It Goes With The Territory: Ownership Across Spatial Boundaries

James W.A. Strachan[1], Merryn D. Constable[2], Günther Knoblich[1]

[1]Central European University, Budapest, Hungary

[2]Northumbria University, Newcastle upon Tyne, United Kingdom

This paper was published in the Journal of Experimental Psychology: Human Perception and Performance. DOI: https://doi.org/10.1037/xhp0000742

Corresponding author:

Name: James W.A. Strachan

Email: james.wa.strachan@gmail.com

Address:

Department of Cognitive Science,

Central European University,

Oktober 6 utca 7,

1051 Budapest

Hungary

Abstract

Previous studies have shown that people are faster to process objects that they own as compared to objects that other people own. Yet object ownership is embedded within a social environment that has distinct and sometimes competing rules for interaction. Here we ask whether ownership of space can act as a filter through which we process what belongs to us. Can a sense of territory modulate the well-established benefits in information processing that owned objects enjoy? In four experiments participants categorised their own or another person's objects that appeared in territories assigned either to themselves or to another. We consistently found that faster processing of self-owned than other-owned objects only emerged for objects appearing in the self-territory, with no such advantage in other territories. We propose that knowing whom spaces belong to may serve to define the space in which affordances resulting from ownership lead to facilitated processing.

Keywords: object ownership; space ownership; territory; self-relevance; self-prioritisation; self-other distinction

Significance Statement

Owning an object makes it special to us, and people identify objects they own faster than objects they don't, and this has typically been assumed to be a general feature of object processing – that is, an object that belongs to you will be subject to a general advantage in processing by virtue of its ownership status. We show that, contrary to this assumption, this general processing advantage depends heavily on where the object appears: owned objects are not processed faster if they appear outside one's own space. This gives important insights into how ownership and self-relevance, which are usually studied in simplified laboratory environments, might operate differently in more complex real-world environments where space itself can be owned.

It Goes With The Territory: Ownership Across Spatial Boundaries

There is something special about the way that humans own things. Although other animals use objects as tools (Sanz et al., 2013) and even save useful or effective tools for future use (sea otters: Hall & Schaller, 1964; apes: Mulcahy & Call, 2006), human ownership of objects goes further. We have a concept of an object being 'mine' even if we are not currently using it, or even holding it, rather as if its owned status were an inherent property of the object. Although the concept of ownership and private property varies considerably on a societal level (Etzioni, 1991), most people are able to reason about ownership effectively (DeScioli & Karpoff, 2015). Indeed, one aspect of successful daily interactions is being able to determine who owns what and preparing appropriate actions based on this judgement.

Some early investigations regarding ownership indicate that humans prefer (Beggan, 1992; Huang et al., 2009) and value (Kahneman et al., 1990; Morewedge et al., 2009; Thaler, 1980) what they own over that which they do not. People also interact with objects differently according to their ownership status (Constable et al., 2011, 2014) and facilitate another person's actions less with objects they own (Constable et al., 2016). There is considerable evidence for ownership advantages in memory (e.g. Cunningham et al., 2008; DeScioli et al., 2015) and some evidence that items designated as self-owned may be perceptually or attentionally prioritised (Truong et al., 2017) or may create a bias in judgement and decision making (Constable, Welsh, et al., 2019; Golubickis et al., 2018; Golubickis, Ho, Falbén, Mackenzie, et al., 2019). Self-relevant stimuli (such as owned objects) are also identified and responded to faster than other stimuli (Constable, Rajsic, et al., 2019; Sui et al., 2012; Woźniak et al., 2018; Woźniak & Knoblich, 2019). These ownership effects are often characterised as a self-privilege stemming from a chronically activated self-schema (the Self-Attention Network, or SAN; Humphreys &

Sui, 2016) or more elaborate semantic networks concerning the self, allowing for more efficient identification, judgement and decision-making (Constable, Rajsic, et al., 2019; Conway & Pleydell-Pearce, 2000; Symons & Johnson, 1997).

If ownership effects are driven by self-relevance, and self-relevance drives efficient processing, then such an ownership attribution should be anchored to the objects in question. However, in a complex social environment it is not just objects that can be self-relevant, but also space. People can hold a psychological sense of ownership over areas of space by similar conventions as ownership of objects – one's peripersonal space belongs to oneself by virtue of its proximity, whereas one's home may be owned by virtue of more abstract conventions such as social or legal consensus. This latter case is of particular interest, as it can dissociate the effects of attributing some self-relevant property to a space from physical affordances (a person's house is still hers even if she is not physically present to act upon anything there). We refer to this kind of owned space as territory, as it is an area independent of the body's location over which an individual holds jurisdiction, unique from other spaces only by virtue of its owned status.

As well as determining ownership on the basis of such information as who is in possession of a resource (Friedman, 2008), or who was necessary for possession of that resource (Friedman, 2010), we can also use ownership of space to infer ownership of objects. Accession (the owner of a property owns the resources on that property) is a strong cue for determining ownership (Merrill, 2009), and by the age of 4-5 years children are able to integrate territory-based with history-based ownership inferences (Goulding & Friedman, 2018). Adults frequently favour landowners when making judgements concerning property law cases (DeScioli et al., 2017). In fact, it is possible that such conventions evolved to prevent costly fights associated with resource distribution. In a virtual foraging task, DeScioli and Wilson (2011) demonstrate that conventions of territory are powerful predictors of fight outcomes over resources – the first individual to start foraging in an area is more likely to defeat a challenger. This phenomenon appears to be driven by challengers having lower thresholds for disengagement. Considering that acting in another's territory can be a dangerous task (given the other's presumed claim over resources within that territory), it is possible that cognitive representations of space ownership may act as a filter for self-facilitation mechanisms, which means that self-relevant objects may only benefit from such mechanisms if they appear in the self-relevant space. Inhibiting mechanisms that increase the likelihood of action – such as these self-facilitation mechanisms – would reduce the likelihood of acting inappropriately on objects in others' territories.

Studies of ownership typically aim to assess how attributing ownership to single objects affects processing. These studies often assume that the self-relevance of an owned object privileges that object in processing merely by virtue of this self-relevance attribution. Dividing up the space into participants' own and other territories allows us to test this prediction. If mere ownership of an object is enough to result in processing advantages, then owned objects should enjoy privileged processing wherever they appear in space. Further, if ownership of a space, or territory, serves as a self-relevant property of the environment and also generates self-relevant processing benefits then these effects may be additive (owned objects in one's own space may see an additional boost in processing beyond owned objects outside one's space, but there is prioritisation of owned objects wherever they appear). Yet, humans live in a complex social environment where self-relevance may not serve as a unitary heuristic. When acting within this social environment, different types of self-relevance such as object ownership and space ownership may be hierarchically structured, such that the combination of these different cues is not additive. Instead, space ownership may be prioritised as a superordinate heuristic over object ownership, and as such may systematically attenuate or enhance ownership advantages for objects depending on where they appear in space.

In the present study we asked whether assigning minimal cues to ownership over a space to create defined territories modulate the identification of self-owned objects. We adapted a basket-sorting task, which has previously been used to study the effect of ownership on memory (Cunningham et al., 2008). In four experiments, participants sorted individual objects into baskets belonging to themselves or another person. Objects could appear either above the participant's own basket or above the other person's basket, implying that self- and other-owned objects could appear in either the self- or other-territory. Crucially, this territory manipulation reflects a minimal division of space driven by the presence of self- or other-relevant landmarks that does not map on to participants' physical affordances (i.e. the other-territory is no less physically accessible than the self-territory).

We suggest that if ownership of space acts as an early filter for incoming stimuli that precedes object-level self-prioritisation, then responses to self-objects should not show a processing advantage over other-objects outside of one's own territory. As such, only objects in the self-territory should exhibit a self-advantage in reaction times.

Experiment 1

Methods

Participants

We recruited 24 participants (11 female; 13 male; M_{age} = 25.58yrs) from the Central European University SONA recruitment service. This number was chosen in line with conventions and as a number that allowed for full counterbalancing, but was not justified by an a priori power analysis – however, see the Methods of Experiment 2 for the results of a power simulation based on observed effect size that justifies this sample in future experiments. Participants received shop vouchers as remuneration worth 1500HUF (approx. 4.60€) that could be redeemed at a variety of local shops. All experiments in this study were approved by the United Ethical Review Committee for Research in Psychology (EPKEB).

Stimuli

Example stimuli are shown in Figure 1. The experiment display was a grey square with a radius of 5 degrees visual angle in the centre of the screen (viewing distance 70cm). The baskets appeared 2° below the horizontal midline of this display, and ±1.5° from the vertical midline, and were regular squares measuring 1°. The left basket was red, and the right was blue.

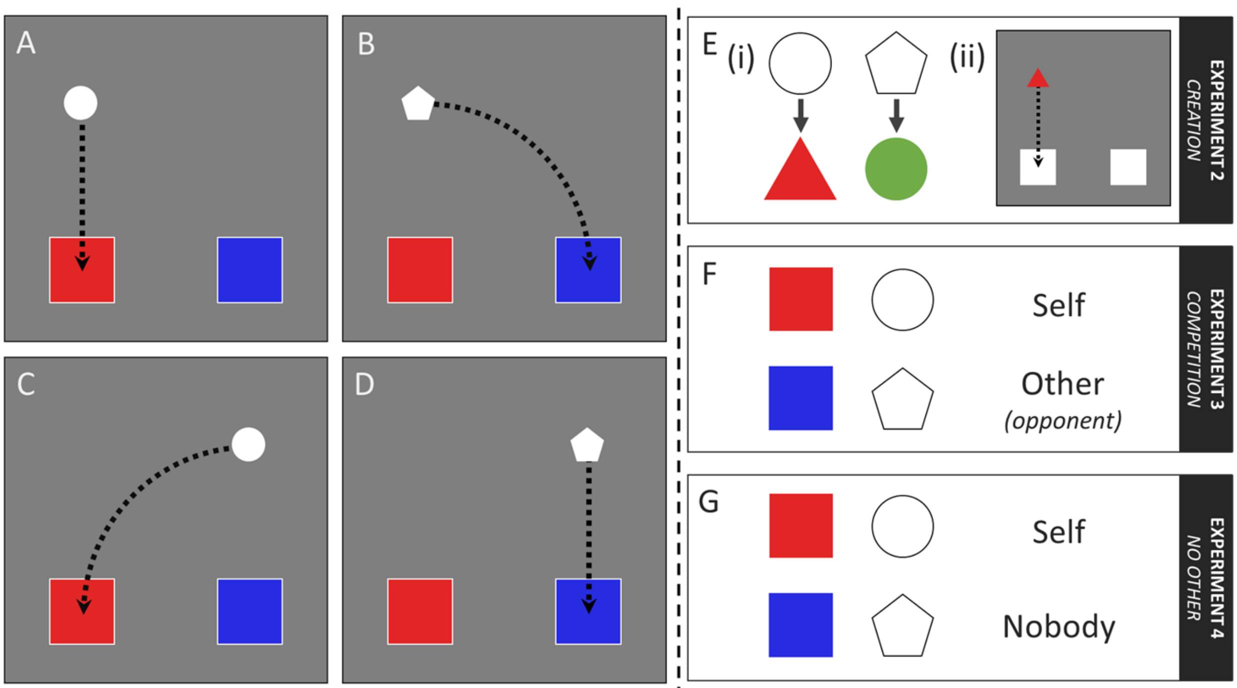

Figure 1. A-D. Example trials in Experiment 1. On every trial two baskets were shown at the bottom of the screen, one belonging to the participant (e.g. red, left) and one either belonging to the Other (Exp.1-3) or serving as a discard basket (Exp.4; blue, right). An object belonging either to the participant (pentagon) or the Other/unowned (circle) would appear above one of the baskets, and participants' task was to decide whether to Drop or Pass the object to put it into the correct basket. Territory is defined according to whose basket the item appears above. Arrows show the trajectory of the correct responses on each example trial (straight Drop, curved Pass). A. Own item over Own basket (Self territory), with correct response to Drop. B. Other item in Self territory, Pass response. C. Own item above Other basket (Other territory), Pass response. D. Other item in Other territory, Drop response. E-G. Designs of

different Experiments. E. Experiment 2: Creation. (i) Instead of being assigned objects (e.g. white pentagon), participants created their own objects by deciding a shape and colour (e.g. red triangle). A complementary object (green circle) was then generated to be the Other object. (ii) Example trial from Experiment 2 shows new object with white baskets to avoid confounds with colour mapping. Participants were told their basket was the left one. F. Experiment 3: Competition. The design was identical to Experiment 1 (panels A-D) except that the Other was described as an opponent in a competitive game. G. Experiment 4: No Other. Identical to Experiment 1, except the Other object and territory belonged to nobody. Configuration of object and basket assignments is consistent here for illustrative purposes only; all features of the design were fully counterbalanced.

Objects were regular white-coloured polygons that measured 0.5º. The two objects differed in terms of their number of vertices; one was a pentagon with five vertices, the other had 100 vertices and thus appeared as a circle.

Design & Procedure

Participants were told that they would be sorting objects that belonged to themselves or another person into respective baskets. The experiment started by assigning one of the two objects (the circle or the pentagon) to the participant. Participants saw an initial screen showing both objects with an explanation of which one had been assigned to them and which belonged to another person. Both objects were shown so that any effects of object ownership could not be explained through differences in visual familiarity.

Participants then had the opportunity to complete 16 practice trials (4 repetitions of each condition). The practice instructions told participants that on every trial an object (either belonging to them or to the other) would appear above one of the baskets (again, belonging to them or the other), and their task was to ‘Drop’ or ‘Pass’ the objects into the appropriate basket by pressing one of two response keys (see Figure 1 for example trials). They were told that if they took longer than 5 seconds to respond that the object would be lost.

Response keys were B and T (mapping to either Drop or Pass actions counterbalanced across participants) on a standard QWERTY keyboard. These keys were chosen to remove stimulus-response compatibility issues. Participants were then told which basket assigned to them (e.g. "*Your basket is the RED basket*"). Following the practice trials, in the main experiment each condition was presented 64 times across 4 experimental blocks. There were 256 trials in total. Between blocks, participants were offered a chance to take a short break.

Each trial began with a 500ms fixation cross presented centrally. The display window, baskets, and object then appeared. Object starting positions were 1º above the horizontal centre midline of the display, centred above either the left or the right basket.

Participants had 5 seconds to make the object move to the appropriate basket by pressing one of two buttons that started a Drop or Pass trajectory. A Drop trajectory was a movement in a straight line from the object's starting position to the basket immediately below it (Figure 1A&D); a Pass trajectory was a movement in an arc from the starting point to the opposite basket, with the starting basket (the one immediately below) serving as the arc centre (Figure 1B&C). Drop and Pass trajectories were matched in terms of total time, and each consisted of 25 frames (this allowed for a reasonably smooth but fast movement).

If participants failed to respond within 5 seconds the trial timed out. The time-out disappearing response involved the object alternating every frame between transparent and opaque before disappearing, giving the appearance of flickering. The duration of this flickering was matched to the length of the movements the object would have made.

Participants then saw a feedback screen telling them if they were correct, incorrect, or if they needed to respond faster.

Data analysis

Accuracy rates were considered for analysis, but participants consistently scored too highly to make analysis of errors meaningful, in this or any of the experiments presented in this study (accuracy rates: 96.68%, 96.68%, 95.06%, and 96.08% for Experiments 1-4, respectively).

Given the low error rates we do not report analysis of accuracy, but these data are publicly available with the raw data files on the OSF.

Reaction times (RTs) were filtered to remove trials where participants failed to respond or responded inaccurately (3.32% of trials) and to remove outliers that were ±3SD from that participant's mean RT (1.69% of trials). We analysed the RTs first with a frequentist factorial ANOVA. For this analysis we took object ownership (own/other) and territory (self/other) as within-subjects factors. Interactions were followed up with planned directional Bayesian contrasts to evaluate the weight of evidence for a canonical object ownership effect (RTs to self-objects < other-objects) in the Self and Other territories separately. For Experiment 1, these Bayesian contrasts were directional and used an uninformed prior with a default Cauchy width (0.707). All analyses were performed using the open-source software JASP v.0.9.0.1.

Results

RT results of Experiment 1 are shown in Figure 2 (top left). A 2x2 repeated measures ANOVA found a main effect of object ownership, where participants were faster to respond to their own object as compared to the other's object ($F(1,23)=13.43$, $p=.001$, $\eta_p^2=0.37$), and a main effect of territory, where participants were faster to respond to objects in the self-territory than those in the other-territory ($F(1,23)=12.63$, $p=.002$, $\eta_p^2=0.35$). These effects were qualified by a significant interaction, ($F(1,23)=11.41$, $p=.003$, $\eta_p^2=0.33$).

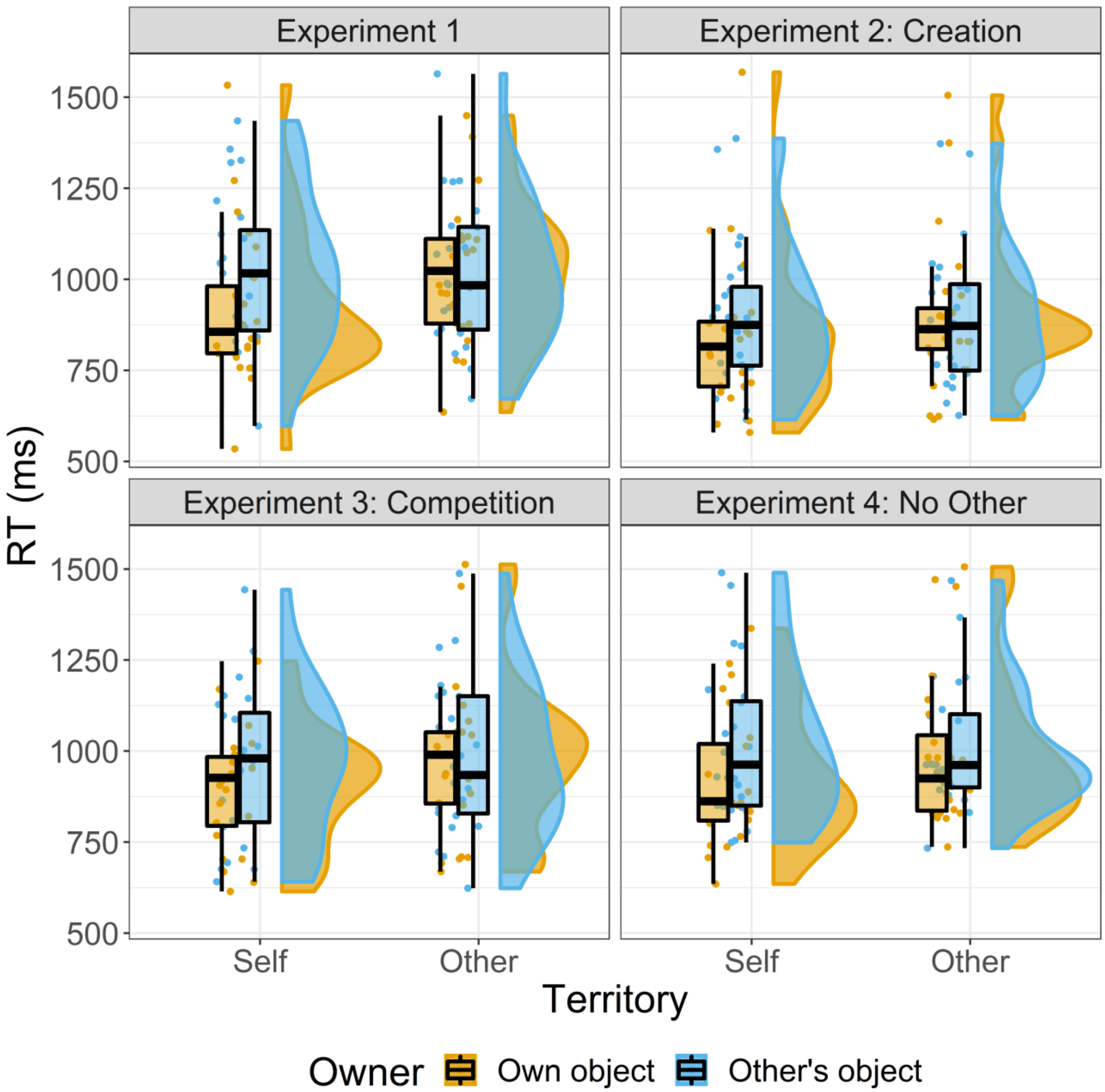

Figure 2. *Raincloud plots showing RTs to sort Own (orange) and Other objects (blue) in the Self (left) and Other territories (right) in each condition. Scatter points (randomly jittered) show individual average RTs for each participant by condition. Boxplots and vertical density plots show the distribution of these averaged RTs. Each pair of boxplots shows the data analysed in one planned Bayesian contrast. Plots were generated using tools described in Allen et al. (2018, 2019).*

The planned Bayesian one-way paired t-tests (own object < other object) found moderate evidence for the null hypothesis in the other-territory (BF_{10}=0.22), indicating that there was no object ownership effect for objects appearing in the other's territory. On the other hand, there was extreme evidence for an object ownership effect in the self-territory (BF_{10}=131.28).

Discussion

The results of Experiment 1 successfully demonstrate that object ownership effects – faster processing of self-owned objects over other-owned objects – occurred only when these objects appeared in participants' own territory, as defined by the location of their baskets. This suggests that, rather than ownership being a bottom-up salient feature of the object *per se* (Humphreys & Sui, 2016), the self-prioritisation for owned objects is only seen in areas of space that belong to oneself.

The following experiments investigated the generality of the observed territory effect by manipulating relational factors, such as the participant's relationship with the owned object (Experiment 2) or with the other person (Experiments 3 and 4).

Experiment 2: Creation

The participant's relationship with particular objects may play an important role in terms of how they respond to object ownership and territory. For example, your mug on a co-worker's desk may be treated as just another object in that co-worker's territory. However, if it is a favourite mug then the ownership status may be weighted more strongly than its location, making it more likely that the self-relevance of the object will break through the space-based filtering mechanism. Thus, in Experiment 2 we manipulated this relational aspect of the object through creation. Previous research has demonstrated that people place higher value on objects they have created (in this case by determining its physical features such as shape and colour) than on identical objects created by someone else (Buccafusco & Sprigman, 2010; Norton et al., 2012). Based on this finding we tested whether the stronger link of created objects to self would result in faster processing of these objects in the other's territory.

Methods

Participants

In Experiment 1 there was no a priori power estimate used to justify sample size, and 24 was selected because this number was in line with convention and allowed for fully randomised counterbalancing. Taking the observed effect in Experiment – crucially, the interaction of object ownership and territory – we conducted a power simulation (5000 simulations, with n=24) and found that this gave adequate power to detect an interaction effect of this magnitude in 86.76% of simulations. As such, for the sake of consistency we continued to use n=24 in subsequent experiments. In Experiment 2 we recruited 24 participants (17 female; 7 male; M_{age}=26.47yrs).

Stimuli, Design & Procedure

All experimental details were identical to Experiment 1. However, in this experiment rather than assigning participants to either a white circle or pentagon, participants were given the opportunity to create an object for themselves. At the beginning of the experiment, a dialog box appeared and prompted participants to pick a shape (options: triangle, square, pentagon, or circle) and a colour (red, orange, yellow, green, blue, or purple) for their object. The experiment then loaded with a screen that read, “Generating…”, to give the impression that the creation of the object was resource demanding.

The participants then saw the same familiarisation screen as in Experiment 1, where they were shown the object they had just created as well as an object that they were told had been created by somebody else. In fact, the other's object was generated automatically in a way that the own and other's object would not share features (e.g. if the participant selected a red triangle, the other's object would be a green circle, see Figure 1E.i).

During the trials the baskets, which were red and blue in Experiment 1, were changed to white (to avoid any issues with object-basket colour compatibility) and the instructions were changed such that the participant's basket was described as either the left or the right basket (Figure 1E.ii).

Data analysis

As in Experiment 1, reaction times were filtered to remove trials where participants failed to respond or responded inaccurately (3.83% of trials) and to remove outliers that were ±3SD from that participant's mean RT (1.55%). The frequentist ANOVA analysis was identical to Experiment 1. For Bayesian planned contrasts of the interaction in this and subsequent experiments, we used informed priors in this experiment based on the estimated effect size obtained in Experiment 1. We calculated the parameters based on a two-way Bayesian t-test of the object ownership effect in the self-territory. Our prior was a normal distribution centred around the median estimated effect size (1.142) and with a standard deviation calculated from the upper 95% confidence interval (1.785, estimated SD=0.328).

Results

When participants created their own objects in Experiment 2 (Figure 2; top right), RTs were noticeably faster than Experiment 1. A 2x2 repeated measures ANOVA found a main effect of object ownership, where participants were faster to respond to their own objects over another person's object ($F(1,23)=5.56$, $p=.027$, $\eta_p^2=0.20$). Contrary to Experiment 1, no effect of territory ($F(1,23)=3.58$, $p=.071$, $\eta_p^2=0.13$) and no interaction ($F(1,23)=3.25$, $p=.084$, $\eta_p^2=0.12$) were observed.

The planned Bayesian one-way t-tests (own object < other's object) found extreme evidence for the null hypothesis in the other-territory (BF_{10}=0.01), suggesting that there was no object ownership effect for objects appearing in the other-territory. There was moderate evidence in favour of an object ownership effect in the self-territory (BF_{10}=4.82).

RTs were generally faster in Experiment 2 than in Experiment 1. This was likely driven by changes to the stimuli that made the sorting task easier (having items of different colours). We conducted an exploratory post-hoc cross-experiment analysis to see if this difference was significant and to see if this significantly impacted the pattern of results from Experiment 1 to Experiment 2. A 2x2x2 mixed ANOVA (object ownership x territory x experiment) found that this difference between experiments was ultimately not significant (F(1,46)=3.96, p=.052, η_p^2=0.08), and more importantly there was no interaction of experiment with object ownership (F(1,46)=1.60, p=.212, η_p^2=0.03) or with territory (F(1,46)=1.53, p=.223, η_p^2=0.03) and there was no three-way interaction (F(1,46)=1.55, p=.220, η_p^2=0.03). Using a Bayesian model selection approach to evaluate evidence in support of this null three-way interaction (using a Bayesian Information Criterion [BIC]; Masson, 2011) provided moderate support for the null (BF_{01}=3.27, pBIC(H1|D)=0.23, pBIC(H0|D)=0.77). This indicates that, while RTs were overall faster in Experiment 2, this did not substantially impact the pattern of results.

Discussion

In Experiment 2 we investigated whether self-advantages in the other-territory would occur if the owned object were more personally relevant. We sought to enhance feelings of ownership over the owned object by instructing participants to create their own object. In this experiment, RTs were overall much faster than in Experiment 1, and we suspect this was due to this manipulation: inadvertently, having items of different colours led to an easier discrimination task for the participants than in Experiment 1 (where objects were all white), which led to faster RTs overall and may have resulted in a ceiling effect. However, the pattern of results was strikingly similar to Experiment 1, and the planned comparisons suggested that the pattern of data did replicate across experiments. Crucially, even though participants had created their own personally relevant objects, these objects were not subject to ownership prioritisation when they appeared in the other's territory.

Experiment 3: Competition

Experiment 3 addressed the participants' relationship with their partners. To explore this we changed the experimental context to create a competitive relationship between the participant and their partner. Competition has been used previously to investigate how expert players in competitive sports monitor their opponents (Williams et al., 2002), and use different bodily cues to anticipate opponents' upcoming actions during competition than during coordination (Streuber et al., 2011). We hypothesised that this monitoring of an opponent during competitive interactions might extend to their space: participants may monitor the other's territory more during competitive interactions than in neutral interactions and be faster to address the incongruence of their own objects appearing in their opponent's territory.

Thus, in Experiment 3, we manipulated the participant's relationship with the other person by describing the task context as a competitive game. Participants came to the lab in pairs, were taken to separate rooms, and told that the other person described in the experiment was the participant in the other room. If participants were motivated to monitor their opponent's territory, then we expected that we would see object ownership effects also emerge in the other territory.

Methods

Participants

In this Experiment we recruited a further 24 participants (15 female; 9 male; M_{age}=26.91yrs).

Stimuli, Design & Procedure

All experimental details were identical to Experiment 1 except that participants were recruited in pairs and run concurrently in separate rooms. Participants were told that they were playing with the other person in a competitive context, and that they should try to make their responses faster and more accurately than their opponent (Figure 1F).

Data analysis

Data analysis in Experiment 3 was identical to Experiment 2. In this experiment 4.94% of trials were removed due to participant error, and 1.93% were removed as outliers (±3SD from participant mean). The same informed priors were used for Bayesian analysis as in Experiment 2.

Results

When participants were instructed that they were to complete the task under a competitive context against a partner in a different room (Figure 2; bottom left), the same pattern was seen as in Experiment 1, with participants responding fastest to their own objects in their own territory. A 2x2 repeated measures ANOVA found a main effect of object ownership, where participants were faster to respond to own objects over another person's object (F(1,23)=5.85, p=.024, η_p^2=0.20), and a main effect of territory, where they were faster to respond to objects in the self-territory than the other-territory (F(1,23)=10.73, p=.003, η_p^2=0.32). As in Experiment 1, there was a significant interaction (F(1,23)=4.76, p=.040, η_p^2=0.17).

Planned Bayesian contrasts looking at object ownership effects in RTs found extreme evidence for the null hypothesis in the other-territory (BF_{10}=0.01), suggesting that there was no object ownership effect for objects appearing in the other-territory. On the other hand, there was extreme evidence in favour of an object ownership effect in the self-territory (BF_{10}=165.44).

Discussion

In Experiment 3 we investigated whether a competitive relationship between self and other would produce processing advantages for self-owned objects in the other's territory. The competitive context did not lead participants to more closely monitor the other's territory, as the results of Experiment 3 replicate the same pattern of results as Experiment 1: participants show an RT advantage for self-owned objects only in their own, and not in the other's territory.

Experiment 4: No Other

So far, an ownership effect for objects emerged only when those objects appeared in one's own territory and not in somebody else's. This raises the question of whether this modulatory effect of territory is driven by some unique quality of one's own space, i.e., enabling or triggering mechanisms responsible for self-facilitation effects. Alternatively, the effect could be related to another person's space, i.e., specifically inhibiting self-facilitation effects in order to avoid infringing on another's space. In order to distinguish between these two possibilities, we removed all mention of the other person and described other-owned objects as unowned objects to be discarded into a 'discard' basket. If the modulation of self-prioritisation observed in previous experiments was driven by one's own space, then Experiment 4 should show the same interaction. However, if it is driven by inhibitory effects in other's spaces then Experiment 4 should show normal object ownership effects in both locations (as there is no reason to inhibit actions in an unowned territory).

Methods

Participants

In this Experiment we recruited a further 24 participants (13 female; 11 male; M_{age}=26.17yrs).

Stimuli, Design & Procedure

All experimental details were identical to Experiment 1 except that, instead of referring to another person as owner of the Other object or basket, objects were referred to as 'YOUR item' or 'NOT YOUR item' and the task was to sort participants' own objects into their basket and unowned objects into the discard basket. As such, all details were the same except that there was no Other (see Figure 1G)

Data analysis

Data analysis in Experiment 3 was identical to Experiment 2. In this experiment 3.92% of trials were removed due to participant error, and 3.11% were removed as outliers (±3SD from participant mean). The same informed priors were used for Bayesian analysis as in Experiments 2 and 3.

Results

When participants were completing the task without another person referenced in the instructions (Figure 2; bottom right), the same pattern was seen as in Experiment 1, with participants responding fastest to their own objects in their own territory. A 2x2 repeated measures ANOVA found a main effect of object ownership, where participants were faster to respond to own objects over the unowned object (F(1,23)=18.47, p<.001, η_p^2=0.45), and a main effect of territory, where they were faster to respond to objects in the self-territory than the other-territory (F(1,23)=5.23, p=.032, η_p^2=0.19). As in Experiments 1 and 3, there was a significant interaction (F(1,23)=5.75, p=.025, η_p^2=0.20).

Planned Bayesian contrasts looking at object ownership effects in RTs found very strong evidence for the null hypothesis in the other-territory (BF_{10}=0.02), suggesting that there was no object ownership effect for objects appearing in the territory that the participant did not own even when this was not owned by anyone else. On the other hand, there was extreme evidence in favour of an object ownership effect in the self-territory (BF_{10}=3669.49).

Discussion

The results of Experiment 4 replicated the results of previous experiments, and indicate that the modulatory effect of territory on object ownership effects does not require another person, suggesting that this is driven specifically by facilitated processing of self-relevant objects within one's own space.

These results indicate that the modulating effect of territory on object ownership effects is not due to a reluctance to act on objects in a territory owned by another person, as in this experiment this territory was not owned by anybody else. One possible criticism of this interpretation is that the use of the term 'discard' for the unowned basket may have led participants to assign a negative valence to unowned objects and the unowned territory, which has been shown to attenuate object ownership effects (Cunningham et al., 2011; Golubickis, Ho, Falbén, Schwertel, et al., 2019). We find this unlikely given the consistency of our results across experiments: if this attenuation were driven by valence, it is not clear why the modulating effect of territory on object ownership effects would not be less pronounced in the ambiguous or neutral context of Experiment 1 compared with the competitive context in Experiment 3. Mere ownership by another person is unlikely to be treated as an inherently negative property because other people's objects are not typically disliked in object ownership studies. They are only rated as relatively less desirable than one's own objects.

The key finding of Experiment 4 is that the modulation of self-prioritisation effects persists even when information about the other person is removed. This result suggests that, rather than a specific inhibition of self-prioritisation in another's space, the self-relevance of one's own space enables self-prioritisation of owned objects and that even minimal parsing of space according to self-relevance (i.e. considering a space as "not mine" rather than "somebody else's") is sufficient to trigger modulation of these effects.

General Discussion

In four experiments we investigated whether processing benefits for self-owned objects are restricted to objects in one's own space using an adapted basket-sorting task that generates a minimal territory distinction between self and other. Specifically, the left or right side of a display space are interpreted as 'self' and 'other' territories defined by the location of a relevant basket. We repeatedly find object ownership effects only in the self-territory, with clear evidence *against* an ownership effect in the other-territory, and this persists even when the other-territory is not owned by another person. This indicates that there is something special about the self-space that allows the ownership effect to emerge, rather than inhibitory mechanisms for objects in other people's spaces.

This is a striking result as these territories were minimally defined according to the position of baskets, rather than by physical proximity to the self (which would affect action affordances and perceptual access, which in turn can affect judgements of ownership; Scorolli et al., 2018) or by visibly defined borders. Instead, we propose that participants represent the left and right sides of space as 'theirs' or 'not theirs' according to the position of a basket and may be monitoring their own space differently from the other space. The fact that participants form such representations about virtual territories on a screen, with such minimal physical cues, and over such a small visual area that monitoring the whole space is not subject to overt attention costs, points to a strong tendency to parse space according to self-relevance. Furthermore, this representation neutralises the well-established self-relevance effect in the other-territory (Sui et al., 2012). This is despite the other-territory being no harder to see, no harder to predict, and no less frequently used than the self-territory.

These results suggest that, rather than reflecting attention capture by self-relevant static object properties (as predicted by the SAN; Humphreys & Sui, 2016), the processing advantage for owned objects is something that can be modulated by the context in which it is embedded. Ownership of space may serve as a filtering mechanism that incoming stimuli must pass before object-level processes are applied. Objects that appear outside of one's own space are not subject to the same self-prioritisation mechanisms that objects appearing inside one's own space enjoy. Similarly to DeScioli and Wilson (2011) who suggest that territory, or space ownership, is an evolutionary pre-cursor to object ownership, we suggest that our results mirror the evolutionary importance of space and object ownership relations on a cognitive level. Specifically, the first thing an agent must do within a social environment is work out what areas of space belong to them (and such are free to act on) and what areas do not (and so may belong to other people or be subject to dispute). Importantly, this parsing is likely driven by the mere presence of another space: modulations of self-prioritisation effects occur only when boundaries between own and other spaces are made relevant or salient – without the presence (actual or implied) of a boundary, everything may be treated as one's own space by default.

An alternative explanation is that the implied presence of a spatial boundary may result in space ownership being used as another self-relevant feature of the scene to be integrated (Treisman & Gelade, 1980) as *where* an object appears becomes as important as *what* it is. Space and object ownership are therefore two features embedded within an object file, and so only when the two features align (the owned object appears in its associated location) do you see a facilitation of processing (Kahneman et al., 1992). Testing these two explanations (space ownership as a filtering mechanism and space ownership as an integrated feature of an object file) offer avenues for future research.

One way in which these explanations might be disentangled would be to explore to what extent this modulating effect of territory on ownership is contingent on action-like effects. In our task, participants were making decisions about whether to Drop or Pass an object, and their decisions elicited a contingent and visually salient response (the trajectory of the movement). It may be that this action-like effect of their responses was what drove this mediating effect of territory. It could be that ownership of space serves as an 'action filter' to inhibit actions outside of one's own space, in which case the action-like task in the current study may be key to the effect. A future study could explore whether this modulating effect of territory persists when participants are asked to make judgements about the stimuli that do not result in an action-like effect.

If space ownership does serve as a filtering mechanism for action, it would also be interesting to explore how other kinds of actions are inhibited or facilitated by psychological ownership over the space in which they are to be performed. If this is a mechanism designed to dictate how individuals act within their social environments (a filtering mechanism that either encourages action within one's own space or inhibits in other areas of space independent of one's physical affordances) it could be that this filter affects other kinds of actions on the object – both instrumental and mental actions. Space ownership may affect action affordances, for example. There are several parallels between object ownership effects and object affordance effects – being able to access and act upon graspable or manipulable objects can also result in memory benefits (Apel et al., 2012; Chrysikou et al., 2017; Dutriaux & Gyselinck, 2016; Snow et al., 2014), and graspable objects are subject to attentional prioritisation (Garrido-Vásquez & Schubö, 2014).

If ownership acts as a type of knowledge-driven affordance (Constable et al., 2011, Experiment 2; Scorolli et al., 2018), where an object's self-owned status invites action in a similar way to its physical properties, then space ownership may serve as a more general affordance-filtering mechanism designating in which spaces it is permissible to act and in which spaces action should not be encouraged (Borghi, 2018; Heft, 2003). Although there is little research investigating the effect of space ownership on action affordances, there is evidence suggesting that handle compatibility effects are absent for objects that appear within another person's peripersonal space (Saccone et al., 2018), which is consistent with the view that objects may need to be within one's own space in order to be subject to affordances, and the presence of other spaces serves to impose constraints on this default.

In summary, we report the results of four experiments that test how typical object ownership effects might be affected by other self-relevant information such as ownership of space by encouraging participants to parse the experimental display as their own and another territory. We consistently find that self-owned objects are only subject to privileged processing when they appear in one's own territory, and there is no advantage for them in someone else's or an unowned territory. This territory effect is particularly striking in that it seems that space ownership heuristics may be so ingrained within our cognitive repertoire that they are immediately activated by even minimal cues. We suggest that, just as we parse our environment in terms of physical properties relevant for action, we do the same for social properties such as whom different parts of space belong to.

Author Contributions

J.S. and M.C. developed the study concept. All authors contributed to study design. J.S. coded the experiment and was responsible for data collection. J.S. and M.C. completed the data analysis and interpretation. J.S. and M.C. drafted the manuscript and G.K. provided critical revisions and theoretical contributions. All authors approved the final version of the manuscript for submission.

Acknowledgements

We would like to thank David Csuros, Fruzsina Kollanyi, Vanda Derzsi, Germain Leveque, and Anna Francóva for their involvement in data collection. This work was supported by the European Research Council under the European Union's Seventh Framework Program (FP7/2007-2013) / ERC grant agreement no. 609819, SOMICS, and by ERC grant agreement no. 616072, JAXPERTISE. Experiment scripts and raw data files are available on the OSF at the following URL: https://osf.io/589nc/?view_only=d3e58510a10d459680484b609501a114.

References

Allen, M., Poggiali, D., Whitaker, K., Marshall, T. R., & Kievit, R. A. (2018). *RainCloudPlots tutorials and codebase* (Version 1.1) [Computer software]. Zenodo.

Allen, M., Poggiali, D., Whitaker, K., Marshall, T. R., & Kievit, R. A. (2019). Raincloud plots: a multi-platform tool for robust data visualization. *Wellcome Open Research*, *4*. https://doi.org/10.12688/wellcomeopenres.15191.1

Apel, J. K., Cangelosi, A., Ellis, R., Goslin, J., & Fischer, M. H. (2012). Object affordance influences instruction span. *Experimental Brain Research*, *223*(2), 199–206. https://doi.org/10.1007/s00221-012-3251-0

Beggan, J. K. (1992). On the social nature of nonsocial perception: The mere ownership effect. *Journal of Personality and Social Psychology*, *62*(2), 229–237. https://doi.org/10.1037/0022-3514.62.2.229

Borghi, A. M. (2018). Affordances, context and sociality. *Synthese*. https://doi.org/10.1007/s11229-018-02044-1

Buccafusco, C., & Sprigman, C. J. (2010). *The Creativity Effect* (SSRN Scholarly Paper ID 1647009). Social Science Research Network. https://papers.ssrn.com/abstract=1647009

Chrysikou, E. G., Casasanto, D., & Thompson-Schill, S. L. (2017). Motor Experience Influences Object Knowledge. *Journal of Experimental Psychology. General*, *146*(3), 395–408. https://doi.org/10.1037/xge0000269

Constable, M. D., Bayliss, A. P., Tipper, S. P., Spaniol, A. P., Pratt, J., & Welsh, T. N. (2016). Ownership Status Influences the Degree of Joint Facilitatory Behavior. *Psychological Science*, *27*(10), 1371–1378. https://doi.org/10.1177/0956797616661544

Constable, M. D., Kritikos, A., & Bayliss, A. P. (2011). Grasping the concept of personal property. *Cognition*, *119*(3), 430–437. https://doi.org/10.1016/j.cognition.2011.02.007

Constable, M. D., Kritikos, A., Lipp, O. V., & Bayliss, A. P. (2014). Object ownership and action: The influence of social context and choice on the physical manipulation of personal property. *Experimental Brain Research*, *232*(12), 3749–3761.

Constable, M. D., Rajsic, J., Welsh, T. N., & Pratt, J. (2019). It is not in the details: Self-related shapes are rapidly classified but their features are not better remembered. *Memory & Cognition*, 1–13. https://doi.org/10.3758/s13421-019-00924-6

Constable, M. D., Welsh, T. N., Huffman, G., & Pratt, J. (2019). I before U: Temporal order judgements reveal bias for self-owned objects. *Quarterly Journal of Experimental Psychology*, 1747021818762010. https://doi.org/10.1177/1747021818762010

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review*, *107*(2), 261–288. https://doi.org/10.1037/0033-295X.107.2.261

Cunningham, S. J., Bos, M. B.-V. den, & Turk, D. J. (2011). Exploring the effects of ownership and choice on self-memory biases. *Memory*, *19*(5), 449–461. https://doi.org/10.1080/09658211.2011.584388

Cunningham, S. J., Turk, D. J., Macdonald, L. M., & Macrae, C. N. (2008). Yours or mine? Ownership and memory. *Consciousness and Cognition*, *17*(1), 312–318. https://doi.org/10.1016/j.concog.2007.04.003

DeScioli, P., & Karpoff, R. (2015). People’s Judgments About Classic Property Law Cases. *Human Nature*, *26*(2), 184–209. https://doi.org/10.1007/s12110-015-9230-y

DeScioli, P., Karpoff, R., & Freitas, J. D. (2017). Ownership Dilemmas: The Case of Finders Versus Landowners. *Cognitive Science*, *41*(S3), 502–522. https://doi.org/10.1111/cogs.12486

DeScioli, P., Rosa, N. M., & Gutchess, A. H. (2015). A Memory Advantage for Property. *Evolutionary Psychology*, *13*(2), 147470491501300200. https://doi.org/10.1177/147470491501300205

DeScioli, P., & Wilson, B. J. (2011). The territorial foundations of human property. *Evolution and Human Behavior*, *32*(5), 297–304.

Dutriaux, L., & Gyselinck, V. (2016). Learning Is Better with the Hands Free: The Role of Posture in the Memory of Manipulable Objects. *PLOS ONE*, *11*(7), e0159108. https://doi.org/10.1371/journal.pone.0159108

Etzioni, A. (1991). Socio-Economics Revisited. *Sociological Inquiry*, *61*(1), 68–73. https://doi.org/10.1111/j.1475-682X.1991.tb00264.x

Friedman, O. (2008). First possession: An assumption guiding inferences about who owns what. *Psychonomic Bulletin & Review*, *15*(2), 290–295.

Friedman, O. (2010). Necessary for possession: How people reason about the acquisition of ownership. *Personality and Social Psychology Bulletin*, *36*(9), 1161–1169.

Garrido-Vásquez, P., & Schubö, A. (2014). Modulation of visual attention by object affordance. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.00059

Golubickis, M., Falben, J. K., Cunningham, W. A., & Macrae, C. N. (2018). Exploring the self-ownership effect: Separating stimulus and response biases. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *44*(2), 295–306. https://doi.org/10.1037/xlm0000455

Golubickis, M., Ho, N. S. P., Falbén, J. K., Mackenzie, K. M., Boschetti, A., Cunningham, W. A., & Neil Macrae, C. (2019). Mine or mother's? Exploring the self-ownership effect across cultures. *Culture and Brain*, *7*(1), 1–25. https://doi.org/10.1007/s40167-018-0068-0

Golubickis, M., Ho, N. S. P., Falbén, J. K., Schwertel, C. L., Maiuri, A., Dublas, D., Cunningham, W. A., & Macrae, C. N. (2019). Valence and ownership: object desirability influences self-prioritization. *Psychological Research*. https://doi.org/10.1007/s00426-019-01235-w

Goulding, B. W., & Friedman, O. (2018). The development of territory-based inferences of ownership. *Cognition*, *177*, 142–149. https://doi.org/10.1016/j.cognition.2018.04.013

Grèzes, J., Tucker, M., Armony, J., Ellis, R., & Passingham, R. E. (2003). Objects automatically potentiate action: an fMRI study of implicit processing. *European Journal of Neuroscience*, *17*(12), 2735–2740. https://doi.org/10.1046/j.1460-9568.2003.02695.x

Hall, K. R. L., & Schaller, G. B. (1964). Tool-Using Behavior of the California Sea Otter. *Journal of Mammalogy*, *45*(2), 287–298. https://doi.org/10.2307/1376994

Heft, H. (2003). Affordances, Dynamic Experience, and the Challenge of Reification. *Ecological Psychology*, *15*(2), 149–180. https://doi.org/10.1207/S15326969ECO1502_4

Huang, Y., Wang, L., & Shi, J. (2009). When do objects become more attractive? The individual and interactive effects of choice and ownership on object evaluation. *Personality & Social Psychology Bulletin*, *35*(6), 713–722. https://doi.org/10.1177/0146167209333046

Humphreys, G. W., & Sui, J. (2016). Attentional control and the self: The Self-Attention Network (SAN). *Cognitive Neuroscience*, *7*(1–4), 5–17. https://doi.org/10.1080/17588928.2015.1044427

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental Tests of the Endowment Effect and the Coase Theorem. *Journal of Political Economy*, *98*(6), 1325–1348.

Kahneman, D., Treisman, A., & Gibbs, B. J. (1992). The reviewing of object files: Object-specific integration of information. *Cognitive Psychology*, *24*(2), 175–219. https://doi.org/10.1016/0010-0285(92)90007-O

Masson, M. E. J. (2011). A tutorial on a practical Bayesian alternative to null-hypothesis significance testing. *Behavior Research Methods*, *43*(3), 679–690. https://doi.org/10.3758/s13428-010-0049-5

Merrill, T. W. (2009). Accession and Original Ownership. *Journal of Legal Analysis*, *1*(2), 459–510. https://doi.org/10.1093/jla/1.2.459

Morewedge, C. K., Shu, L. L., Gilbert, D. T., & Wilson, T. D. (2009). Bad riddance or good rubbish? Ownership and not loss aversion causes the endowment effect. *Journal of Experimental Social Psychology*, *45*(4), 947–951. https://doi.org/10.1016/j.jesp.2009.05.014

Mulcahy, N. J., & Call, J. (2006). Apes Save Tools for Future Use. *Science*, *312*(5776), 1038–1040. https://doi.org/10.1126/science.1125456

Norton, M. I., Mochon, D., & Ariely, D. (2012). The IKEA effect: When labor leads to love. *Journal of Consumer Psychology*, *22*(3), 453–460. https://doi.org/10.1016/j.jcps.2011.08.002

Saccone, E. J., Szpak, A., Churches, O., & Nicholls, M. E. R. (2018). Close interpersonal proximity modulates visuomotor processing of object affordances in shared, social space. *Attention, Perception, & Psychophysics*, *80*(1), 54–68. https://doi.org/10.3758/s13414-017-1413-7

Sanz, C. M., Call, J., & Boesch, C. (2013). *Tool use in animals: cognition and ecology*. Cambridge University Press.

Scorolli, C., Borghi, A. M., & Tummolini, L. (2018). Cues of control modulate the ascription of object ownership. *Psychological Research*, *82*(5), 929–954. https://doi.org/10.1007/s00426-017-0871-9

Snow, J. C., Skiba, R. M., Coleman, T. L., & Berryhill, M. E. (2014). Real-world objects are more memorable than photographs of objects. *Frontiers in Human Neuroscience*, *8*. https://doi.org/10.3389/fnhum.2014.00837

Streuber, S., Knoblich, G., Sebanz, N., Bülthoff, H. H., & de la Rosa, S. (2011). The effect of social context on the use of visual information. *Experimental Brain Research*, *214*(2), 273–284. https://doi.org/10.1007/s00221-011-2830-9

Sui, J., He, X., & Humphreys, G. W. (2012). Perceptual effects of social salience: evidence from self-prioritization effects on perceptual matching. *Journal of Experimental Psychology. Human Perception and Performance*, *38*(5), 1105–1117. https://doi.org/10.1037/a0029792

Symons, C. S., & Johnson, B. T. (1997). The self-reference effect in memory: a meta-analysis. *Psychological Bulletin*, *121*(3), 371–394.

Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior & Organization*, *1*(1), 39–60.

Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology*, *12*(1), 97–136. https://doi.org/10.1016/0010-0285(80)90005-5

Truong, G., Roberts, K. H., & Todd, R. M. (2017). I saw mine first: A prior-entry effect for newly acquired ownership. *Journal of Experimental Psychology. Human Perception and Performance*, *43*(1), 192–205. https://doi.org/10.1037/xhp0000295

Tucker, M., & Ellis, R. (2004). Action priming by briefly presented objects. *Acta Psychologica*, *116*(2), 185–203. https://doi.org/10.1016/j.actpsy.2004.01.004

Vainio, L., Ellis, R., & Tucker, M. (2007). The role of visual attention in action priming. *The Quarterly Journal of Experimental Psychology*, *60*(2), 241–261. https://doi.org/10.1080/17470210600625149

Williams, A. M., Ward, P., Knowles, J. M., & Smeeton, N. J. (2002). Anticipation Skill in a Real-World Task: Measurement, Training, and Transfer in Tennis. *Journal of Experimental Psychology: Applied*, *8*(4), 259–270. https://doi.org/10.1037/1076-898X.8.4.259

Woźniak, M., & Knoblich, G. (2019). Self-Prioritization of Fully Unfamiliar Stimuli. *Quarterly Journal of Experimental Psychology*, 1747021819832981. https://doi.org/10.1177/1747021819832981

Woźniak, M., Kourtis, D., & Knoblich, G. (2018). Prioritization of arbitrary faces associated to self: An EEG study. *PLOS ONE*, *13*(1), e0190679. https://doi.org/10.1371/journal.pone.0190679