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# I before U: Temporal order judgements reveal bias for self-owned objects

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**Abstract**

A multitude of studies demonstrate that self-relevant stimuli influence attention. Self-owned objects are a special class of self-relevant stimuli. If a self-owned object can indeed be characterised as a self-relevant stimulus then, consistent with theoretical predictions, a behavioural effect of ownership on attention should be present. To test this prediction, a task was selected that is known to be particularly sensitive measure of the prioritisation of visual information: the temporal order judgement. Participants completed temporal order judgements with pictures of "own" and "experimenter" owned objects (mugs) presented on either side of a central fixation cross. There was a variable onset delay between each picture, ranging between 0 ms and 105 ms, and participants were asked to indicate which mug appeared first. The results indicated a reliable change in the point of subjective simultaneity (PSS) in favour of their own mug. Such a change in the PSS was not observed for two groups of participants who were exposed to a mug but did not keep the mug. A further experiment indicated that the source of the bias in PSS was more consistent with a criterion shift or top-down attentional prioritisation rather than a perceptual bias. These findings suggest that ownership, beyond mere-touch, mere-choice, or familiarity, leads to prioritised processing and responses, but the mechanism underlying the effect is not likely to be perceptual in nature.

**Keywords**

Ownership; self-relevance; temporal order judgement; attention; self-bias

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You are at a party. It is noisy. The volume levels are high and you are listening closely and intently to your conversation partner's fascinating story. Yet somehow, through the banter and over the top of numerous other conversations occurring, you hear your name. Your attention is redirected immediately and you have lost track of your partner's story. This is an example of the widely described cocktail party phenomenon (Cherry, 1953), one of the most well-known examples of the influence of self-relevant stimuli on attention.

Self-relevant stimuli are significant and meaningful. Such stimuli, including your own name, the possessions you choose to surround yourself with, your job, and your own face, are all means by which you define yourself from the others around you (Belk, 1988; Dittmar, 1992; James, 1890). It is not surprising that these self-relevant stimuli seem to enjoy benefits associated with information processing. In terms of attention, the vast body of research in this area concerns names and faces. Participants are sensitive to their name and face (e.g., Alexopoulos, Muller, Ric, & Marendaz, 2012; Arnell, Shapiro, & Sorensen, 1999; Brédart, Delchambre, & Laureys, 2006; Moray, 1959; Ninomiya, Onitsuka, Chen, Sato, & Tashiro, 2002; Shapiro, Caldwell, & Sorensen, 1997; Sugiura et al., 2000; Sui, Zhu, & Han, 2006; Tacikowski & Nowicka, 2010; Tong & Nakayama, 1999; Yang, Wang, Gu, Gao, & Zhao, 2013), although these effects may not be entirely automatic (Bundesen, Kyllingsbaek, Houmann, & Jensen,

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1997; Devue & Brédart, 2008; Harris, Pashler, & Coburn, 2004; Laarni et al., 2000; Qian, Gao, & Wang, 2015), require an initial allocation of attention (Gronau, Cohen, & Ben-Shakhar, 2003; Harris & Pashler, 2004; Keyes & Dlugokencka, 2014), and might result from delayed disengagement rather than directly from attention (Devue, van der Stigchel, Brédart, & Theeuwes, 2009). Importantly, these "self" effects can be established beyond familiarity at a neurological level (Sui et al., 2006), though behavioural investigations have, so far, been unable to dissociate the effects of familiarity and self-reference (Devue & Brédart, 2008; Devue, van der Stigchel et al., 2009; Devue, Laloyaux, Fayers, Theeuwes, & Brédart, 2009). In this article, we extend our investigations to another class of self-relevant stimuli: owned objects.

Owned objects provide an interesting point for investigation because, unlike names and faces, object ownership may be a transient association and the association varies in strength. Possessions also represent a featurally complex stimulus, like names and faces, and may contribute to self-identity in a number of ways. For example, humans may choose possessions to represent themselves or how they would like to be viewed by the world. Furthermore, what ownership means to an individual can vary, e.g., cultural orientation can influence the social norms associated with property and the link that the object has with the individual (Bobroff, 2001; Hahm, 1963).

Although there is a wealth of research demonstrating that self-relevant stimuli interact with information processing networks (see Humphreys & Sui, 2015, for a review), there is relatively little evidence that ownership influences perceptual or attentional processes. Of the few studies that have addressed this issue, ownership has been investigated in terms of transient forms of virtual ownership or self-associations (Truong, Roberts, & Todd, 2017; Turk, van Bussel, Brebner et al., 2011a; Turk, van Bussel, Waiter, & Macrae, 2011). This "temporary ownership paradigm" arbitrarily assigns images of objects as either owned by the participant or owned by someone else. For example, Turk, van Bussel, Brebner et al. (2011a) used this paradigm with electroencephalogram (EEG) to explore neurological indicators of attention as related to ownership. In this particular variation, participants sorted pictures of everyday items (e.g., socks) into images of baskets, designated as owned by the participant or owned by another individual. Items designated as self-owned showed a lower occipital P1 component which the authors interpreted as indicative of a narrowing of spatial attention in relation to self-owned objects relative to other-owned objects. Self-owned objects also elicited a larger P300 component which the authors suggested to be indicative of greater attentional processing.

These effects may be interpreted in the context of the Humphreys and Sui's (2015) "Self-Attention Network" (SAN) which contains three main mechanisms that interact to produce self-biases. First, a self-representation is necessary, and such a representation is rapidly activated by the presence of self-related stimuli. This rapid self-activation then triggers bottom-up orienting processes. Finally, top-down attentional control modulates self-orienting to inhibit these processes for other related stimuli and enhance self-biases by tapping into prior expectancies of the presence of self-related stimuli. Further context dependent effects on the self-bias can be explained by the degree of top-down attentional control involved. For a more thorough explanation that encompasses the neurological aspects of the theory, see Humphreys and Sui (2015).

Whereas previous studies have used the temporary ownership paradigm, we sought to determine if ecologically induced ownership can influence attention in such a way that is behaviourally observable. That is, are objects that are actually owned, rather than categorised as owned only for the duration of an experiment, preferentially attended to? This line of inquiry is important because, although self-associations may provide a direct path to self-referential processing, ownership as a construct contains many factors that may be processed in conjunction with the self-referential aspects of the stimulus. That is, ownership as a real-world construct contains a large number of factors that are meaningful in terms of not just self-associations but also social networks, and legal rules and regulations (Pierce, Kostova, & Dirks, 2003). Thus, examining how theories such as the SAN scale up to real-world concepts such as ownership can provide meaningful insight for more applied directions. Cueless Temporal Order Judgement (TOJ) tasks have been successful at detecting effects from other complex motivationally relevant stimuli (Rajsic, Perera, & Pratt, 2017; Truong et al., 2017; West, Anderson, Bedwell, & Pratt, 2010; West, Anderson, & Pratt, 2009; West, Pratt, & Peterson, 2013). For this reason, we opted to adapt the cueless TOJ task for this work to determine if self-owned objects receive preferential processing.

Titchener's (1908) so-called "law of prior entry" is based on the notion that the stimuli individuals attend to will enter into conscious awareness prior to stimuli that they do not attend to. TOJs measure the time taken to become aware of a stimulus. This "prior entry" is thought to arise from early perceptual enhancements (Vibell, Klinge, Zampini, Spence, & Nobre, 2007) and attention induced enhancements during early sensory processing which are later represented as a difference in temporal perception (McDonald, Teder-Sälejärv, Di Russo, & Hillyard, 2005; see Aghdaee, Battelli, & Assad, 2014; Spence & Parise, 2010, for a synthesis of the underlying mechanisms of prior entry). Decision processes such as criterion shifts are also indexed within the TOJ task (García-Pérez & Alcalá-Quintana, 2015; Rajsic et al., 2017; Schneider & Bavelier, 2003). A standard TOJ task involves the presentation of two stimuli separated temporally by a variable

interval. Participants are then asked to make a judgement regarding which stimulus appeared first. At large stimulus onset asynchronies (SOAs), participants are generally very accurate. At shorter SOAs, the stimulus which receives elevated attention (i.e., prioritisation) is more likely to be reported as occurring first. This prioritisation of one stimulus over another is observed in a shift in the point of subjective simultaneity (PSS) from "zero" in favour of the prioritised stimulus such that we can determine temporally how far in advance the unfavoured stimulus would need to be presented for the stimuli to be reported as occurring simultaneously.

Using the TOJ task with a temporary ownership paradigm, Truong et al. (2017) demonstrated a visual prior entry effect for virtual (i.e., drawings of) objects that participants learn are "their own" objects or the "research assistant's" objects. Importantly, the authors show that this effect was not correlated with preference for the 24 objects used in the stimulus set. It is possible, however, that ownership effects may not be entirely distilled down to the self-association task used in experiments using virtual objects due to the complexity of the concept and the absence of the strong induction procedure that the temporary ownership paradigm uses. To elaborate, such virtual experiments arbitrarily assign pictorially depicted items (images/drawings) to an individual and designate these items as the individual's own items. The individual does not keep these items (or pictures, see Cunningham et al., 2008, for the original version of this manipulation). Such a manipulation could be characterised as a self-association task and as a result tap into a direct self-association that is meaningful in the context of the SAN (Humphreys & Sui, 2015), and/or the manipulation could result in a strong sense of ownership where the manipulation highlights the importance of self-owned and other-owned through manual sorting of the objects. Characteristics of the stimuli that stem from the temporary ownership paradigm may not necessarily carry over to real-world ownership because participants are not primed to the self-association in the same way. In addition, and as mentioned already, ownership is constructed of many factors that may be highlighted depending on context (Pierce et al., 2003). For example, it is possible that ownership may not immediately trigger the SAN in the same way a self-association does because the objects are being processed in terms of meaningful relationships (e.g., Constable et al., 2016) or the rules and regulations associated with the object (Truong, Turk, & Handy, 2013). As a result, it is unclear how a stimulus comprised of multiple factors (one of which includes a self-association) fits in with the SAN theory. For this reason, we extend beyond the existing literature to look at real-world ownership to determine if a shift in PSS occurs for owned objects in a more ecological setting while aiming to rule out potential confounds of choice, familiarity (mere-touch), and decisional biases. To preview the results, in the first two experiments, we only found a bias in PSS in an ownership condition where the judgement task relates to ownership as a feature. In a final experiment, we found evidence that the source of this bias was likely to be a criterion shift associated with judgement and decision-making processes rather than a perceptual bias.

## Experiment 1

This study employed a cueless TOJ task to determine if self-owned objects result in a shift in PSS relative to other-owned objects. Participants judged the temporal order of appearance of two photographs: one image of their own mug and one image of the experimenter's mug. Because other forms of self-relevant stimuli receive the preferential allocation of attention, it was predicted that the PSS would be shifted away from zero such that the other-owned stimulus would need to be presented in advance of the self-owned stimulus to be judged as occurring before the self-owned stimulus. To control for the fact that a self-association with the object could occur via mere-touch (Peck & Shu, 2009), an additional control condition was included where a separate set of participants did not get to keep the mug but carried a mug to the experimental room. Thus, participants in this condition had a similar degree of interaction and familiarity with one of the two mugs but did not own it. If contact alone can lead to a prior entry effect, then a significant shift in PSS should be seen for both groups of participants. If prioritisation is dependent on ownership, then a shift in PSS should be observed for the participants who owned the mugs, but not for the "mere-touch" group who simply interacted with the mugs.

### Method

*Participants.* In total, 48 undergraduate students (18 males) from the University of Toronto participated in exchange for course credit. They were aged 18-24 years ($M = 19.0$) and had normal or corrected-to-normal vision. All participants provided informed consent prior to completing the study. The procedures of this study were approved by the University of Toronto's Social Sciences, Humanities, and Education Research Ethics Board.

*Design and procedure.* Participants were greeted by the experimenter who was holding a mug (colour counterbalanced). Participants were randomly assigned to one of two conditions: ownership or mere-touch. Participants in the ownership condition were told that they were able to keep a mug as a part of the study and were able to choose their mug from the two mugs presented to them. Participants in the mere-touch condition were asked to pick up a mug that was sitting on the table. Participants in both groups were asked to carry the selected mug to the experimental chamber. The colours of the mugs in the mere-touch condition were yoked

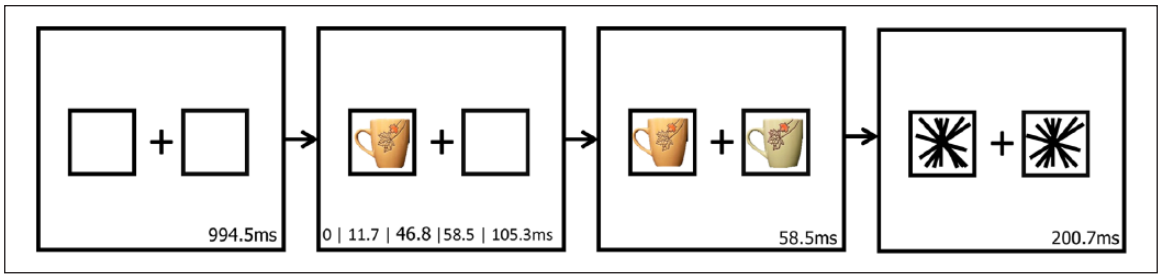


**Figure 1.** Time course of a trial (not to scale).

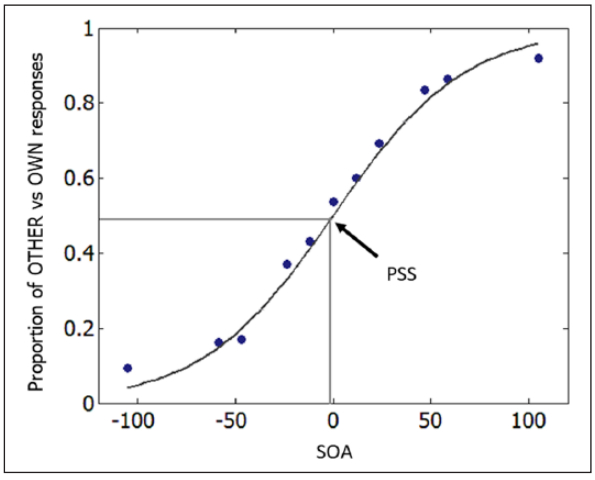


**Figure 2.** An illustrative example of a typical participant's data. The PSS is the point at which the logistic function estimates 50% of the responses were made to OTHER and 50% of responses were made to OWN stimuli as estimated by the psychometric function.

to the chosen colours in the ownership condition. Participants placed the mug that they carried on a table partitioned away from the testing computer.

Trials begun with a central fixation cross and two square placeholders on either side of the fixation cross for 85 frames (994.5 ms at 85 Hz). Participants were asked to fixate on the cross and allocate their attention evenly over the screen. Either a photograph of the participant's mug or the experimenter's mug then appeared in the left or right placeholder. After a variable interval of 0, 1, 2, 4, 5, or 9 frames (0 ms, 11.7 ms, 23.4 ms, 46.8 ms, 58.5 ms, 105.3 ms at 85 Hz), the other stimulus was presented for 5 frames (58.5 ms at 85 Hz). A mask then appeared for 171 frames (200.7 ms at 85 Hz) followed by a blank screen for 85 frames (994.5 ms at 85 Hz). Thus, participants had approximately 1115 ms to indicate which mug appeared first (their own or the experimenter's) by means of a depressing the "z" or "/" key after the stimuli disappeared (see Figure 1 for the time course of a trial). Note that in the mere-touch condition participants responded to "the mug you carried to the room" or "the mug the experimenter carried to the room" to maintain a self-association. For simplicity, the mugs will be referred to as "own" (participant's owned for the ownership group or carried for the mere-touch group) or "other" (experimenter's) for both conditions. The third mug was not seen in the computer-based task and response mappings were counterbalanced between participants. Each participant completed 20 practice trials at the longest SOA followed by six blocks of 88 trials. Self-relevance (own vs other or touched vs not touched), SOA, orientation of handle, and first onset stimulus were fully randomised and counterbalanced within each block.

*Stimuli and apparatus.* Photographs of three differently coloured mugs (green, cream, and brown) were taken with the handle oriented both left and right. The mugs had identical shapes and sizes and a simple design of lines and a maple leaf (coloured red). The photographs measured approximately 5° × 5° (visual angle [VA]) while presented on screen and were presented in square placeholders measuring approximately 6° × 6° VA whose centres were located approximately 6° VA horizontally from the centre of the screen. The fixation cross measured 4° VA.

Stimuli were presented on a cathode ray tube monitor with a refresh rate of 85 Hz. Participants responded on a standard QWERTY keyboard. Stimuli presentation was controlled with Python using Psychopy (Peirce, 2007).

## Results

Trials on which participants made no response were removed prior to analysis (<1%). Three participants performed at chance and were thus not analysed. One participant's data were not included because they expressed surprise that they were able to keep the mug (ownership condition). As such, we inferred that they did not believe the ownership manipulation. Finally, data from one participant were not processed due to experimenter error. For remaining data, a logistic curve of the form $y = 1/(1+e^{-a(x-b)})$, where $a$ scales the slope of the curve fit and $b$ scales the intercept of the curve fit, was fit to each participant's data. The PSS was calculated as the $x$ value at which $y = .5$ (e.g., Figure 2). A negative PSS indicates a shift in favour of the self-owned stimulus, and a positive PSS indicates a shift in favour of the other-owned

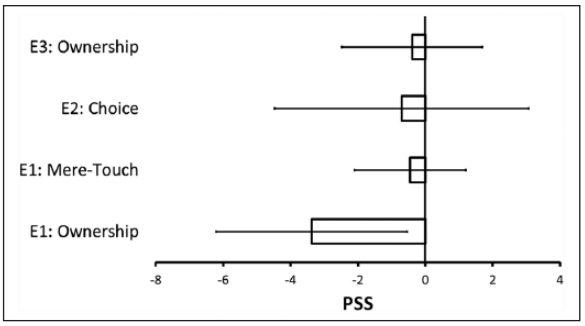


**Figure 3.** Mean points of subjective simultaneity in ms (x-axis) for Experiments 1, 2, and 3.
Error bars denote 95% confidence intervals for the individual conditions.

stimulus. To estimate the standard errors of *a* and *b*, we used a bootstrapping procedure (1000 iterations). For each iteration, a dataset matching the size of the original was created via randomly selecting, with replacement, trials from the original dataset: a curve was fit to that surrogate dataset and saved the parameter estimates each time. If the bootstrapping procedure indicated that the participants calculated curve was unreliable, then the PSS was not entered into the analysis. Failure to achieve a reliable curve was characterised by high standard errors regarding the parameters of the logistic curve or by low accuracy. For example, of the eight participants for which an unreliable curve was returned, six had exceptionally by low accuracy (<75% at the longest SOA), and as a result, a logistic curve was not representative of their data, and they were unlikely to be adequately attending to the task. In the end, the final analysis was performed on 35 participants (ownership = 17 participants, mere-touch = 18 participants).[1] On average, at the longest SOAs, the remaining participants achieved 91.92% accuracy.

The calculated PSS for each participant was submitted to a 2 (condition: ownership/mere-touch) × 3 (mug colour: green/cream/brown) between-subjects analysis of variance (ANOVA). The factor "mug colour" was included to assess if the colour of the mug in and of itself influenced prioritisation. Thus, the assessment of the influence of colour was an important control to ensure the mug colour itself did not bias the PSS.

A significant main effect of condition, $F(1, 29) = 5.47$, $p = .0267$, $\eta_p^2 = .159$, revealed that the average PSS of −3.37 ms in the ownership condition was significantly different from the −0.45 ms PSS in the mere-touch condition. No main effect of colour was observed, $F(2, 29) = 1.62$, $p = .22$, $\eta_p^2 = .10$, and no interaction was found, $F(2, 29) = 0.61$, $p = .55$, $\eta_p^2 = .04$. To determine if there were any statistically significant PSS shifts in either group, we conducted one-sample t-tests against zero on both conditions. Consistent with the main effect for condition, a significant shift in PSS was found in the ownership condition, $M = -3.37$, $t(16) = 2.58$, $p = .02$, $d = .61$, 95% CI = [−6.21, −0.53], but not in the mere-touch condition, $M = -0.45$, $t(17) = .80$, $p = .43$, $d = .18$, 95% CI = [−2.10, 1.21] (see Figure 3).

The slope of the line was also investigated to determine if there was a difference in perceptual sensitivity between the ownership condition and the mere-touch condition. No main effect of condition, $F(1, 29) = 1.78$, $p = .19$, $\eta_p^2 = .05$, or colour, $F(2, 29) = 1.44$, $p = .26$, $\eta_p^2 = .08$. The interaction between condition and colour was not significant as well, $F(2, 29) = 1.16$, $p = .33$, $\eta_p^2 = .06$. Thus, no evidence for differences in perceptual sensitivity as induced by the experimental manipulation was obtained in Experiment 1.

## Experiment 2

The results of Experiment 1 seem to indicate that self-owned objects display PSS shift compared to other-owned objects. The effect of ownership cannot be accounted for by mere-touch or familiarity because participants in the mere-touch group did not demonstrate this same effect. Preference, however, often co-occurs with ownership for obvious reasons. More often than not, we choose what we own; indeed, this is a particularly obvious confound in ecologically valid paradigms. But even when there is no choice involved, we often come to prefer the things we own over things that we do not (see the mere ownership effect, e.g., Beggan, 1992). As such, dissociating preference from ownership is extremely challenging, if not impossible. Nevertheless, investigating how choice influences PSS shifts by itself provides a means of evaluating if this factor is a critical component of the previously observed effect. In Experiment 2, we sought to determine the influence of preference, in the absence of ownership, on the PSS. To this end, we repeated the TOJ task using only choice as a variable. That is, participants were given a choice regarding which mug they would observe in the experiment. Future ownership (or not) or the mug was never discussed. If choice or preference is involved in the effect, then a similar shift in PSS should be observed for the mug the participant chose, otherwise, the PSS should not differ from the point of objective simultaneity.

### Method

*Participants.* In total, 25 undergraduate students (eight males) from the University of Toronto participated in exchange for course credit. They were aged 17-24 years ($M = 19.2$) and had normal or corrected-to-normal vision. All participants provided informed consent prior to completing the study. The procedures of this study were approved by the University of Toronto's Social Sciences, Humanities, and Education Research Ethics Board.

*Stimuli and apparatus.* The stimuli and apparatus were identical to that used in Experiment 1.

*Design and procedure.* Participants were presented with an array of the same three mugs used as stimuli in Experiment 1 and were asked to choose one mug to use during the experiment. The experimenter then chose a second mug and explained that these two mugs would be shown as pictures during the experiment. The colours of the mugs were yoked to the ownership condition (post hoc). We chose to evaluate preference as a variable rather than assign ownership without choice because preference is an inherent component of ownership—humans tend to prefer the things they own even when they do not choose those things (see mere ownership effect, Beggan, 1992). Thus, we chose to arrange a situation in which participants chose a mug but did not own it, rather than arranging a situation in which ownership was assigned but not chosen. The trial sequence followed that of Experiment 1.

### Results and discussion

Four participants who chose a mug that resulted in a duplicate colour combination were removed prior to analysis. Trials on which participants did not make a response (<1%) were removed from the data prior to calculations. The same modelling procedure used in Experiment 1 to calculate each individual's PSS was used. The data from five participants did not meet the inclusion criteria established in Experiment 1. Because analysis on this data would be very different in terms of the colours participants observed relative to Experiment 1, we replaced the colour combination that these five removed participants chose using a subsequent participant who chose the appropriate combination. This process resulted in a final sample of 17 that performed the task with the same colour combinations used for the critical condition of ownership in Experiment 1. On average, the participants included in the final analysis achieved 89.19% accuracy.

To determine if a PSS shift was present for mugs that participants chose over those that the experimenter chose, we conducted a one-sample t-test on the participants PSSs against a test value of 0. No shift in PSS was observed, $M = -0.70$, $t(16) = .39$, $p = .70$, $d = .20$, 95% CI = [−4.46, 3.07], see Figure 3. Thus, no evidence of prioritisation on the basis of choice was obtained.

## Experiment 3

In the previous experiments, we restricted our discussion to the performance-based measure of PSS. This approach gives little insight into the underlying mechanisms that drive the effect. For example, such a shift in PSS for a TOJ task is often discussed in terms of perceptual mechanisms (MacDonald, 2005; Vibell et al., 2007). But attempts have been made to explore the contribution of other mechanisms such as a criterion shift in decision-making using both modelling work (e.g., Alcalá-Aquintana & García-Pérez, 2013) and experimental design (Rajsic et al., 2017; Shore, Spence, & Klien, 2001). In the current experiment, participants were asked to do a task relevant judgement on the stimuli. That is, the judgement they made was based on the condition of interest. This design decision was made because previous work suggests that without active processing of the self-relevant stimulus, self-prioritisation should not be observed (e.g., Bundesen et al., 1997, but see Truong et al., 2017). Using a judgement that is orthogonal to the condition of interest (ownership), any possible criterion shift associated with the condition of interest should be minimised. Following this line of reasoning, when the judgement task is orthogonal (e.g., did the left or right mug appear first?), the effect of the PSS shift should be abolished. That is, the purpose of Experiment 3 was to answer the following question: Does the owned object enter into conscious awareness prior to the other-owned stimulus or do participants have a tendency to decide the self-owned object appeared first under conditions of uncertainty? Thus, if the PSS shift in Experiment 1 manifested due to a perceptual mechanism, then a similar PSS shift should be observed in Experiment 3. Conversely, if the effect was primarily due to participants shifting their criterion for response under conditions of high uncertainty, then no PSS shift should be observed.

### Method

*Participants.* In total, 34 undergraduate students (14 males) from the University of Toronto participated in exchange for course credit. They were aged 18-25 years ($M = 19.15$) and had normal or corrected-to-normal vision. A larger number of participants was sought here to account for the fact that we anticipated the criterion shift would be removed and this might impact the size of any potential perceptual effect. All participants provided informed consent prior to completing the study. The procedures of this study were approved by the University of Toronto's Social Sciences, Humanities, and Education Research Ethics Board.

*Stimuli and apparatus.* The coffee mugs used in Experiment 3 were different to those used in the previous experiments because the store had discontinued production of the mugs used in those studies. The mugs used in Experiment 3, however, were of approximately equal value and could similarly be differentiated by colour. Otherwise, the apparatus was identical to that used in Experiment 1.

*Design and procedure.* The procedure followed that of Experiment 1, except that participants chose from three mugs that were randomly selected from four different colours. In the task, participants were asked to judge whether the mug to the left or right of fixation appeared first.

### Results and discussion

Trials on which participants did not make a response (<1%) were removed from the data prior to calculations. The same modelling procedure used in Experiment 1 to calculate each individual's PSS was used. Six participants did not meet the inclusion criteria. The remaining participants achieved 92.96% accuracy at the longs SOAs.

To determine if a PSS shift was present for self-owned mugs relative to experimenter owned mugs, we conducted a one-sample t-test on the participants PSSs against a test value of 0. No evidence for a shift in PSS was observed, $M=-0.39$, $t(27)=.62$, $p=.54$, $d=.12$, 95% CI=[−1.69, 0.91]: see Figure 3. Thus, we were unable to detect a shift in PSS associated with ownership when participants were not required to actively process ownership as a feature of the stimulus to do the task.

## General discussion

The results of the first experiment indicated that there was a shift in the PSS such that the self-owned mug was reported to occur first more frequently under conditions of uncertainty than a similar mug owned by another individual. Furthermore, additional data and analyses revealed that the aforementioned effect cannot be readily explained as an artefact of unbalanced colour pairings, simply touching and carrying the object, or the act of choosing the object. Finally, Experiment 3 revealed that the original "ownership" effect found in Experiment 1 did not manifest when participants were not required to actively process ownership as a feature of the stimuli to complete the task. In light of the pattern of results, we suggest the original ownership effect reported is most likely to represent a criterion shift rather than a perceptual effect.

Although our initial results are consistent with a recent study that examined attentional prioritisation for transient self-relevant stimuli using a variation of the temporary ownership paradigm (Truong et al., 2017), our final experiment seems contradictory to their findings. Using a version of TOJ task similar to that used by West et al. (2009, 2010, 2013), Truong et al. assigned ownership to images of stimuli (e.g., toothbrush, coconut, binder) through a memory instruction. The results revealed prioritisation of attention to owned images, and the magnitude of the effect was similar to that found in this work (average estimated values for prior entry of 4-5 ms). Contrary to our results from Experiment 3, however, their effect was obtained when participants made a judgement *unrelated* to the self-relevance of the stimulus (left/right judgement). Similar to our argument, the authors suggest that a judgement that is orthogonal to the dimension of interest is less likely to result in a criterion shift.[2] Thus, their effect may be more reflective of a perceptual mechanism and in line with the ideas proposed by Humphreys and Sui (2015), whereby manipulating the degree of self-relevance may be akin to manipulating the perceptual salience of a stimulus (see also Sui, He, & Humphreys, 2012; Sui, Lui, Mevorach, & Humpreys, 2013), resulting in enhanced attention that propagates to later information processing benefits that are manifested as a misrepresentation of temporal presentation. Furthermore, given that there is some evidence that prior entry results from both greater attentional allocation towards attended stimuli (McDonald et al., 2005) and faster perceptual processing (Vibell et al., 2007), prior results are consistent with hypotheses laid out by the SAN (Humphreys & Sui, 2015).

We do not contest the notion that self-relevant stimuli under specific circumstances may enjoy perceptual and/or attentional enhancements, but we do suggest that the conditions under which such enhancement occur needs to be further investigated. For example, the conditions under which attentional effects are obtained for one's own face and name seem to be highly specific (e.g., Devue, Laloyaux et al., 2009; Gronau et al., 2003). The results of the experiments reported in this article suggest that relative to the temporary ownership paradigm, an ecological ownership manipulation results in a criterion shift only whereby participants are more likely to report they saw their own object first rather than effect based upon any perceptual mechanism. It is also possible that our effects represent top-down attentional prioritisation when the feature of interest is relevant to the task. The fact that the feature of interest needs to be task relevant for the effect to emerge may be because the manipulation we used does not highlight the self-relevance of the object to the same extent as the temporary ownership paradigm where participants spend time virtually sorting objects into self-owned or other-owned categories or imagining themselves owning the object. Specifically, the act of manually sorting owned objects (self-owned and other-owned) highlights the importance of the self-association of the object and the distinction between the objects. A real-ownership manipulation does not highlight this feature as directly because the participants do not need to repetitively distinguish between the objects prior to the experimental task. In this sense, we suggest that it is very important to test these effects in a more ecological context because self-relevance may not be automatically processed in all circumstances.

Our results may also prove to be consistent with Miyakoshi, Nomura, and Ohira (2007) who suggest that self-relevance effects are primarily observed at later stages of information processing. In that paper, Miyakoshi et al. (2007) recorded Event-related potentials while participants passively observe objects that were self-owned, familiar but not owned, and unowned. They were only able to dissociate between self-owned and familiar objects at later stages of processing past 300 ms. Indeed, this article joins a growing body of literature that suggests that later information processing stages are pivotal in self-reference

effects (Golubickis, Falben, Cunningham, Macrae, in press; Golubickis et al., 2017; Siebold, Weaver, Donk, & van Zoest, 2015; Woźniak, Kourtis, & Knoblich, 2018).

This study provides evidence of a shift in PSS associated with ownership. Yet, other self-relevant judgements did not manifest a similar shift. To be clear, the judgements regarding which one the participant carried (E1: mere-touch) and which one they chose (E2: choice) are still self-relevant judgements. The absence of an effect from these other self-relevant judgements further suggests that signalling an important feature of the stimulus that the participant must attend to cannot explain the results of the first experiment in and of itself. We contend that our results and the results of other similar studies such as Truong et al. (2017) are consistent with the notion of motivational relevance relative to the current context. That is, ownership (relative to familiarity or choice) might be more readily elevated to motivational relevance due to an interaction between self-representative mechanisms and top-down control and this manifests in the pattern of results across the three studies. Without some top-down indication that this feature is relevant (via the judgement task to be done: E1 current article, or by prior training: Truong et al., 2017), the effect will not manifest. This explanation also accounts for the fact that we were unable to detect a shift in PSS for mere-choice and mere-touch conditions; these features, although task relevant in the experiments, do not elevate the self-related object to a level of motivational relevance.

Overall, we suggest that ownership seems to be a means of exploring contextually based effects, but with the caveat that it must be done in such a way that scales up appropriately to the actual phenomenon due to ownership's highly social nature. Indeed, there are effects whereby another-owned object provides the more interesting or "enhanced" effect (see Constable et al., 2016; Constable, Kritikos, & Bayliss, 2011; Constable, Kritikos, Lipp, & Bayliss, 2014; He, Lever, & Humphreys, 2011). Here, we show that the ownership effect in an ecological context may be most representative of a bias towards self-related stimuli. Perhaps, previously reported perceptually based effects are too subtle to manifest with ecologically based manipulations and require strong laboratory-based associations to manifest at a behavioural level.

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## Notes

1. It should be noted that the number of discarded participants is substantially larger than typically observed in attentional paradigms. This relatively high exclusion rate was not unexpected due to the difficulty of the task. Participants needed to be particularly diligent in performing the task.
2. Other methods of examining or reducing response biases include simultaneity judgements or asking which item came second (e.g., Shore et al., 2001).

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