but not objects. Interestingly, right-hand responses further showed a stronger facilitation of self-relevant information processing compared to left-hand responses, suggesting a functional hemispheric lateralization of perceptual and social saliency processing for simple stimuli. This idea would be supported by previous studies showing involvement of the left intraparietal sulcus and left superior temporal gyrus in regulating perceptual and social saliency of visual stimuli (Melloni et al., 2012; Mevorach et al., 2009; Sui, Chechlacz, et al., 2012; Sui, Liu, et al., 2015). Nevertheless, as the present study was not designed to assess functional lateralization of self-related processing, it would be interesting for future studies to systematically assess this effect in order to derive stronger conclusions about lateralization of self-relevant processing.

In both the matching and the categorization task, stimulus contrast significantly interacted with identity when self-owned objects were used. When abstract shapes were used, the trend showed a similar pattern, but effects were smaller and less consistent. Interestingly, the directionality of this interaction effect differed between the tasks. In the matching task, RT

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towards self-owned objects showed significantly greater stability when contrast was degraded, compared to stranger-owned objects. In contrast, RT of self-owned objects in the categorization task were more flexibly modulated by stimulus contrast compared to stranger-owned objects. This opposing effect may reflect different underlying mechanisms being involved in these two tasks, as would further be suggested by different RT. In the matching task, self-owned objects were responded to faster ($M_{\text{Shapes}} = 851.7\text{ms}$; $M_{\text{Objects}} = 803.2\text{ms}$; $\Delta_{\text{RT}} = -48.5\text{ms}$) than shapes. In the categorization task, responses towards abstract shapes were faster than towards personally-owned objects ($M_{\text{Shapes}} = 490.2\text{ms}$; $M_{\text{Objects}} = 505.3\text{ms}$; $\Delta_{\text{RT}} = 15.1\text{ms}$). In fact, classification into self-associated and other-associated stimuli in both tasks requires a perceptual representation to be formed and recognized, involving both stimulus-driven computations as well as memory templates of prior experience (Kubilius et al., 2014; Schendan & Ganis, 2015). Self-owned objects differ in a number of higher-order visual properties, while abstract shapes differ in a single dimensions, suggesting that task-dependent differences in RTs to either stimulus category pertains to the involvement of different level of visual processing for object recognition.

The absence of consistent main effects of contrast on response performance, independent of stimulus identity, further suggest that contrast manipulation was compromised by the adaptation to online-testing in the task design (Plainis & Murray, 2000; Rea & Ouellette, 1988). Due to task demands, response windows in the matching task were twice as long as those in the categorization task (2000ms vs 1000ms). In previous lab-based studies assessing self-prioritization by means of matching, participants typically had to respond within 1000ms, providing responses around 650-700ms on average (Enock et al., 2018; Golubickis et al., 2017; Hu et al., 2020; Sui, He, et al., 2012). The longer RT in the present study (852ms on average) might reflect attentional processes compensating for differences in contrast appearance by increasing the salience of low-contrast stimuli (Carrasco et al., 2004; Itthipuripat et al., 2019).

Overall, the present data cannot give a definite answer on the influence of self-relevant processing on perception, however, they provide some evidence for this account with

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self-relevant information interacting with stimulus contrast across both tasks when more complex stimuli are used.

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S3: Participant recruitment and power analysis

Sample size estimation was conducted using the simR package (Green & Macleod, 2016) and was based on Monte Carlo simulation of reaction time data to determine the power for a generalized mixed-effect model using shape and contrast as interaction terms and participant as random factor. Simulation offers a flexible and more accurate way of estimating power in mixed effect models (Arnold et al., 2011; Guo et al., 2013). An effect size of 31.8ms was estimated for the interaction term based on pilot data from 11 naïve participants. In order to prevent overestimation of the effect size a more conservative interaction effect size of 25ms was assumed. Based on 1000 simulations with an alpha level of 0.05, it was determined that 38 participants would allow to detect an effect of similar size with 92.7% [CI_{95%}:90.9-94.2%] power (Figure S3). In order to allow for full counterbalancing of shape-associations and response keys, we aimed to recruit 48 participants, which estimated to allow for 96.5% [CI_{95%}: 95.2-97.6%] power.

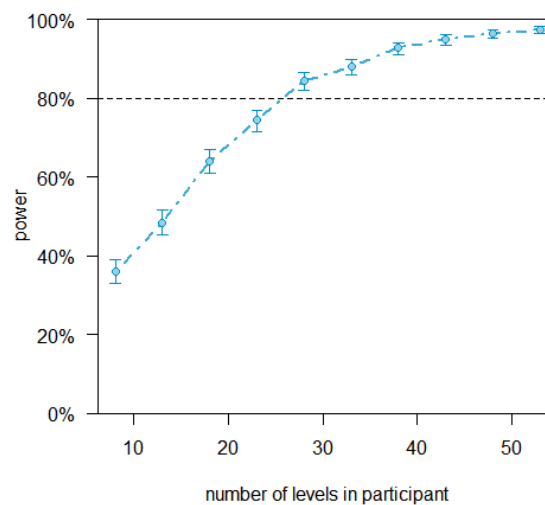


Figure S3. Visualized simulated power curve for a range of participant numbers between 8 and 53 participants. Error bars indicate 95% CI based on 1000 simulations per sample size.

In total, 51 healthy volunteers were recruited to take part in Experiment 1. Participants with overall accuracy below 60% ($n = 3$) were removed from further analyses, leaving 48 participants. Due to a frame rate recording error in the testing platform, which altered stimulus presentation and response recording times, data from nine sessions across

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seven participants had to be excluded. Furthermore, four participants did not complete the second session. Similar to the participant exclusion criterion, a task-based exclusion criterion was applied with data for which performance below 60% was excluded on a participant-by-task basis. Here, single-task data from 2 participants failed to reach accuracy thresholds (<60%) in the second session, one in the matching task and one in the categorization task. Thus, data from 43 participants (23 female, age: 27 ± 6 years) that completed the first session (using shape stimuli) and 38 participants (21 female, age: 26.7 ± 6.1 years) that completed the second session (using personal objects as stimuli) were retained for the main analysis. After accounting for data availability across tasks and sessions, complete data was present for 36 individuals. In Experiment 2, 50 naïve, healthy volunteers were recruited, all of which completed both sessions. Two participants indicated response accuracy below 60%, one in the matching task and the other in the categorization task. Data from these participants was excluded from further analyses in the respective tasks. Across experiments, all participants were right-handed according to self-report and had normal or corrected-to-normal vision. Participants provided informed consent and were compensated with £7.50 per hour.

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S4: Effects of response lateralization

In the present study participants were allowed to use both hands for responding in order to increase homogeneity across the sample. Response key was included in all models (section 1) to control for unexplained variance due to response lateralization. In an exploratory analysis, we therefore assessed the influence of response key lateralization on task performance. This furthermore allows comparison of findings to previous studies (e.g. Sui, He, et al., 2012) that typically used unimanual (right hand) responses. Lateralization effects are reported for each task separately.

Matching task: To assess the influence of response lateralization on performance in the matching task, the response key was added as fixed factor interacting with stimulus identity and contrast to the generalized linear effects models for performance data (sensitivity, criterion, RT). Modelling perceptual sensitivity towards abstract shapes and personally owned objects showed a significant three-way interaction between stimulus identity, contrast, and response key when using abstract shapes ($\beta = -1.26$, $CI[-2.25 \ -0.27]$; $t = 2.49$; $p = .01$). Hence, two separate models with identity and contrast were created for each hand individually. These indicated that stimulus identity and contrast interacted for the self- and friend-shape only when the right hand was used ($\beta = -0.73$, $CI[-1.40 \ -0.05]$; $t = 2.1$; $p = .04$), but not when the left hand was used ($\beta = 0.54$, $CI[-0.16 \ 1.24]$; $t = 1.5$; $p = .134$). Here, self-shapes were less strongly affected by stimulus contrast degradation compared to the friend (Figure S4), in line with findings from Sui and colleagues (2012) showing a stronger modulation of perceptual sensitivity by stimulus contrast for the friend-shape compared to the self-shape. There was no interaction effect of response key, contrast, and identity when pictures of personally-owned objects were used, neither for the friend ($\beta = 0.07$, $CI[-1.04 \ 1.17]$; $t = 0.12$; $p = .903$) nor the stranger ($\beta = -0.09$, $CI[-1.20 \ 1.01]$; $t = 0.16$; $p = .872$). There was a marginally significant lateralization effect of match-key on response criterion for shapes, with friend-shapes being more strongly affected by contrast degradation when using the right hand compared to the left hand ($\beta = 0.43$, $CI[-0.01 \ 0.87]$; $t = 1.91$; $p = .056$), and no effect of response key on personally owned objects ($p > .462$). Response key lateralization affected RTs differently when self-

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associated shapes were distinguished from stranger-associated shapes ($\beta = -60.32$, $CI[-79.10 -41.54]$; $t = 5.32$; $p < .001$), independently of contrast ($p = .862$). Here, follow-up Tukey-adjusted contrasts indicated that self-associated shapes were significantly faster responded to with the left hand compared to the right hand ($\beta = -69.01$; $z\text{-ratio} = 3.81$; $p_{adj} = .002$), while there was no difference between hands for the stranger-shape ($\beta = -7.67$, $z\text{-ratio} = 0.38$; $p_{adj} = .999$). A similar, albeit weaker non-significant trend was observed for the personally owned objects ($\beta = -18$, $CI[1.64 -37.64]$; $t = 1.80$; $p = .072$).

Categorization task: To assess the influence of response lateralization on performance in the categorization task, the response key that was associated with the self was added as fixed factor interacting with stimulus identity and contrast, or stimulus identity and decision boundary to the generalized linear effects models for performance data (accuracy, RTs). There was an overall effect of response key on categorization accuracy when using abstract shapes ($\beta = -0.62$, $CI[-1.09 -0.15]$; $t = 2.56$; $p = .01$, Figure S4), however this was independent of stimulus identity and contrast ($p > .313$) and was not present for personally-owned objects ($\beta = -0.11$, $CI[-0.65 0.43]$; $t = 0.42$; $p = .678$). RT analysis indicated an effect of response key on identity-associated processing for shapes ($\beta = -8.68$, $CI[-16.63 - 0.74]$; $t = 2.14$; $p = .032$) and a marginally significant trend in the same direction for personally-owned objects ($\beta = -8.08$, $CI[-16.24 0.07]$; $t = 1.94$; $p = .052$), independently of stimulus contrast and decision boundary ($p > .214$). Follow-up Tukey-adjusted contrasts indicated that self-associated stimuli were significantly faster responded to than stranger-associated stimuli when responding with the right hand compared to the left hand (shapes: $\beta = -12.70$, $z\text{-ratio} = 4.66$; $p_{adj} < .001$; objects: $\beta = -14.28$, $z\text{-ratio} = 3.05$; $p_{adj} < .001$). This self-processing advantage was reduced for left-hand responses (shapes: $\beta = -4.02$, $z\text{-ratio} = 1.31$; $p_{adj} = .557$; objects: $\beta = -6.19$, $z\text{-ratio} = 2.20$; $p_{adj} = .124$).

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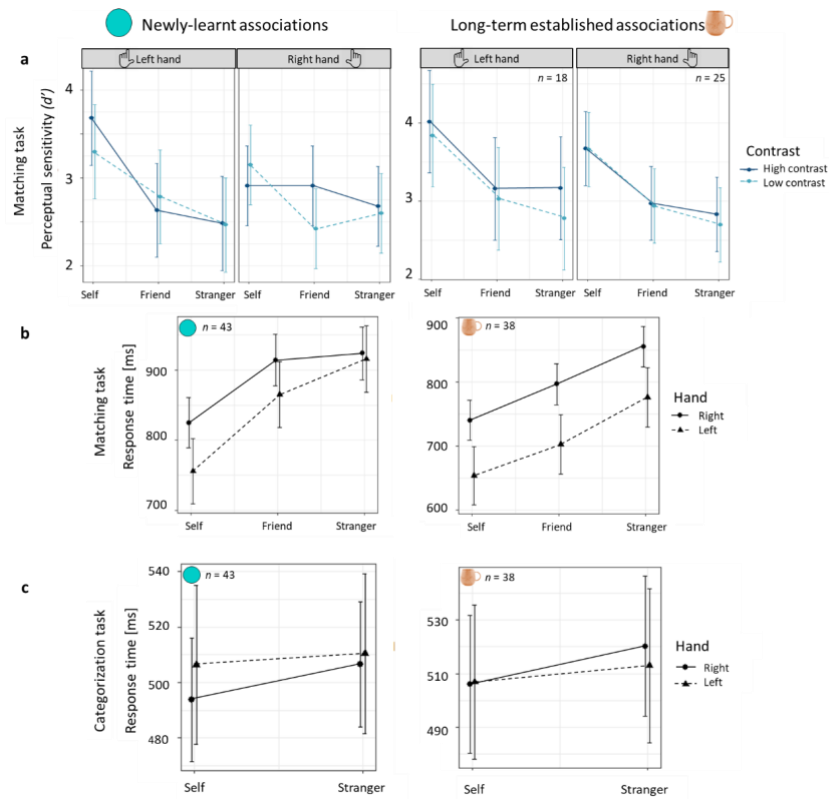


Figure S4. Effects of response lateralization on performance measures. In the matching task, perceptual sensitivity (a) and RT were influenced by response key: When abstract shapes were used, response key interacted with stimulus contrast and identity (a) or with identity alone (b). In the categorization task (c), RT towards self- and stranger associated stimuli was also influenced by response key.

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S5: Friend-prioritization effects (FPE) across stimulus domains

While the main aims of the manuscript were focussed on the prioritization of self-related information over information related to close and distant others, it may be of interest to consider the prioritization of friend-associated information across stimulus domains directly. To this end, the benefit afforded to friend-association is presented below in Figure S5.1. While prioritization effects for the friend-associated stimuli were present in both stimulus domains, the effect was significantly stronger for friend-owned objects compared to friend-associated arbitrary shapes (matching: $t(33) = 2.06$; $p = .047$; categorization: $t(32) = 3.21$; $p = .003$). This further supports that, in contrast to self-prioritization, friend-prioritization is more prone to stimulus-specific differences, such as the type of association that was made between the friend and the stimulus representing them or the complexity of the stimulus. Indeed, in the follow-up experiment in which first-name initials were used, which possess a long-term association with the individuals, the differences between stimulus domains was not present (matching: $t(44) = 0.17$; $p = .866$; categorization: $t(45) = 1.07$; $p = .289$). This is also reflected by the absence of a difference in SPE (relative to the friend) in the follow-up experiment, reported in the main text. This would suggest that stimulus complexity, rather than stimulus association type influences the degree of friend-prioritization, pointing towards the involvement of different processing levels in its generation.

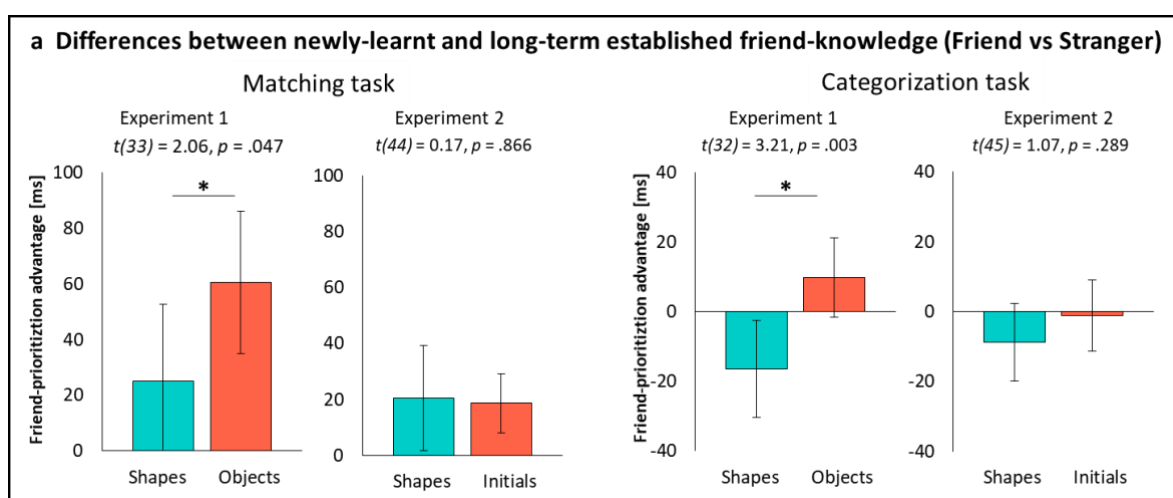


Figure S5.1. Friend-prioritization effect. Friend-prioritization, measured in RT shortening for friend- compared to stranger-associated stimuli, as a function of stimulus domain (newly-learned associations

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with shapes, long-term established associations with owned objects). Higher values indicate faster RTs to the friend-associated stimulus. Error bars represent SEM.

In the matching task, we found that individual SPEs consistently and significantly correlated across stimulus domains when measured relative to the stranger, but not when measured relative to the friend in Experiment 1. In line with this, we found that the FPE was not significantly correlated across stimulus domains in Experiment 1 ($r(32) = 0.202$, $p_{adj} = .502$), while it was in Experiment 2 ($r(46) = 0.564$, $p_{adj} < .001$), supporting the above point that processing of the friend-associated stimuli, but not the self- or stranger-associated stimuli, were more prone to changes in stimulus domain. In the categorization task, no significant correlation of the FPE was present across stimulus domains, neither in Experiment 1 ($r(33) = 0.205$, $p_{adj} = .504$) nor in Experiment 2 ($r(46) = 0.305$, $p_{adj} = .609$). There was also no significant correlation of the FPE across tasks (E1: $r(36) = -0.066$, $p = .706$; E2: $r(45) = -0.021$, $p = .891$).

When pooled across experiments, FPE magnitudes were significantly correlated across stimulus domains in the matching task ($r(79) = 0.367$, $p_{adj} = .002$; Figure S5.2), but not in the categorization task ($r(79) = 0.157$, $p_{adj} = .334$). Furthermore, there was no significant correlation of friend-prioritization effect strength across tasks ($r(81) = -0.037$, $p = .744$).

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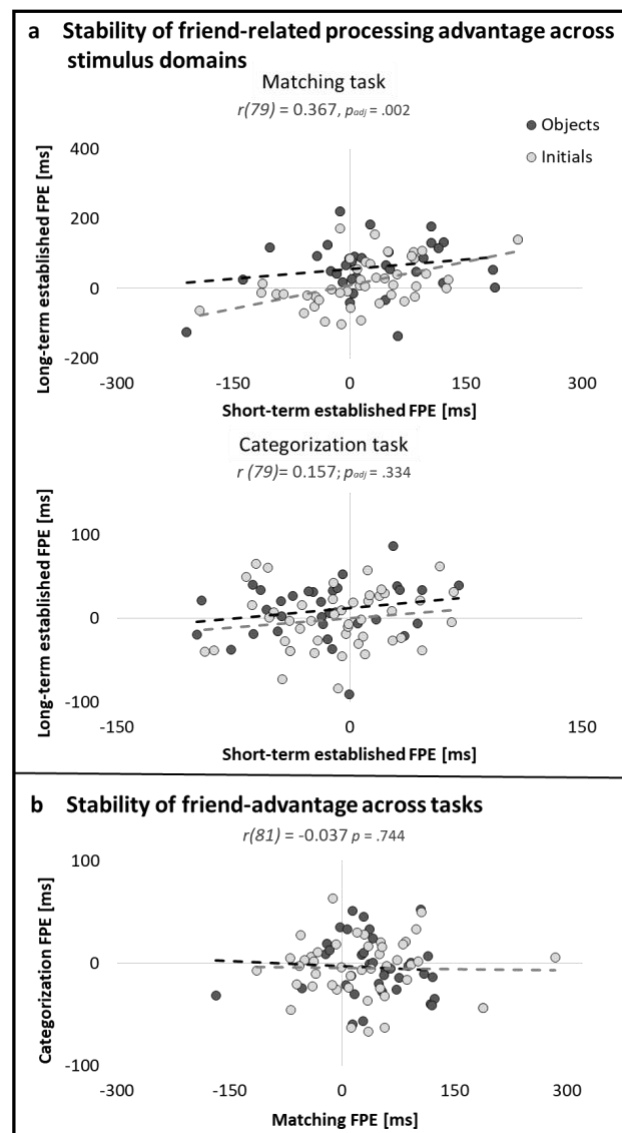


Figure S5.2. Intra-individual stability of friend-prioritization across (a) stimulus domains and (b) tasks. Each point represents data from one individual. Dark gray circles indicate SPEs from the main experiment, in which shapes and personally owned objects were used, while light gray circles indicate SPEs from the follow-up experiment, in which shapes and first name initials were used. Gray dashed line indicates line of best fit. Pearson's correlation coefficients, Bonferroni-Holm adjusted p-values, as well as Bayes Factors are given above each graph.

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S6: Preregistration disclosure

The study has been pre-registered on the Open Science Framework (Scheller & Sui, 2021, February 22). The preregistration was initiated just before the beginning of COVID-19 pandemic related lock-down. As at that time-point it was unclear whether lab-based testing could resume soon, or whether the study would be conducted online, it was described with some alternatives. We will outline these alternatives and the reason for the choices we made below:

1. The type of long-term self-associated stimuli: faces/personal objects.

Previous studies have often, but not exclusively, used face-stimuli to test the effects of long-term self-associations on perceptual decision making performance (Liu et al., 2016; Sui, Chechlacz, et al., 2015; Sui & Humphreys, 2013a). However, in order to maintain a higher level of information security that is necessary in studies conducted online, we chose personal everyday objects (Exp. 1) and first name initials (Exp. 2) over faces or full names as they constitute less sensitive information. That is, while individuals build self-associations with their owned objects that can be personally meaningful (Constable et al., 2019; Ye & Gawronski, 2016), the objects cannot be used to identify individual participants. Participants were asked to choose an object they interact with regularly and/or which consider personally meaningful. They were instructed to supply two pictures of objects: one that belongs to themselves (e.g. their favourite mug), and one object of the same category that belongs to their friend (e.g. their friend's favourite mug). A third object image was assigned to a stranger after matching it for similar object category (e.g. computer mouse, mug, pen) and balancing it in low-level features (colour, size, orientation). Participant-selected categories included personally meaningful belongings such as household ware (mugs, plates, souvenirs), technology (phones, tablets, desktop computers, gaming consoles and mouses), toiletries (perfumes, hair brushes), stationary (pens), clothing (hats, shirts, shoes), as well as pictures of companions such as pet dogs.

For data protection purposes the original stimuli cannot be shared. The stimulus example in Fig. 1 has been created for illustrative purposes only.

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2. The nature of the study (lab-based or online) dictated the amount of trials and whether model-based analyses could be used

In order to conduct model-based RT analyses, a sufficient number of trials per condition ($n > 60$) is necessary to reliably reconstruct parameters. At the same time, data quantity and quality were underlying a stricter trade-off. Reduced experimenter control over the testing environment and participant compliance in speeded response tasks constrains the quantity/quality of data that can be obtained within an online setting. With 48 conditions in total (3 identities x 2 contrasts x 2 match/decision boundaries x 2 tasks x 2 stimulus domains), the amount of trials had to be limited to 30 trials per condition in order to minimize effects of boredom and attentional lapses, and to maintain sufficient data quality. This prevented the application of RT data modelling and the internal organization analysis. However, the design of the study allowed to test the hypotheses outlined in our preregistration through experimental manipulation directly.

We further specified that “Intra-Individual stability of self-referential processing will be assessed by means of correlation analyses across tasks and stimulus types (abstract shapes vs faces/objects)”. Notably, due to a number of different task demands that vary across label-image matching and image categorizing, correlating raw performance scores across tasks needs to be interpreted with caution. Model-based analyses would have provided the advantage to correlate specific parameters of interest (specifically: μ , σ , τ) across tasks, as these have been argued to be more closely linked to different underlying processes in perceptual decision making. However, of main interest was to understand whether the self can flexibly adapt to new contexts, by elucidating whether the self can rapidly bind different types of external information to its underlying representation and thereby facilitate processing.

3. Accuracy score translation into d' and C

The preregistration specified that “Raw accuracy scores will be translated into the more sensitive measure d' [...], which acts as a response-bias corrected measure of accuracy. Self-reference effects are expressed through higher accuracy and shorter RTs in the self-related, compared to friend- and other-related conditions.” Here, we did not specify that, due

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to the task design, this is only possible for the matching task and not the categorization task. This is because d' depends on both hit rate and false positives. With a counter-balanced shape-label pairing, false positives can be directly associated with one identity. In the categorization task, on the other hand, identities are grouped together. This does not allow to disentangle whether a false response was made to a specific identity. Furthermore, we did not pre-register the calculation of response bias C as this was not necessary to test the hypothesis. However we included C in our final report for completeness. This further allowed us to estimate a response bias measure via signal detection theory, and to compare to reports on changes in response bias identified via Hierarchical Drift Diffusion modelling (starting point z ; Golubickis et al., 2018; Macrae et al., 2017).

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