Sticking together? Re-binding previous other-associated stimuli interferes with self-verification but not partner-verification.

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Contribution Statement: GK conceived of the study. Authors jointly designed the study. MDC programmed the experiment. Research Assistants (Fruzsina Kollanyi, Dávid Csuros, Vanda Derzsi) helped translate the experiment to Hungarian and collected the data. MDC wrote the manuscript.

The self-prioritisation and we-prioritisation effects can be observed through faster responses to self-stimuli (self and group) than non-self-stimuli. It remains uncertain if we-prioritisation extends to individual members of one's own group. In light of recent work that implicates memory-based processes in identity-prioritisation effects, the present experiment was developed to determine whether a task-partner's identity relevant information also benefits from an enhanced representation, despite conflicting evidence of partner-prioritisation. To this end, pairs of participants were recruited to perform a joint task. Each partner was assigned a shape and a stranger was also assigned a shape. Participants then completed a shape-to-label matching task where one participant responded if a shape and a label pair matched and the other responded if the shape and a label pair did not match. Halfway through the task the associated identities were switched such that the same shapes and labels were reassigned. Overall, a standard self-prioritisation effect was observed with match-responders making faster responses to self- over partner- and stranger-stimuli. After identities were remapped a decrement in performance was observed for self-trials relative to baseline self-responses. Conversely, responses were faster to partner- and stranger-stimuli relative to baseline performance for each stimulus type. Thus, no evidence was observed for an enhanced representation for task-partner-associated identities. However, an interaction between old and new memory traces for self- and other-associated identities does seem to interfere with self-retrieval and self-verification process.

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Retaining information about the self and our interaction partners provides scaffolding for effective interactions within our environment. Specifically in regards to the self, many researchers have suggested a dedicated self-network that works to select and filter information (e.g. Conway, 2005; Humphreys & Sui, 2016; Sui & Humphreys, 2015) facilitating engagement with self-relevant information. Such a system would ultimately guide behavior in a structured and coherent way in line with the goal states of the self (Conway & Pleydell-Pearce, 2000). Similarly, a dedicated 'we-mode' could encompass a range of processes that support interactions within a social environment (Gallotti & Frith, 2013). The present work considers how newly self-associated information and newly task-partner-associated information might interact to provide evidence of enhanced representation within memory in line with both self-prioritisation (Conway, 2005; Humphreys & Sui, 2016) and we-prioritisation theories (Gallotti & Frith, 2013). As a result, the present work approaches this dedicated self-network from a memory standpoint (Conway, 2005; Conway & Pleydell-Pearce, 2000; Symons & Johnson, 1997) to further evaluate the possibility that facilitated information processing observed for identity-relevant stimuli is the result of stronger and more accessible memory traces for encoded identity-relevant information (Constable, Rajsic, et al., 2019; c.f. Humphreys & Sui, 2016).

The self-prioritisation effect (Sui et al., 2012), faster categorization of minimally self-associated stimuli than non-self-associated stimuli, has generated a boom of research within the cognitive community in recent years with early theories implicating perceptual and attentional processes (Humphreys & Sui, 2016; Sui & Rotshtein, 2019; Truong & Todd, 2017). Some experimental research implicates perceptual and attentional processes (Macrae, Visokomogilski,

Golubickis, & Sahraie, 2018; Truong, Roberts, & Todd, 2017; c.f. Stein, Siebold, & van Zoest, 2016), and yet other research implicates judgment and decision making biases (Constable, Welsh, et al., 2019; Golubickis et al., 2018). Even more recently, experimental evidence has provided support for a memory-based approach to the self-prioritisation effect (Constable, Rajsic, et al., 2019; Janczyk et al., 2019; Muñoz et al., 2019; Wang et al., 2016; Woźniak et al., 2018) allowing for the re-emergence of theories (Conway, 2005; Conway & Pleydell-Pearce, 2000; Symons & Johnson, 1997; Wheeler et al., 2007) that were originally developed in response to the robust finding that self-relevant stimuli are recalled better than non-self-relevant stimuli (Rogers et al., 1977).

Memory-based theories that aim to explain enhanced recall for self-stimuli rest on rich and elaborate self-semantic networks. According to Conway (2005) the self-memory system is formed of the 'working self' and an autobiographical memory knowledge base. The autobiographical memory base (or self-semantic network) is a vast, highly connected, and strong schema of self-related information. Retrieval of information is facilitated through strong and vast memory traces within the self-semantic network because the likelihood of activating relevant information through presented cues is higher (Greenwald et al., 2002). In addition, the working self is influenced by the goal states of the individual and their 'conceptual-self' which is developed from socially constructed schema that shapes the self in relation to others. This working self can also be thought of as an 'active self' which directs memory construction and accessibility to memory structures in line with current goal states, for example, the goal of completing a task with a partner. During encoding, relevant information that is consistent with the current 'self' is selected for encoding. During retrieval, the active self accesses a subset of the autobiographical memory base (or self-semantic network) to satisfy the current goal and identity

state. Essentially, the active self operates to shift and accommodate situational demands if context changes without interrupting the relatively static global self (Conway, 2005; Conway & Pleydell-Pearce, 2000; Markus & Wurf, 1987; Wheeler et al., 2007). Indeed, recent research shows that the current identity state of an individual modulates the magnitude of the self-prioritisation effect (Golubickis et al., 2020).

The present work is primarily concerned with the premise that self-information (and subsequently self-relevant information in the form of self-to-other relations) enjoys a more robust place in memory though stronger and more accessible memory traces. In this sense, it should be more difficult to override an association that has a stronger memory trace and/or more difficult to access an association with conflicting memory traces. To this end, participants engaged in a standard matching task (Krueger, 1978; Proctor, 1981; Ratcliff, 1985) adapted to evaluate self-prioritisation (Sui et al., 2012). In this standard self-prioritisation task participants are asked to associate shapes with a given identity (E.g. Self, Mother/Best Friend, Stranger). They are then required to respond if a given shape and label pairing match or do not match. The present task was adapted into a joint task with self, partner and stranger as tested identities. One participant was required to respond on match trials and the other on mismatch trials (see also Experiment 4, Constable, Elekes, Sebanz, & Knoblich, 2019). Halfway through this task participants were required to switch associations, for example, the new self-shape could become what was originally the partner's or the stranger's shape. A strong memory trace (particularly in the case of self) should produce interference and be indexed as longer reaction times to the newly associated self-stimulus relative to the baseline self-response (before associations were switched). Indeed, Wang and colleagues (2016) provided initial evidence for this assertion through poorer accuracy towards shapes on mismatch-trials that had been previously associated

with the self. Unfortunately mismatch-trials have provided inconsistent results across studies, sometimes producing a self-benefit (E2: Constable, Elekes, et al., 2019; Constable, Rajsic, et al., 2019; E2 &E3: Moradi, Sui, Hewstone, & Humphreys, 2015; Reuther & Chakravarthi, 2017), sometimes producing no statistical differences between identities (Constable, Elekes, et al., 2019; E3: Constable, Rajsic, et al., 2019; Enock, Sui, Hewstone, & Humphreys, 2018; Frings & Wentura, 2014; Golubickis et al., 2017; Schäfer, Frings, & Wentura, 2016; Sui et al., 2012) and other times producing a self-decrement (Constable, Elekes, et al., 2019; E1: Moradi et al., 2015; Woźniak & Knoblich, 2019). Thus, the present work will focus on match-trials where self-prioritisation is reliably indexed.

Beyond the initial confirmation of self-switch-costs, the possibility of partner-switch-costs are of particular interest. The reason for expecting a partner-switch-cost are two-fold. First, and in line with the reasoning concerning access to self-memory structures, a partner stimulus should provide more scaffolding on which to anchor the partner-association as compared to a stranger-association. This is because the stranger as an identity is not tangible whereas the partners are introduced to each other and thus represent a real person providing more opportunity to encode a stimulus well. Indeed, response facilitation for best-friend-stimuli and mother-stimuli over stranger-stimuli is sometimes observed (Schäfer et al., 2017; Sui et al., 2012) although the effect does not seem universal (e.g. Constable, Rajsic, et al., 2019). Such response facilitation towards a known other also may extend to a newly met experimental partner (Cheng & Tseng, 2019). Cheng and Tseng (2019) recruited pairs of participants to engage in an adapted identity matching task. After making associations between a shape and an identity (self, partner, stranger) participants were required to indicate if a given shape and label pairing matched or did not match. One participant was required to respond when the trials were green and the other required

to respond when the trials were red. As expected, a robust self-prioritisation effect was observed and this effect was complimented by a partner-prioritisation effect. Interestingly, no partner-prioritisation effect was observed when the participant had not met their task partner (Experiment 3: Cheng & Tseng, 2019). Constable and colleagues presented a similar study with five different identities (E4: Constable, Elekes, et al., 2019) except one participant was in charge of match responses and the other in charge of mismatch responses. In this case, no partner-prioritisation effect was observed. Thus, it remains uncertain if directly observable partner-prioritisation effects are robust in the context of identity matching tasks. The present study aims to explore the potential for partner-prioritisation at a more sensitive level than direct response facilitation which indexes a wide range of information processing stages (Becker, 2010).

A second, and alternative route to a partner-switch-cost can be predicted through joint action mechanisms. When individuals engage in a task together they are thought co-represent their partner's task and simulate their actions (Sebanz et al., 2003, 2006). Co-actors also seem to co-represent or simulate the mental actions of each other (Elekes et al., 2016). Specifically, knowing that a co-actor devotes their attention to a stimulus leads to deeper encoding as evidenced by better recall. Although Elekes and colleagues (2016) explicitly provided information to participants regarding attentional targets, it is possible in the case of the present work that implicit importance of the self- (partner-) identity is co-represented and thus encoded more elaborately as compared to the stranger-stimulus. Thus, the partner-stimulus might also demonstrate a switch-cost.

Method

Participants

Forty-six adult pairs (92 participants, $M = 21.93$, $SD = 2.78$) volunteered to participate in the study in exchange for supermarket vouchers (1500HUF). Seventy-three participants were female and nineteen were male. All had normal or corrected-to-normal vision and were native Hungarian speakers. All participants provided written informed consent prior to testing. The procedures were approved by the local ethics committee (United Ethical Review Committee for Research in Psychology [EPKEB]) and complied with the ethical standards outlined in the Declaration of Helsinki (1964).

Procedure

All instructions were in Hungarian. All English text describing instructions has been translated. Before the experiment participants were asked to type their name as input to the experiment (to be displayed as stimuli). The pairs were also asked to select a name from a list of 20 names (10 male, and 10 female) that did not belong to someone they knew. The names were randomly selected from the most common Hungarian first names given to babies born between 1995 and 1999[1] as taken from freely available government data.

Shape Assignment and Training

Pairs were instructed that they would be performing a task together. They were told that each person would be represented by a given shape. One shape (Triangle, Diamond, Circle, Pentagon, Star) was randomly allocated to each individual.

Participants then performed a training session (12 trials) to ensure that the stimulus mappings were committed to memory. Participants were posed with the question 'Who does this stimulus

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[1] Bence, Fanni, Máté, Anna, Dávid, Réka, Viviene, Dániel, Alexandra, Tamás, Péter, Dóra, Ádám, Eszter, Márk, Nicolett, Balázs, Petra, László, Viktória.

represent?' and the shape (in text) appeared below the question. Participants were required to indicate if the type of stimulus represented themselves or the selected name using the 'c', 'v', and 'b' keys (response mappings displayed on screen). Participants were asked to decide on the answer together and confirm with each other before making a response. This training was completed to ensure that both participants had committed the stimuli to memory separate from the experimental task. That is, participants were required to learn the associated concept before engaging in the experimental task. On average, pairs achieved high accuracy on this task (*M*=98.01%, *SD*=4.37%).

Participants then completed the matching task below and then the shapes and the labels were rearranged. How the shapes and the labels were rearranged was counterbalanced between participants. Due to convenience sampling there was an imbalance in counterbalancing for the between-subjects 'switch' condition. Twenty-four pairs switched associations such that the identity of the shape changed from 'partner' in Phase 1 to 'self' in Phase 2 (Phase1->Phase 2: Self->Stranger, Partner -> Self, Stranger -> Partner). The other twenty-two pairs switched associations such that the identity of the shape changed from 'stranger' in Phase 1 to 'self' in Phase 2 (Phase1->Phase 2: Self->Partner, Partner -> Stranger, Stranger -> Self). Participants then jointly performed a second block of 12 training trials before performing the second phase of matching trials. On average, pairs achieved similarly high accuracy in the second training block (*M*=97.28%, *SD*=5.84%).

Matching Task

The joint task was to indicate if a given shape (Factor: Shape Identity) and an identity label (Person 1's name, Person 2's name, Selected Name) matched or not by pressing the 'Z' or '3' (the 3 on the number pad of the keyboard). One participant was assigned to respond when the

labels matched and the other was assigned to respond when they did not match. Response mappings were counterbalanced such that half of the participants assigned to the 'match' response would press the 'Z' key and the other half would press the '3' key. Participants were asked to avoid communicating verbally during matching task trials.

We estimated the visual angle on the basis of the average viewing distance of 57cm. A trial began with a white fixation cross (1.4° X 1.4° VA) on a black background presented for 500ms. A white shape (3.5° X 3.5° VA) appeared above or below the fixation cross paired with a white label (height: 1.4° VA) that was on the other side of the fixation cross (vertical dimension) for 233ms, after which the screen went blank. The center of the fixation cross was 5.0° VA away from the center of each stimulus (Shape and Label). Participants were required to respond within 1500ms of the stimulus disappearing. As in Constable et al. (2019), the length of the response window means that participants were able to prioritise accuracy and allow response time to be the primary dependent measure. Sensitivity cannot be accurately determined in a dual task where the individual task requires the participant to either initiate a response or inhibit a response and partner responses could disrupt the determination of hits, misses, false alarms etc. For this reason, only the first response was taken and response feedback ('Correct', 'Incorrect', 'Too slow') on that response was presented for 500ms. Taking only the first response and tying feedback to the first response avoided trials that were contaminated with a partner response. Specifically, if a participant was to make an incorrect response then this response would likely influence the execution of the slower (but correct) response from the partner and not reflect the processes that the study was designed to investigate. There was a variable intertrial interval of 500-800 ms. Participants initially completed 2 blocks of 120 trials (Phase 1). Shape identities were then remapped, and pairs completed a second lot of the training trails described above. Two

final matching task blocks of 120 trials were then completed. Participants were given feedback regarding the percentage of trials on which they (as a pair) answered correctly after each block. The factors of location, stimulus, label, trial type (match/mismatch) were fully counterbalanced and randomized within a block.
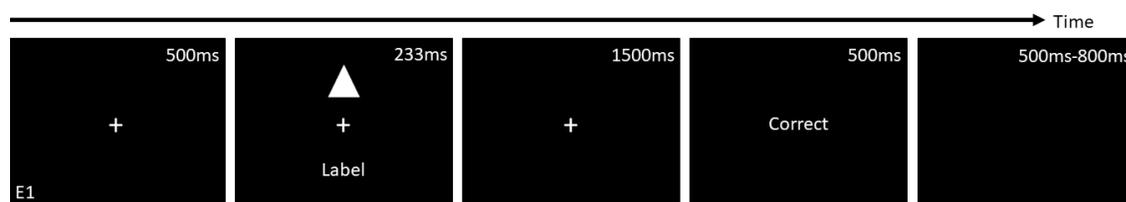

Figure 1. Time course of a trial.

Results

The raw data, and data submitted to inferential statistics has been uploaded to the OSF.[2] As mentioned, measures derived from accuracy are not optimal indicators of the processes of interest for the present design. Therefore, mean response time serves as the only dependent variable.[3] Prior to analysis, the data were checked for anticipatory responses which were defined as response times lower than 100 milliseconds (Luce, 1986), none were observed. Only data from match-responders is presented because patterns of results from mismatch-trials has been inconsistent across studies. Nevertheless, the data from mismatch-responders was collected and is freely available on the OSF. The mean response times on correct trials were submitted to a 3 (Shape Identity: Self, Partner, Stranger) X 2 (Phase: 1,2) X 2 (Switch Identity: Partner, Stranger) mixed ANOVA with Switch Identity as the between-subjects factor using JASP (JASP Team, 2020). A posthoc power simulation was also conducted on each omnibus ANOVA (Lakens & Caldwell, 2019) to evaluate power for the observed interactions (1000 simulations). Overall,

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[2] https://doi.org/10.17605/OSF.IO/5ZAEJ
[3] Nevertheless, an exploratory accuracy analysis may be accessed on the OSF as requested during review.

correct trials represented 83.82% (SD=9.97%) for Phase 1 and 84.45% (SD=12.96%) for Phase 2

of the matching task on all trials on which a response was made.

Main effects of Identity (F(2,88) = 121.71, p <.001, η_p^2 = .73) and Switch (F(1,44) = 6.48, p

=.01, η_p^2 = .13) were observed. No effect of Phase was observed, F(1,44) = 2.03, p =.16, η_p^2 =

.04. The main effects were qualified by an Identity X Switch and an Identity X Phase interaction,

F(2,88) = 4.17, p =.02, η_p^2 = .87 and F(2,88) = 14.675, p =< .001, η_p^2 = .25, respectively. No

other interactions reached significance ps>.26. The source of each significant interaction was

followed up with targeted t-tests.

Identity X Switch

Participants who adopted their partner's stimulus in Phase 2 responded faster on partner- and

stranger-trials than those who adopted the stranger's stimulus, t(44) = 2.38, p =.02, d= .70 and

t(44) = 3.01, p =.004, d= .89 respectively. No such difference was observed for self-trials, t(44) =

1.45, p =.15, d=.43. The power simulation for match-responders revealed that 73.6% of

simulations detected an Identity X Switch interaction. Because this result falls below

conventional power thresholds we caution against placing too much weight in this interaction.

Identity X Phase

Participants responding to self-trials were slower in the second phase than in the first phase, t(45)

= -2.86, p =.006, d_{av}= -.37. This pattern was reversed for partner- and stranger-trials, t(45) =

2.73, p =.009, d_{av}= .38 and t(45) = 2.25, p =.03, d_{av}= .28 respectively. The power simulation for

match-responders revealed that 98.2% of simulations detected an Identity X Phase interaction.
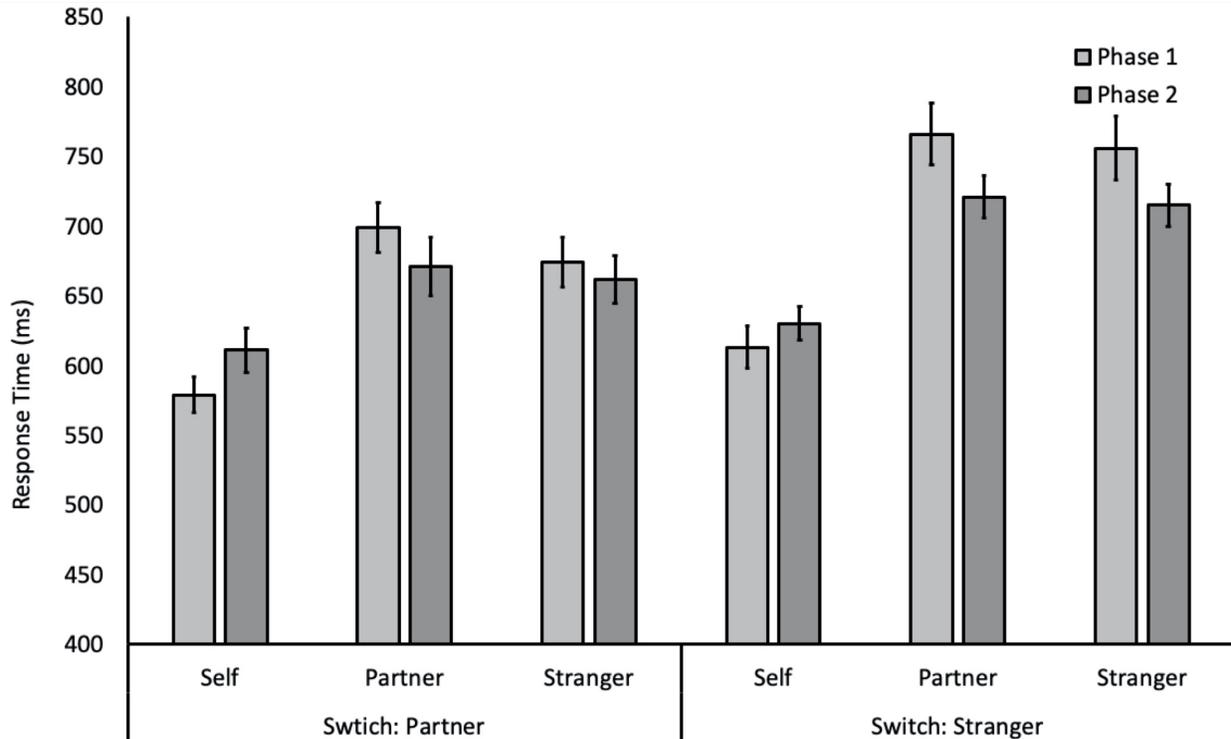
Figure 2. Response times as a function of Identity, Switch Identity and Phase, error bars represent standard error of the mean.

General Discussion

The aim of the present work was to evaluate the possibility that information associated with the self and with a task-partner might be represented with privilege within memory structures. Enhanced representation of partner-associated stimuli can be predicted via two routes. First, and as with the self, a partner-stimulus could provide more scaffolding on which to anchor the partner-association as compared to the stranger-association. Second, joint action mechanisms might be employed. The participant might represent their co-actor's mental actions and thus encode their co-actor's assigned stimulus with similar priority to their own (we mode: Gallotti & Frith, 2013).

There is clear evidence of a self-prioritisation effect in that participants responded faster to self-associated stimuli than partner- or stranger-associated stimuli. Consistent with Constable et al.

(2019), however, no statistical difference between partner-associated and stranger-associated stimuli was observed. Thus, no evidence for a partner-prioritisation effect was obtained (c.f. Cheng & Tseng, 2019). A lack of an overall partner-prioritisation effect, however, was no surprise given previous results. Indeed, the experiment was designed to test whether previous and current identity associations would interact to produce difficulty during retrieval. Stimuli that were re-bound to the self after previously being associated with another identity did seem produce poorer retrieval and verification effects (slower RTs) relative to baseline 'self' performance. The retrieval and verification of partner-stimuli in Phase 2, however, was faster relative to baseline 'partner' performance in Phase 1 and mirrored the pattern of results obtained for stranger-stimuli. We surmise that these faster responses are most likely due to practice effects rather than facilitated retrieval after switching associations. To summarize, only a switch-cost was observed for self-stimuli.

There are a number of possible explanations for the observed self-switch-costs. First, focusing on encoding and retrieval, it is possible that the second binding of a shape that was previously associated with another identity is not tied to the self as effectively as a shape with no previous identity association (as shapes were in Phase 1). Poorer binding to the self would mean that accessing the association would be more difficult. Given that the previously self-associated stimulus does not produce similar problems when it is re-bound to the partner or stranger such a simple encoding account seems unlikely. Second, and focusing on verification uncertainty, it is possible that the self-stimulus is more difficult to retrieve and verify in Phase 2 because there are now two conflicting associations present. That is, judgments could be slower because the participant experiences uncertainty with two encoded associations. But again, this explanation is not entirely satisfactory because it requires that previous associations remain bound to the

original identity and no decrement in performance was observed for partner- and stranger-stimuli in Phase 2 when the self-stimulus was remapped to them.

The remaining explanation involves encoding, retrieval and verification. If self enjoys a more robust place in memory, then this association should be less susceptible to decay or un-binding than another identity that does not enjoy an enhanced representation. After stimulus remapping, new connections are made, and the extent of these connections reflects the same encoding process that occurs for the initial associations. Two shapes are now well integrated within the self-semantic network. Initial partner- and stranger-associations do not enjoy the same level of encoding as the self and thus the initial association decays and the new association is more active. So, when an association must be retrieved and verified, a cue to 'self' activates two robustly associated shapes causing uncertainty and slowing judgement times relative to the initial 'self' baseline. A cue to 'partner' or 'stranger', however, activates the fresher association (even if this association is also tied to the self) and, to a lesser extent, the weaker decayed association. So, judgement and verification occur similarly well in Phase 2 (with the additional benefit of a practice effect).

Previous work has suggested that self-reference makes it difficult to re-bind a new association to a stimulus formerly linked to the self (Sui & Humphreys, 2015; Wang et al., 2016), that is, to un-bind the self and re-bind to another. Although the data might be consistent with the notion of difficulty unbinding information with the self, there is no indication in the present data that it is difficult to bind a previously self-associated stimulus to other. Further research could confirm whether it is problematic to bind other identities to self or whether it is difficult to un-bind previous self-identities.

An unexpected interaction between Identity and Switch was observed. The source of this interaction was a between groups difference in performance on partner- and stranger-trials but not self-trials. Participants who adopted their partner's stimulus responded faster overall on partner- and stranger-trials (regardless of phase) than participants who adopted the stranger's stimulus. Because participants had no indication that they would be switching associations in Phase 1, the interaction might be driven by the pattern of results in Phase 2. A second and possibly more likely explanation given the pattern of results relates to individual differences in response times. If the main effect of switch was due to coincidentally having participants who generally responded slowly in the stranger-switch condition (unrelated to the manipulation) then the interaction might be reflective of a self-boost in all participants approaching some level of optimal processing resulting in a failure to detect a difference between groups despite starting from a slower baseline (slower partner or stranger judgements). Nevertheless, because the interaction did not reach conventional thresholds for power, caution should be exercised when interpreting this result.

One of the primary goals of the present joint-task was to determine if a partner-prioritisation effect might be observed through a task that was designed to pick up on subtle partner effects given that there has been inconsistency in observing partner-prioritisation (Cheng & Tseng, 2019; Constable, Elekes, et al., 2019). Joint tasks often provide evidence that a representation of a partner's task, actions or cognitive states is formed (E.g. Elekes et al., 2016; Sebanz et al., 2003; Welsh et al., 2005). Yet, some select studies demonstrate that joint action mechanisms might be situationally dependent. That is, cues to an active partner and their cognitive state in a joint task might create a common perceptual ground that ultimately facilitates interacting within a shared environment (Tollefsen, 2005), but these cues might selectively be used to activate

relevant joint action mechanisms (Constable et al., 2015, 2018). To elaborate, creating a space for action (Bhatia et al., 2019; Welsh et al., 2020) or a space for perception (Constable et al., 2015) via different action or postural cues may lead to different perceptual biases in an agent but also in an engaged observer. Similarly, understanding the nature of the task or goal of the task might produce different effects. For example, a joint psychological refractory period is not elicited spontaneously, but can be observed when participants were required to monitor their partner's task (Liepelt & Prinz, 2011). Similarly, no joint attentional blink can be detected (Constable et al., 2018). In the case of the attentional blink, even when participants were asked to actively monitor their task-partner's task no evidence of co-representation was obtained. Future work will need to consolidate evidence to establish the conditions under which varied joint action mechanisms may be deployed or inhibited.

The current experiment was specifically designed to test hypotheses that were generated from a memory-based framework. The present experiment speaks to one aspect of self-prioritisation without negating the potential for self-prioritisation at other levels of processing. For example, self-privileges have been observed in experiments targeting perception (Macrae et al., 2018; c.f. Stein et al., 2016), attention (Truong et al., 2017; Turk et al., 2011), action (Constable et al., 2011, 2014, 2016) and judgement and decision making (Beggan, 1992; Constable, Welsh, et al., 2019; Thaler, 1980). As a result, a range of influential theoretical accounts outside of memory have been generated to aid research into self-privileges within cognition (e.g. Humphreys & Sui, 2016; Sui & Humphreys, 2015; Truong & Todd, 2017).

The present work has raised a number of interesting avenues for future research. First, how are different identities connected and integrated within the self? The present data suggest that when identities that were previously associated to others are re-bound to the self then retrieval and

verification of self-stimuli may be impaired. Second, it seems that when the self-prioritisation task is performed as a joint task the pattern of results mirrors what would be expected in an individual task. This highlights that joint action mechanisms might be employed in a task-dependent manner but what are the conditions under which joint action mechanisms are selectively employed?

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