Self-bias effect: movement initiation to self-owned property is speeded for both approach and avoidance actions

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ABSTRACT

Recall of, and physical interaction with, self-owned items is privileged over items owned by other people (Constable et al, 2011; Cunningham et al, 2008). Here we investigate approach (towards the item), compared with avoidance (away from the item) movements to images of self- and experimenter-owned items. We asked if initiation time and movement duration of button-press approach responses to self-owned items are associated with a systematic self-bias (overall faster responses), compared with avoidance movements, similar to findings of paradigms investigating affective evaluation of (unowned) items. Participants were gifted mugs to use, and after a few days they completed an approach-avoidance task (Chen & Bargh, 1999; Seibt et al, 2008; Truong et al, 2016) to images of their own or the Experimenter's mug, using either congruent or incongruent movement direction mappings. There was a self-bias effect for initiation time to the self-owned mug, for both congruent and incongruent mappings, and for movement duration in the congruent mapping. The effect was abolished in Experiment 2 when participants responded based on a shape on the handle rather than mug ownership. We speculate that ownership status requires conscious processing to modulate responses. Moreover, ownership status judgements and affective evaluation may employ different mechanisms.

Introduction

In experimental psychology paradigms, the physical features, meaning, affect and self-relevance of information all contribute to motor responses times (Cacioppo, Priester, & Bernston, 1993; Chen & Bargh, 1999; Humphreys & Sui, 2015a, b; Sparks, Cunningham & Kritikos, 2016; Strack, Martin, & Stepper, 1998). Affective evaluations show a bidirectional relationship with motor output, leading to propositions that cognitive and affective processes are embodied (Cacioppo et al., 1993; Fischer & Zwaan, 2008; Lavender & Hommel 2007; Soussignan, 2002; Strack et al, 1998; Truong, Chapman, Chisholm, Enns & Handy, 2016). For example, Cacioppo et al (1993) had participants rate Chinese ideographs. In the arm flexion condition, participants were instructed to place their palms under the table and press upwards. In the arm extension condition, they placed their palms on the table surface and pressed downwards. While performing these actions, they rated whether they liked or disliked the ideographs (experiments 1 and 2). Ideographs viewed in the flexion condition were rated more positively (better liked) than ideographs viewed in the extension condition (Cacioppo et al, 1993). In these two experiments, we investigate whether the same bidirectional motor output pattern holds for self-relevant objects.

Affective evaluation and approach-avoidance movements

Affective evaluations of words (pleasant - unpleasant; good - bad; simple - complex) modulate arm flexion-extension response times, as indicated in joystick approach-avoidance paradigms (Chen & Bargh, 1999; Krieglmeyer et al., 2010; Seibt, Neumann, Nussinson & Strack, 2008; Zajonc, 1980). These approach-avoidance response differences fit within the framework of Strack and colleagues (Körner & Strack, 2018; Strack & Deutsch, 2004), who postulated that behaviour can be attributed to reflective and impulsive processes. Reflective processes are 'higher-level' decision-making mechanisms regarding actions. Conversely, impulsive processes drive approach-avoidance actions (typically flexion and extension movements) to positive or negative stimuli. Impulsive processes can be thought of as well-established associative links related to motivation-triggered actions, are automatic, and require little or no attention (Körner & Strack, 2018; Strack & Deutsch, 2004; see also Chen & Bargh 1999).

Many studies report a systematic association between direction of response (approach-avoidance) and evaluation of the word (positive-negative) (Chen & Bargh, 1999; Eder & Hommel, 2013; Koch, Holland, & Knippenberg, 2008; Krieglmeyer, et al, 2010; Lavender & Hommel, 2007; van Dantzig, Pecher, & Zwaan, 2008; but see for example van Dantzig, Zeelenberg, & Pecher, 2009; Seibt et al, 2008 for an opposing view). Chen and Bargh (1999) had one group of participants evaluate and classify a word on a monitor as 'good' by pushing the lever towards it and thus pulling away from the self, and 'bad' by pulling the lever away from the word and thus towards the self (incongruent condition). The second (congruent condition) group reversed this direction-evaluation mapping): words were classified as 'good' by pulling the lever towards the self and away from the word, and 'bad' by pushing the lever away from the self and towards the word. Evaluation latencies were significantly faster for congruent than incongruent mappings, with faster responses when participants made movements away from 'good' words and towards the self, and moved toward 'bad' words and away from the self (Chen & Bargh, 1999). The explanation was that evaluation of a stimulus as positive or negative activates flexor muscles pulling towards the body or extensor muscles pushing away respectively (Chen & Bargh, 1999) such that positive information is ‘brought’ towards the self while negative information is ‘pushed’ away. Rotteveel, Gierholz, Koch et al, (2015), conversely, directly replicated Chen and Bargh’s (1999) methods and were unable to find approach-avoidance differences to the affect of word items.

The findings of other studies, however, indicate that the direction of differences depends on the frame of reference of the approach-avoidance movement, and can change due to task demands. Seibt et al (2008) point out that the (in)congruence of the mapping - that is, which direction is considered approach versus avoidance - depends on whether the physical self versus the item is the frame of reference of the movement. That is, the simple instruction to move towards versus away from the item, or towards versus away from the self, changes the frame of reference (Seibt et al, 2008; experiment 3). If the frame of reference is the self (‘move the joystick towards / away from yourself’) then approach-avoid refers to approaching or avoiding the body. Conversely, if the frame of reference is the item of information (‘move the joystick towards / away from the word’) then approach-avoid refers to approaching or avoiding the word on the monitor. Therefore, the frame of reference of approach-avoidance movements is in terms of the goal of the action, rather than the extensor / flexor muscles that are activated. Here we had participants move to the near or far button according to mug ownership (experiment 1) or shape on mug handle (experiment 2), so arguably the frame of reference is mug-based because the goal is to process information relating to the mug. Hence, approach implies reducing the distance between self and the mug, while avoidance implies increasing the distance.

Other factors, such as conscious processing of the information and hand posture, may further modulate the approach-avoidance response latency pattern. Rotteveel and Phaf (2004), investigating evaluation of emotional faces using flexion and extension movements, reported that conscious processing of the emotional expressions was crucial in revealing systematic approach-avoidance differences. When focusing on gender of the face instead, approach-avoidance dissociation was not evident (Rotteveel & Phaf, 2004). Finally, Freina, Baroni, Borghi and Nicoletti (2009) showed that when the hand is holding a tennis ball latencies are faster to near reaches for positive words and far reaches for negative ones. This is possibly because with a ball, and hence a wide grasp, positive features are 'brought in' towards the self and negative ones are pushed away.

Self-relevance, ownership and motor control

There is substantial evidence that self-relevant items are also attended to preferentially compared with non-self-relevant items. An early example of this is the work of Moray (1959) who used dichotic listening paradigms to present distinct streams of information to the two ears. Participants were instructed to attend to information presented to one ear, but personal information such as the participant's name, presented to the other ear captured attention away from the attended ear (Moray 1959). Subsequent work showed that personality traits ascribed to the self (for example, "Does [*trait*] describe you / the experimenter?") are rated more positively and recalled more accurately than traits ascribed to the Experimenter (Kuiper & Rogers, 1979; Rogers, Kuiper & Kirker, 1977), consistent with a positivity bias in self-evaluation (Greenwald, 1980). In face recognition tasks, upright and inverted self-faces are identified faster than other-owned faces (Keenan, McCutcheon, Freund-Gordon, Gallup, Sanders & Pascual-Leone, 1999).

Following from our earlier work on ownership (Constable, Kritikos & Bayliss, 2011; Constable, Kritikos, Lipp & Bayliss, 2014) and in line with the self-positivity bias (Greenwald, 1980) and speeded responses to self-relevant information (Kuiper & Rogers, 1979; Rogers, et al, 1977) we speculated that ownership could be an instantiation of positive or negative evaluation of items (for example, Morewedge, Shu, Gilbert, & Wilson, 2009). Specifically, a self-owned item might be processed as more positive than an item owned by someone else. Moreover, the work of Kahneman and Tversky (1984; Kahneman, Knetsch & Thaler, 1991) indicates that items are judged to be of greater or lesser financial value, as a function of ownership status. In related literature from consumer psychology, previously neutral, unowned items (such as pens and mugs) gifted to participants are thought to become part of the extended self (Belk, 1998). Thus, it may be that owned items become a part of the extended self, and evaluated more positively in terms of increased attractiveness (Beggan, 1992) than identical items that are not owned, or owned by other people. In combination with the positivity bias in self-evaluation (Greenwald, 1980), and engagement in adaptive self-enhancement strategies (Taylor & Brown, 1988), we speculate that the self could be viewed as positive. The value or positive association of self-related items is probably distinct from a financial or monetary-type value, that is, they are intrinsically rewarding (Humphreys & Sui 2015a).

If self-owned items can be viewed as valenced, the principle of approach-avoidance differences in movement should apply. First, in simple grasp-lift-replace tasks with self- versus other-owned items (mugs; Constable eta l, 2011; Constable et al, 2014; Holubar & Rice 2011), movement parameters of actions involving self-owned items differ from those with other-owned items. Constable et al (2011; 2014) gifted a plain white mug to participants. To promote ownership, participants decorated and then used the mug for 14 days before returning to perform a simple reach-grasp-lift-replace task with their own mug, the experimenter’s mug, or an unowned mug. Constable et al (2011; 2014) reported that the acceleration of the lifting phase and deceleration of the replacement phase of the self-owned mugs was faster than the experimenter-owned mugs. Relevant to the approach-avoidance literature above, Constable et al. (2014) found that at the end of the lifting phase of the movement self-owned mugs were positioned closer to the self, and the experimenter-owned ones away from the self (Constable et al, 2011 Experiment 1; Constable et al, 2014). The findings suggest that there are systematic differences in the kinematic parameters that describe physical interactions with self- versus other-owned property. In this paradigm, moreover, there was some evidence that responses to other-owned mugs was suppressed: in a stimulus-response compatibility task (Constable et al, 2011, Experiment 2), self- and experimenter-owned mugs were presented with handles oriented to the left or right, and participants responded to the colour (green or red) superimposed on the handle. While the typical stimulus-response compatibility effect was seen for self-owned mugs, it was supressed for experimenter-owned mugs, perhaps indicating that the potential for action towards another's property is abolished.

Moreover, recent work by Truong et al (2016) brings together the concepts of approach-avoidance actions, ownership and embodied cognition. Relevant to the current study, they followed the Cunningham et al (2008) shopping paradigm, which could be characterised as having a self-centred frame of reference. Participants categorised novel, virtual shopping items as self- or experimenter-owned by pushing them away (avoidance) or pulling them towards themselves (approach; Experiment 3) to far or near locations respectively. Ownership and movement direction (away, towards) did not influence initiation (reaction) time for this sorting task. Ownership also did not influence movement duration (reach time), although movement time was faster for pushing (avoidance) actions, consistent with biomechanical constraints. Despite this, items allocated to the self that were pulled towards the body (approach) were subsequently recognised better than other-owned items or items that are pushed away (Truong et al, 2016).

Although Truong et al (2016), reported no significant effects in reaction and reach time as a function of ownership and movement type, we believe that our paradigm modifications might lead to a detection of effects in movement parameters. Specifically, in the current experiments, we established a real (rather than virtual) ownership association and usage with items (mugs). We asked whether response latency and movement duration to self- versus other-ownership show the same dissociation as positively- and negatively-evaluated items (Chen & Bargh, 1999). We compared response times and movement duration in congruent and incongruent movement direction-ownership mappings, relative to the position of the item. We expected that there should be benefits in terms of speeded responses for the congruent mapping but a cost in terms of slowed responses for the incongruent mapping.

Previous studies typically have reported one measure of response, evaluation initiation time (Chen & Bargh, 1999; Lugli, Baroni, Gianelli, Borghi & Nicoletti, 2012). Conversely, Truong et al (2016) recorded both initiation (reaction) and movement duration (reach time). These parameters showed a dissociation, such that, while initiation time was unaffected by ownership and movement direction (towards, away), movement duration was faster for away (avoidance) movements, averaged over ownership status. In the present two experiments, we recorded time to lift the hand off the start button (initiation time), as well as the subsequent time to press the away-from-body or towards-body buttons (movement duration). In this way, we hoped to gain a further indication of the modulation of both initiation and movement duration times reflecting planning and execution of behavioural responses respectively (for example, Pratt & Abrams, 1994). Some work has suggested that in certain tasks such as distractor interference, changes can be restricted to one measure, for example, initiation time but not duration (Kritikos, Mattingley & Breen, 2004). Other work in distractor interference tasks (Pratt & Abrams, 1994) or in sequential tapping tasks (Stelmach, Worringham & Strand, 1987), however, does not indicate a clear dissociation between initiation and duration. It is possible that differences in evaluation responses are restricted to response planning which, in this task, should be weighted primarily within the initiation time, rather the movement execution phase (duration) because participants must select a flexion or extension prior to action onset.

Experiment 1

In Experiment 1, participants made flexion or extension arm movements based on ownership of the mug presented on a monitor. Because they were instructed to process ownership status of the mug, it can be argued that the task has an item-based frame of reference (see Seibt et al, 2008). Therefore, we define approach movements as arm extensions towards the mug on the monitor, while avoidance movements are arm flexions away from the mug.

Previous studies have reported evaluation latencies, that is, initiation times (Chen & Bargh, 1999; Krieglmeyer et al., 2010; Zajonc, 1980). Along with their findings, the planning phase of the movement should be affected because stimulus onset of the self- or experimenter-owned mug would require selection (that is, planning) of a flexion versus extension movement, associated with an approach versus avoidance action. Thus, if response selection adds to the robust effect of privileged processing for self-owned objects, responses should be faster for the congruent compared with the incongruent mapping in initiation time – that is, for approaching the self-owned mug and avoiding the Experimenter-owned mug compared with the reverse.

Predictions regarding expected speeding of responses and congruent-incongruent mapping for movement duration are not quite so clear, however. Given that movement planning and on-line adjustments are possible during movement execution, stimulus evaluation may continue during the execution phase of the approach-avoidance movements, and thus movement duration (MD) will follow the same cost-benefit pattern for congruent and incongruent mappings as IT. Conversely, there may be a dissociation between IT and MD: the approach-avoidance response latencies effects may depend only on initial, early exposure to and responding to the items, that is, the early phase of the movement (Pratt & Abrams, 1994), and evaluation may not impact the subsequent execution phase.

Method

Participants: To maximise the possibility of obtaining a systematic difference in performance, we included only female participants because there is evidence that females are more tuned to social cues such as gaze than males (Bayliss, di Pellegrino, & Tipper, 2005; see also Sparks, Sidari, Lyons & Kritikos, 2016; Sparks, Douglas & Kritikos, 2016). More specifically, in recent research investigating the ability to track owned items within reaching space, Scorolli, Borghi and Tummolini (2018) showed that female participants were more sensitive to ownership cues than males, particularly if the co-actors were also female. In this study, both participants and the experimenter were female.

Forty-nine Caucasian females (mean age = 18.75 years, SD = 1.50, range 17 – 23 years) volunteered for course credit and gave their consent to participate in the study, which was cleared by the University of Queensland School of Psychology ethics committee. They were born in Australia, and English was their first language. They were self-reportedly right-handed and had normal or corrected-to-normal vision.

Apparatus and Stimuli: Participants were initially gifted a mug (height 8cm, rim diameter 9cm), which had either brown-and-white stripes or white spots on a blue background. They were instructed to use it, returning 6-11 days later to complete an experimental task.

For the approach-avoidance task (AAT), display of the stimuli and response time (IT and MD) data collection were programmed in Eprime 2.0 and displayed on a windows 19-inch (48cm) Acer AC915 colour CRT monitor (resolution 1024 X 768, refresh rate 85Hz. Participants were seated such that their eyes were 54cm from the monitor and their midsagittal axis aligned with the centre of the monitor. Responses were made on a modified QWERTY keyboard. This had all keys removed except for “~”, “0” and “/” on the numeric keyboard, because the “~” and “/” keys were equidistant (19 cm) from the 0 key. The keyboard was covered with black cloth with three white foam circles (2.5 cm diameter) attached over the position of the “~”, “0” and “/” keys, and positioned lengthwise in front of the monitor such that it was oriented along the participant’s midline axis with the space bar of the keyboard in the right hemispace. In this arrangement, the “/” key was 52cm from the centre of the monitor, the “0” key 46 cm and “~” key 26cm (see figure 1 panel A for a diagram and panel B for an image of the apparatus). Participants started each trial with the index finger on the central “0” key, and then moved either towards the monitor or their body in response to the ownership status of the depicted mug, according to instruction.

FIGURE 1 HERE

An instruction to “Get ready…” (white 18 point Arial font, on a black screen) followed by a centrally positioned white cross (18 point Arial font, on a black screen), and then a life-sized mug (height 8cm, rim diameter 9cm) were displayed on centrally on the monitor, on a black background. The image of the mug was presented such that the handle was central and aligned with the participant’s midsagittal axis.

<u>Procedure</u>: In line with our previous work on embodied ownership involving physical interaction with self- and other-owned mugs (Constable et al, 2011; 2014), we aimed to promote ownership through familiarity and usage of the mug. We postulated that the familiarity and usage would establish sensorimotor as well as semantic links between the self and the mug, as would happen with items we acquire in daily life. This, in turn, should increase the likelihood that systematic approach-avoidance effects might be revealed.

In the initial session, participants were allocated either the brown-and-white striped or white-on-blue spotted mug, on an alternating basis, and were told the mug was now theirs to keep forever. During this session, the Experimenter (TB) displayed the other mug held in her hand (that is, if the participant was allocated the brown-striped mug, TB displayed the blue-spotted one, and vice versa) and said that it was hers. To convince them of her ownership, the Experimenter’s mug was half-filled with water, she drank from it, and to explain the mug’s presence she said she was also participating in the experiment. When given their mug, participants were asked to use it for hot or cold drinks at least twice daily, and to tally as closely as they could the number of times they had used it each day. Participants were instructed to bring their mug and tally sheet to the second session, and then allowed to leave. (Note that due to the variability of responses, and frequent lack of responses, on this tally, this measure was not used in further analyses).

They returned for the second, experimental session 6-11 days later (M = 7.5 days, SD = 0.53), and produced their mug and tally sheet. The Experimenter produced "her" mug, to reinforce experimenter-ownership as well as ensure distinction of ownership status. They were seated comfortably at the table in front of the monitor, ensuring they could move their hand and arm up and down the keyboard. They were given verbal as well as written instructions for task completion. Specifically, they were told that they would see images of either their own or the Experimenter's mug. Participants were instructed to hold their right thumb and index finger together lightly in a 'pinch' grip, and that on seeing the words "Get ready…" on the monitor, they should press down on the middle button with their thumb and forefinger of the right hand touching together.

Participants were instructed to respond with their right hand and arm, starting from the middle button. Half the participants were instructed to lift the hand, move towards the monitor and press the button farthest from their body (approach movement) when they saw their own mug on the monitor, and to move away from the monitor and press the button closest to their body (avoid movement) when they saw the Experimenter's mug. This was the congruent mapping. The other half of the participants were assigned the opposite, incongruent ownership-movement mapping. Each trial began with the centrally positioned "Get Ready…." instruction on a black background. This remained on the monitor until participants moved their hand to the central "0" white button and pressed it. Participants reached to one of the two button locations, and subsequently returned to the start position (middle button) when the next "Get ready…" text appeared.

An instruction to "Get ready…" (Arial 18 point white font) appeared centrally on the screen until the participant depressed the middle white button with the index and thumb held together. At depression of this button, a blank black screen appeared for 1506 msec followed by a centrally positioned fixation cross for 506 msec (Arial 18 point white font), then by mug stimulus onset. Mug stimulus duration was 411 msec, and at its offset a blank black screen appeared and remained for 2506 msec (all timings synchronised to the refresh rate; see Figure 1 panel C).

The mug handle was always visible and oriented centrally. Our intention was to avoid as much as possible a potentiation of attention and action directed towards the right versus left hemispace, by orienting the handle centrally rather than to the left versus right (e.g. Tucker & Ellis, 1998). Moreover, participants only used the right hand to respond, so grasp potentiation was constant across all conditions. We reasoned that if participants used a pointing movement, the mug handle may have triggered an affordance of narrow (pinch) grip. We have shown previously that initial hand posture (pinch, spread fingers, flat palm) does influence temporal kinematics of reach-to-grasp and reach-to-point actions (Kritikos, Jackson & Jackson, 1998). More relevant to the current paradigm, Freina et al. (2009) had participants make far or near button-press responses to positive or negative words. When they used an open hand to respond, latencies were faster to far reaches for positive words and near reaches for negative words. The pattern was reversed when they reached with a tennis ball in their hand, with faster latencies to near reaches for positive words and far reaches for negative ones, possibly associated with bringing in positive features and pushing away negative ones. To hold these factors constant, we had participants perform the task using a pinch grip.

Participants were also instructed not to lean either elbow on the table while making the movement. Each mug (self-owned, Experimenter-owned) was presented equally often, in randomised order. During the AAT, the experimenter was seated unobtrusively behind a partition 1.5m to the left of the participant. The task consisted of 100 trials across 5 blocks (that is, 20 trials per block), with a brief rest between each block.

On completion of the AAT, on a scale of 0 (do not like at all) to 7 (like very much), participants rated how much they liked their own and the Experimenter's mug.

Design: We measured initiation time (IT; time, in milliseconds, from the onset of the image of the mug to lifting of the finger from the middle start "0" key; please note: IT recording differed slightly in Experiment 2, where participants responded to a shape appearing 82 msec after mug image onset on the handle of the mug) and movement duration (MD; time, in milliseconds, from lifting of the finger from the start "0" key to depressing one of the two response keys("~" or "/").

We analysed initiation time and movement duration of responses for Congruency and Ownership Status. Following an item-based frame of reference (Seibt et al., 2008), we defined congruent mapping as approaching the self-owned mug by moving the hand and arm towards the mug on the monitor and away from the body, and avoiding the Experimenter-owned mug by moving the hand and arm toward the body and away from the monitor when they saw an image of the Experimenter's mug. The difference between these two initiation times should give an index of the self-bias for congruent mapping. The incongruent mapping was the reverse: avoiding the self-owned mug by moving the hand and arm away from the mug on the monitor and towards the body, and approaching the Experimenter-owned mug by moving the hand and arm away from the body and towards the mug on the monitor. The difference between these two initiation times should give an index of the self-bias for incongruent mapping.

To simplify conceptualisation, analysis and graphing of the results, we calculated a 'self-bias effect'. For initiation and movement duration times, we subtracted the self-trials from the experimenter trials for congruent and incongruent mapping groups. That is, a positive value represents an advantage for self-trials, where as a negative value represents an advantage for experimenter trials. We conducted one-sample t-tests on these values.

Results and Discussion

Design and data analysis. We conducted one-sample t-tests on these values, separately for the congruent and incongruent mappings, to determine whether the values were significantly different from zero and thus indicative of a self-bias. We also conducted an independent samples t-test, comparing the congruent with the incongruent mapping and Bayesian analyses of the non-significant comparisons, to determine whether self-bias was significantly different between the scores of the two mappings.

In the Supplementary data, however, we also present a mixed-design analysis of the data (IT and MD for Experiments 1 and 2), with Ownership (self; experimenter) as the within-subjects factor and Congruency (reflecting movement direction to mug ownership status) as the between-subjects factor (approach self-mug / avoid experimenter-mug; avoid self-mug /approach experimenter-mug).

Data Screening. One participant forgot to bring her mug but described it to ensure she knew which one it was; her data were retained. Prior to analysis, one participant was excluded because she did not remember that the mug was permanently hers, another because she did not use her mug, and a final participant because she did not follow approach-avoidance mapping instructions for the AAT. From the remaining data, individual trials were excluded if IT was faster that 150 msec or slower than 2000 msec and we excluded three participants whose response accuracy was less than 80% correct overall. Thus 43 participants' data were included in the analysis. Of these, 21 had been randomly assigned to the congruent mapping group, and 22 to the incongruent mapping group. At the end of the experiment, participants indicated that they liked their own mug more than the Experimenter's ($M_{Self\text{-}owned}$ = 5.8 range 1 -7 and $M_{Experimenter\text{-}owned}$ = 4.5 range 2 – 7 respectively).

Initiation Time (IT)

A t-test on approach versus avoid actions (that is, extension versus flexion) averaged over ownership status and congruence mappings across all participants showed that there was no overall difference in IT for the two types of movements ($M_{approach}$ = 395.279, M_{avoid} = 395.911 , t(42) = .161, p = .873 SD = 25.671, SEM = 3.915, lower = -7.2.69 upper = 8.532). Bayesian analysis of this difference (using SPSS for PC version 25) showed the data were 8.295 times more likely under the null hypothesis than the alternative (BF_{10} = .121). Thus we felt justified in subtracting experimenter from self-own IT for the cost-benefit analyses and subsequent one-sample t-tests.

Based on one-sample t-tests, for the congruent mapping, there was a significant overall self-bias effect in IT for initiating actions towards the image of the self-owned mug and away from the body, and correspondingly initiating actions away from the image of the Experimenter's mug and moving towards the body, t(20) = 2.885, p = .009, mean difference = 14.438, SD = 22.932, SEM = 5.004, lower range= 4.000 upper range = 24.877 Cohen's *d* = 0.629 (see figure 2 panel A).

Similarly, for the incongruent mapping, there was a significant overall self-bias effect in IT for initiating actions away from the image of the self-owned mug and moving towards the body, and correspondingly initiating actions towards the image of the Experimenter's mug thus moving away from the body, t(21) = 2.791, p = .011, mean = 12.548, SD= 24.921, SEM = 5.313, lower range = 3.199 upper range = 21.896 Cohen's *d* = 0.609 (see figure 2 panel A).

A t-test for congruent vs incongruent mapping was not significant ($M_{Congruent}$ = 14.438 $M_{Incongruent}$ = 12.548 SEM = 4.495, SEM = 5.004, equal variances not assumed, t(41) = .281, p = .780 lower range =-15.482 upper = 11.701. Bayesian analysis revealed that the data were 4.286 times more likely under the null hypothesis than the alternative (BF_{10} = 0.233). This suggests there is a self-owned bias effect for IT to the self-owned mug, regardless of whether the action is towards or away from the item.

FIGURE 2 HERE

Movement Duration (MD)

A t-test on approach versus avoid actions (that is, flexion versus extension) averaged over ownership status and congruence mappings showed that there was no overall difference in MD for the two types of movements ($M_{approach}$ = 281.440, M_{avoid} = 291.202, t(42) = 2.672, p = .011 SD = 23.953, SEM = 3.653, lower range= 2.390 upper range = 17.134). Bayesian analysis revealed that the data were 2.134 times more likely under the null (BF_{10} = 0.469). In line with the above analysis we subtracted experimenter from own MD for the cost-benefit analysis and subsequent one-sample t-tests.

Based on one-sample t-tests, for the congruent mapping, there was a significant self-bias effect for MD for executing actions towards the image of the self-owned mug, and away from the body and correspondingly executing an action away from the image of the Experimenter's mug and moving towards the body, t(20) = 2.774, p = .012, mean difference = 13.795, SD = 22.789, SEM = 4.493, lower range= 3.422 upper range = 24.169 Cohen's *d* = .620 (see figure 2 panel B).

For the incongruent mapping, there was no significant overall self-bias effect for MD for executing actions away from the image of the self-owned mug and moving towards the body, and correspondingly executing actions towards the image of the Experimenter's mug and moving away from the body, $t(21) = 1.113$, $p = .278$, mean difference = 5.912, SD= 24.921, SEM = 5.313, lower range = -16.961 upper range = 5.134. Bayesian analysis indicated that the data were 4.461 times more likely under the null hypothesis than the alternative ($BF_{10} = 0.224$). (see figure 2 panel B).

A t-test for congruent vs incongruent mapping was significant ($M_{Congruent} = -13.796$ SEM = 4.973, $M_{Incongruent} = 5.912$ SEM = 5.313, equal variances not assumed, $t(41) = 2.708$, $p = .010$ lower range = -34.405 upper range = -5.009, Cohen's $d = .423$ indicating that MD to the self-owned mug when making an avoid movement benefited performance compared with making an approach action to the self-owned mug.

In summary, there was a self-bias effect for initiating (IT) responses to self-owned mugs, but this was the case for both congruent and incongruent mappings, that is, for both approach and avoidance actions. There was also a self-bias effect for executing (MD) approach movements to self-owned mugs, that is, in the congruent mapping. In other words, the self-bias effect seems to be in responding to self-owned property in general, for both congruent and incongruent mappings.

This pattern of findings may indicate that responses to ownership for both approach and avoidance movements are generally speeded. Before we discuss this further, however, we need to consider the possibility that this lack of dissociation in responses between congruent and incongruent mappings is due to task requirements. Specifically, in Experiment 1 ownership was goal-relevant: participants needed to process ownership consciously to respond with an approach or avoidance movement. Button-press responses to consciously processed self-relevant items are faster than other-relevant items (Cunningham, Brady-Van den Bos, & Turk, 2011; Sui, Sun, He & Humphreys, 2012; Sui, Rothstein & Humphreys, 2013). Approach-avoidance directional differences, conversely, are reported in tasks where affective processing is unconscious (Chen & Bargh, 1999; Krieglmeyer, et al, 2010), and this conscious processing may have masked approach-avoidance differences. In Experiment 2 we altered task requirements, such that processing of ownership was implicit (unconscious), by asking participants to respond to a shape positioned on the mug's handle, rather than to the ownership of the mug

Experiment 2

Rather than responding based on ownership, in this experiment participants viewed their own or the Experimenter's mug very briefly to promote implicit registration of ownership. Then, they made movements in response to a triangle or square that appeared superimposed on the handle of an image of a mug.

If approach-avoidance systematic differences are automatic and elicited with implicit processing of ownership, then we should see a self-bias effect for responses in the congruent mapping for self-owned mugs (approach towards the self-owned mug on the monitors; avoid away from the experimenter-owned mug on the monitor; Seibt et al, 2008). It is possible that this will be the case for both IT and MD. Conversely, we should see a cost for responses in the incongruent mappings (avoid the self-owned mug on the monitor; approach the Experimenter-owned mug on the monitor). This will tell us if, overall, self-related information is privileged in implicit/automatic cognitive processing.

Method

Participants: Thirty-four Caucasian females (mean age = 19.21 years, SD = 4.36) who had not completed Experiment 1 volunteered for course credit and gave their consent to participate in the study, cleared by the University of Queensland School of Psychology ethics committee. They were born in Australia, and English was their first language. They were self-reportedly right-handed and had normal or corrected-to-normal vision.

Apparatus, Stimuli, Trials and Procedure: These were largely identical to Experiment 1, except for three differences. The first difference was that the mug appeared briefly (82 msec) before a small shape was superimposed on the handle. The second difference was that response direction was now mapped to the shape (triangle or square; height 2 cm, width 2 cm; see Figure 1 panel D) appearing on the handle of the mug. That is, half participants were instructed to move away from the body and press the button closest to the monitor if it was a triangle and move towards the body and away from the monitor when the shape was a square. The other half of the participants were given the opposite instruction.

The third difference was that mug ownership (Self, Experimenter) and movement direction- cue shape mapping was presented equally often in randomised order within each block. Thus, participants saw presentations of their mug with a triangle cue, their mug with square cue, the experimenter's mug with a triangle cue and the experimenter's mug with a square cue. The instruction to perform flexion or extension hand and arm movements to the triangle or square was counterbalanced across participants. For analysis, this was a repeated-measures design, with follow-up t-tests comparisons: we collapsed across shape categories, but divided compared across mug ownership (Self, Experimenter) and movement direction (approach, avoid). Thus, although ownership was implicit in this experiment, we derived the same congruent and incongruent mappings and self-bias values as for Experiment 1.

An instruction to “Get ready…” appeared centrally on the screen until the participant depressed the middle white button (“0”) with the index and thumb held together. At depression of this button, a blank black screen appeared for 1506 msec, followed by a centrally positioned fixation cross for 506 msec. At fixation cross offset, the mug appeared, and 82 msec after mug onset the shape appeared on the handle of the mug for 353 msec, at which point both mug and shape offset but a blank black screen remained for 2506 msec to allow sufficient time for participants to respond (all timings synchronised to the refresh rate; see Figure 1 panel D for sequence of trial events). Note that in this experiment, the image of the mug was displayed for 82 msec, then the shape appeared on the handle of the mug to trigger movement response. Initiation time was recorded from the onset of the shape.

The task consisted of 100 trials across 5 blocks (that is, 20 trials per block), with a brief rest between each block. Each mug (Self, Experimenter) was presented equally often, in randomised order. During the task, the Experimenter was seated unobtrusively behind a partition 1.5 metres to the left of the participant. In contrast to Experiment 1, IT and MD (in msec) were taken from onset of the shape on the handle of the mug to lifting of the “0” key (IT) and depression of “~” or “/” keys (MD).

Design: We calculated a self-bias effect for initiation time and movement duration of responses for Congruency and Ownership Status, as for Experiment 1. To re-cap, we defined congruent mapping as approaching the self-owned mug on the monitor and moving away from the body from the starting midpoint, and avoiding the Experimenter-owned mug on the monitor by moving the hand and arm towards the body and away from the monitor. The incongruent mapping was the reverse: avoiding the self-owned mug on the monitor by bringing the hand and arm towards the body from that midpoint, while approaching to the Experimenter-owned mug by moving the hand and arm towards the monitor. We conducted one-sample and independent samples t-tests on these values, as for Experiment 1. Positive values indicate a self-bias effect, while negative values indicate a bias away from the Self in responses. (Note: in the Supplementary data, we present a mixed-design analysis of the data).

Results and Discussion

Data Screening. As with experiment 1, individual trials were excluded if initiation time was faster that 150 msec or slower than 2000 msec, and we excluded data from two participants whose overall response accuracy was less than 80%. Two participants did not bring the mugs to the second session, but were able to describe their mug's design, hence their data were included in the analysis. Thus, the final number of included participants for this experiment was 32, 16 each for the congruent and incongruent mapping groups.

Average daily use of the mug ranged between 2.43 and 5.57 times per day (M = 3.66, SD = 1.06). At the end of the second session, participants reported that they liked their own mug more than the Experimenter's ($M_{Self\text{-}owned}$ = 5.9 range 2-7 and $M_{Experimenter\text{-}owned}$ = 4.6 range 4-7 respectively).

Initiation Time

A t-test on approach versus avoid actions (that is, extension versus flexion) averaged over ownership status showed that there was no overall difference in response time (IT) for the two types of movements ($M_{approach}$ = 473.665, M_{avoid} = 472.249 t(31) = .443, p = .661, SD = 18.102, SEM = 3.199, lower range = -7.943 upper range = 5.109). Bayesian analysis revealed that the data were 6.636 times more likely under the null (BF_{10} = 0.150). Thus we felt justified in subtracting experimenter from self-owned IT for the cost-benefit analyses and subsequent one-sample t-tests (Note that: in this experiment, the image of the mug was displayed for 82 msec, then the shape appeared on the handle of the mug. Participants initiated responses on appearance of the shape. Therefore we note that in comparison to experiment 1 IT appears inflated, because it includes mug display time). Based on one-sample t-tests, for congruent mapping of movements, there was no overall self-bias effect in IT for initiating actions towards the image of the self-owned mug and away from the body, and correspondingly initiating actions away from the image of the Experimenter's mug and moving towards the body t(15) = .133, p = .895, mean = .597, SD= 25.413, SEM = 4.492, lower range =-8.566 upper range = 9.759). Bayesian analysis revealed that the data were 7.237 times more likely under the null hypothesis (BF_{10} = 0.138). (see figure 3 panel A).

Similarly, in incongruent mapping, there was no overall self-bias effect in IT for initiating actions away from the image of the self-owned mug and moving towards the body, and correspondingly initiating actions towards the image of the Experimenter's mug thus moving away from the body, t(15) = .796, p = .432, mean = 3.429, SD =24.377, SEM = 4.309, lower range= -5.359 upper range = 12.218). Bayesian analysis revealed that the data were 5.375 times more likely under the null (BF_{10} = 0.186). (see figure 3 panel A).

A t-test for congruent vs incongruent mapping also was not significant ($M_{Congruent}$ = -.597 SEM = 4.492, $M_{Incongruent}$ = -3.4295 SEM = 4.309, t(31) = .443, p=.661 lower range =-15.885 upper range = 10.219. Bayesian analysis indicated that the data were 6.636 times more likely under the null hypothesis than the alternative (BF_{10} = 0.151).

FIGURE 3 HERE

Movement Duration

A t-test on approach versus avoid actions (that is, flexion versus extension) averaged over ownership status showed that there was no overall difference in MD for the two types of movements ($M_{approach}$= 344.64, SD = 80.991, M_{avoid} = 335.464 SD = 71.093, t(31) = 1.389, p = .175, SD = 37.454, SEM = 6.621, lower range = -22.703 upper range = 4. 304). Bayesian analysis showed a Bayes factor of 2.927, indicating inconclusive results but more support for the null (BF_{10} = .342).

Based on one-sample t-tests, for congruent mapping of movements, there was no overall self-bias effect for MD for executing actions towards the image of the self-owned mug, and away from the body, and correspondingly executing an action away from the image of the Experimenter's mug and moving towards the body t(15) = .894, p = .378, mean = -7.179, SD= 45.422, SEM = 8.029, lower range = -23.555 upper range = 9.198). Bayesian analysis revealed that the data were 4.967 times more likely under the null (BF_{10} = 0.201). (see figure 3 panel B).

Similarly, for incongruent mapping of movements, there was no overall self-bias effect for MD for executing actions away from the image of the self-owned mug and moving towards the body, and correspondingly executing actions towards the image of the Experimenter's mug and moving away from the body t(15) = .133, p = .164, mean = 11.221, SD =44.521, SEM = 7.871, lower range= -4.831 upper range = 27.273.). Bayesian analysis showed a Bayes factor of 2.794 in favour of the null which would be conventionally considered inconclusive (BF_{10} = 0.358). (see figure 3 panel B).

A t-test for congruent vs incongruent mapping also was not significant ($M_{Congruent}$ = 7.179 SEM = 8.029, $M_{Incongruent}$ = -11.221 SEM = 7.871, t(31) = .443, p= .175 lower range =-

45.406 upper range = 8.601. Bayesian analysis indicated that the data were 2.927 times more likely under the null hypothesis than the alternative ($BF_{10} = 0.342$).

The results from Experiment 2 indicate that ownership status (Self, Experimenter) did not influence congruent or incongruent actions when ownership was not goal-relevant, that is, was processed implicitly. There was no overall automatic benefit for response times or movement duration associated with approaching self-owned mugs and avoiding experimenter-owned ones. Similarly, there was no cost associated with approaching experimenter-owned mugs and avoiding self-owned ones.

General Discussion

In these experiments, we reasoned that the self-ownership typically results in a positive affective evaluation of the item. In turn, following on from previous Approach-Avoidance Task (AAT) literature, this should result in a systematic self-bias effect in approach (towards the item) movements, compared with avoidance (away from the item) movements, while the opposite should hold for an experimenter-owned item. Participants were gifted mugs which they used for 6 to 11 days. They then returned to the lab and completed an approach-avoidance task, moving their hand and arm towards or away from images of their own of the experimenter's mug. In the congruent mapping in Experiment 1, participants were instructed to move towards (approach) the item if it was their own mug, and move away from (avoid) the item and towards themselves if it was the Experimenter's mug. In the incongruent mapping, another group of participants performed the opposite actions. Thus, processing of the ownership of the item was conscious and goal-relevant, with an item-based frame of reference.

There was a self-bias effect for Initiation Time (IT) to the self-owned mug, for both congruent and incongruent mappings, and for Movement Duration (MD) in the congruent mapping. That is, initiation and movement duration were speeded to self-owned mugs, regardless of the approach-avoid direction of the movement. This indicates there was no systematic difference in movement planning or execution for approach and avoidance movements based on consciously processed ownership.

In Experiment 2, participants responded to a shape appearing on the centrally positioned handle of the mug. Thus, while congruent and incongruent mappings were the same as Experiment 1, processing of the ownership of the item was implicit and not goal-relevant. This time, there was no evidence for a self-bias effect for responses to the Self-owned mug for either the congruent or incongruent mapping, in either IT or MD.

These findings raise three issues. First, responses to self-owned items are indeed privileged overall compared with responses to other-owned items. This is consistent with previous investigations of self-reference effects using button-press response tasks rather than arm flexion- extension (for example, Kuiper & Rogers, 1979; experiment 2). There was no dissociation between congruent and incongruent mappings, however, and specifically there was no indication that approach movements to self-owned mugs benefited in comparison with avoidance movements. Second, there is no firm evidence for a dissociation between planning and execution (IT vs MD) in responses to self- versus experimenter-owned mugs. Finally, findings of this task indicate that to influence behaviour ownership processing needs to be conscious and goal-relevant.

Responses to self-owned items show an overall initiation and movement duration self-bias effect, but not specifically for approach movements

In button-press tasks not involving flexion-extension movements, responses to self-referenced items are reportedly speeded. For example, Cunningham et al (2008; 2011) showed that accuracy was greater and responses faster for recognising self- compared with other-owned items. Sui and Humphreys (Humphreys & Sui, 2015a; Sui et al, 2012, 2013) instructed participants that one of three simple shapes (circle, square, triangle) referred to themselves, their friend or a stranger. Subsequently, each shape appeared along with the word "self", "friend" or "stranger", and participants indicated via button-press response whether the shape-name pair was correct or incorrect. Responses were faster when the pairing contained "self" information (Humphreys & Sui, 2015a). Consistent with the literature on self-prioritization we show that the processing of self-owned objects is privileged as indexed by initiation time. It is unclear whether response selection subsequently enhances this self-prioritization advantage because there was no evidence of modulation with reference to approach or avoidance trials. We also extend upon the self-prioritization literature by showing that self-prioritisation also applies to movement execution which could indicate that ownership influences online motor planning and execution.

Although in Experiment 1 responses to self-owned items were faster than to experimenter-owned ones, there was no further benefit for approaching the self-owned item and avoiding the Experimenter-owned item, or the reverse mapping. This is in contrast to expectations that there should be a benefit for responses in the congruent mapping, that is, when approach movements were made towards self-owned mugs and avoidance movements away from the experimenter-owned mugs. If one assumes self is typically construed as positive then the absence of a congruency effect is inconsistent with reports of approach-avoidance responses in affective evaluation (good – bad) tasks (Seibt et al, 2008;

but also Chen & Bargh, 1999; Eder & Hommel, 2013; Krieglmeyer, et al, 2010). Regarding ownership specifically, however, Truong et al (2016) also do not report clear ownership X movement direction interactions for initiation time or movement duration. It may be that ownership judgments are not comparable to affective evaluation: ownership is a category judgement (as opposed to a subjective evaluation) and thus clearly defined (either self- or other-owned) though negotiable. An item belongs to no-one, to the self or to another person(s), unless ownership is allocated or transferred accordingly. This conceptualisation of ownership is evident in very early childhood (for example, Gelman, Manczak, & Noles, 2012; Kanngiesser, Gjersoe, & Hood, 2010). Thus ownership is a concept that is developed even before language and semantics become highly elaborated (Hay, 2006; Saylor, Ganea & Vazquez, 2011).

Recall that in affective evaluation paradigms (described in greater detail in the Introduction) participants responded to positive and negative items by making either flexion or extension movements, away from or towards the self (Chen & Bargh, 1999; Eder & Hommel, 2013; Koch, Holland, & Knippenberg, 2008; Krieglmeyer, et al, 2010; Lavender & Hommel, 2007; Seibt et al, 2008; van Dantzig, Pecher, & Zwaan, 2008). Affective evaluation, however, engages different cognitive processes, and can be superimposed on to ownership. Indeed, it is a common experience that we own an item we do not like very much, and we like items that do not belong to us until we purchase or otherwise acquire them – the retail sector of the economy is based on this. More importantly, previously neutral items *become* more positive by being allocated to the self, that is, becoming owned even in a virtual capacity, as indicated by the mere ownership and endowment effects (Kahneman et al., 1991). Other-owned or unowned items may not necessarily be rated as negative, however; they are only relatively less positive than the self-owned items. Therefore, the visuomotor system may engage with owned items in a fundamentally different manner to affectively valenced stimuli because the salient factor is ownership rather than valence.

It is possible that hand-based responses to ownership are faster than responses based on affective evaluations, reducing the likelihood that clear approach-avoidance differences would emerge. We note that our latencies are comparable to those reported by Truong et al (2016) for ownership. Conversely, the affective evaluation latencies (comparable to our initiation time) reported by Chen and Bargh (1999) were in the order of up to approximately 2000 msec in Experiment 1, and about 1200msec in the Rotteveel et al (2015) attempted replication. RTs were approximately 690 msec in Experiment 2 of Chen and Bargh, and about 570msec in the Rotteveel et al (2015) attempted replication. Seibt et al (2008; experiment 3) report latencies of between 720 and 820msec with an item-based frame of reference. These are all considerably longer than the IT reported here. The initiation time latencies reported by Markman and Brendl (2005) are also considerably longer than ours. Conversely, release times for arm flexions and extensions reported by Rotteveel and Phaf (2004) for evaluation of emotional faces are about 500 msec.

One methodological issue is that in this task there were only two items to base this decision, compared with the multiple words of Chen and Bargh (1999) or virtual shopping items of Truong et al (2016). In the surprise recall tasks of Cunningham, Turk et al which involve about 144 previously presented self- or other-owned items, however, median response times were rather lower than Chen and Bargh, at approximately 1000 msec or less (Cunningham, Turk, Macdonald & Macrae, 2008). Although it is difficult to draw conclusions from this essentially different recognition task, it does suggest that including multiple items may slow responses compared with only two in the current task.

As regards the extent to which the self-owned mug was liked, there is some indication in Constable et al (2014, experiment 3) that preference (that is, liking but not owning) for an item is associated with subtly different embodied behaviours (motor output) than ownership. Constable et al (2014) had participants select from an array of six differently-painted mugs not painted by the participant. They were instructed that they would use this mug for a short period, while completing the lifting task. The experimenter selected another mug from the same array. Using this preferred but unowned mug, there was a trend for participants to position their selected mug closer to themselves at the peak of the lifting movement, compared with the mug selected by the experimenter. Thus there may well be an overlap in the way behaviour manifests in terms of preference and ownership. A possible paradigm for future studies may involve participants bringing in a certain number and type of already-owned items.

Responses to self-owned items impact planning and execution of movements

Previous studies have typically reported on initiation response times (Chen & Bargh, 1999; Koch et al, 2008; Krieglmeyer, et al, 2010; Seibt et al, 2008; but see Truong et al, 2016), corresponding to the planning of the movement (Pratt & Abrams, 1994). Here, we reported on IT and MD, corresponding to response selection and execution (Pratt & Abrams, 1994). We did not observe a clear dissociation between IT and MD in Experiment 1. There was an overall self-bias effect in IT (that is, processes up to and including movement planning) for approach and avoidance responses to self-owned mugs, and a benefit in MD (movement execution) to self-owned mugs for approach movements. In Experiment 2, there was no self-bias effect for either IT or MD.

Truong et al (2016) also recorded IT and MD (reaction and reach time). The reported pattern of findings for their two parameters was inconsistent across relevant experiments. In Experiment 1, IT trended towards being faster, and MD was significantly faster to self-owned items. In Experiment 3 there was no main effect for ownership or movement direction in IT, but MD was faster for self- than other-owned items, and faster for away (avoidance) movements (Truong et al. 2016).

Thus at this point, the parsimonious interpretation is that, under the type of conditions of the current Experiment 1, where ownership is consciously processed and is goal relevant (see below), both initiation and execution of movement are susceptible to alteration depending on ownership status.

Conscious, goal-relevant processing of ownership

In previous tasks showing speeded approach (compared with avoid) responses, affect evaluation (like-dislike, good-bad) is goal-relevant and requires that participants consciously process the items. Similarly, in Truong et al (2016) and the present Experiment 1, processing of self- versus experimenter-owned items was also conscious and goal-relevant, showing a self-bias for self-owned items. In other research reporting an advantage for responses to self-referenced items, the responses are button-presses, not involving approach-avoidance (flexion-extension) movements (Cunningham et al, 2008; Sui et al, 2012). In the Cunningham et al recognition memory tasks, ownership is explicitly processed in the initial basket allocation part of the paradigm (Cunningham et al, 2008, 2011), although it is not goal-relevant or explicit in the subsequent memory task. The self-other shape-name pairs of the Sui and Humphreys paradigm (Humphreys & Sui, 2015a; Sui et al, 2012, 2013) are also explicitly processed, and owned mugs only show a benefit in information processing when explicitly processed (Constable, Welsh, Huffman & Pratt, 2019).

When cognitive evaluation is unconscious and not referenced to self versus other distinctions, there is evidence that flexion movements are associated with faster responses to positive items, while extensions are associated with faster responses to negative ones (Chen & Bargh, 1999, experiment 2), although Rotteveel et al (2015) did not replicate these findings. Moreover, Rameson, Satpute and Lieberman (2010) showed that similar brain areas (including ventromedial and medial prefrontal cortex, and amygdala) activate during both explicit and implicit processing of self-relevant images. Conversely, in the present Experiment 2, when ownership evaluation was implicit and thus and goal-irrelevant, there were no evident differences in responses to self- versus experimenter-owned mugs, for either approach or avoid movements. Likewise, Rotteveel and Phaf (2004, experiment 2) found that when participants were categorising face stimuli on the basis of gender rather than emotion, there were no significant differences between flexion and extension response times. This suggests that arm flexion and extension (corresponding to approach and avoidance) may not be clearly an automatic, non-conscious response to evaluations of affect, similar to our conclusions regarding ownership. In the framework of Strack and colleagues (Körner & Strack, 2018; Strack & Deutsch, 2004) we speculate that the current findings are consistent with reflective rather than impulsive processes, because they indicate involvement of conscious processing. What is clear is that instructions and task requirements may have a major consequence for task performance.

In these experiments we attempted to hold constant familiarity and usage of the items, as well as visual and physical (colour, design) and volumetric (shape, size, weight) features. One line of future work is asking participants to provide images of their own 'loved' mugs or other precious items for use in the experiment. This would mean that positive evaluation of the mug has become strongly associated with the mug (Greenwald, Banaji, Rudman, Farnham, Nosek, & Mellott, 2002), and automatic. Under these circumstances a difference in approach-avoid movements may be detected even when participants are responding to the shape on the handle rather than to the ownership.

Future work could also address the debate about what approach-avoidance movement differences achieve in terms of the interactions between self and information in the environment. Neumann and Strack (2000) had participants respond by finger button-press but not flexion-extension of the arm to positive or negative words on a monitor. The words were presented within concentric circles that appeared to loom or recede, giving the sensation of approaching or moving away. Button-press responses were faster to positive words that appeared to be looming (approaching) and to negative words that appeared to be receding. This suggests that the systematic differences in response times may not be due to flexion-extension 'pushing away' and 'bringing towards' of negative and positive information, but may indicate an adjustment of the distance of valenced information from the self.

In summary, we found there is a self-bias effect for response times to self- compared with other-owned items. There is no specific bias, however, for congruent action mappings (approaching the self-owned items while avoiding experimenter-owned ones), over incongruent mappings. We speculate, therefore, that processing ownership status is not comparable to affective evaluation. Moreover, this pattern was evident only when ownership was consciously processed and goal-relevant, rather than implicit. Finally, under these task requirements, there was no evident dissociation between initiation and movement duration times.

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Conflict of Interest

The authors declare they have no conflicts of interest.

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Figure legends

<u>Figure 1:</u> Panel A: Apparatus (keyboard and computer monitor) and distances between eyes, computer monitor, and keyboard response buttons for Experiments 1 and 2. Panel B: image of the actual apparatus. Panels C and D: trial event sequences for Experiments 1 and 2 respectively.

<u>Figure 2:</u> Self-bias values (with standard error bars), Experiment 1 (responding to mug ownership), for Initiation Time (panel A). Values for the self-bias were significantly different from 0 in both the congruent and incongruent approach-avoidance mappings ($p = .009$ and $p = .011$ respectively). For Movement Duration (panel B), values for the self-bias (with standard error bars) were significantly different from 0 in the congruent mapping ($p = .012$), but not the congruent approach-avoidance mapping ($p = .278$).

<u>Figure 3:</u> Self-bias values (with standard error bars), Experiment 2 (responding to a shape on the mug handle), for Initiation Time (panel A). Values for the Self-bias were not significantly different from 0 for either the congruent or incongruent approach-avoidance mappings ($p = .895$ and $p = .432$ respectively). For Movement Duration (panel B), values for the self-bias (with standard error bars) were also not significantly different from 0 for either the congruent or incongruent approach-avoidance mappings ($p = .378$ and $p = .164$ respectively).