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Editorial: A review of self-processing biases in cognition

Sheila J. Cunningham [a] and David J. Turk[b]

[a]Division of Psychology, Abertay University, Dundee, UK; [b]School of Experimental Psychology, University of Bristol, Bristol, UK

It has long been established that when cues in the environment are perceived to have relevance to self (e.g., hearing your own name across a crowded room, seeing your own face in an array), these cues are difficult to ignore (Bargh, 1982; Brédart, Delchambre, & Laureys, 2006). Indeed, stimuli associated with self are among the most evocative of environmental cues and give rise to significant memory advantages (Conway & Dewhurst, 1995; Rogers, Kuiper, & Kirker, 1977; Symons & Johnson, 1997). While the attentional and memorial effects of self-relevant cues have been discussed in the psychological literature for decades, there has been a recent resurgence of research interest in self-processing biases more widely. This has followed demonstrations that the effects of the self in cognition are more wide ranging and influential than previously thought. The goal of this *Quarterly Journal of Experimental Psychology* special issue is to share recent developments in research on self-processing biases. We present new studies examining the cognitive consequences of self-relevance, before considering conditions of their application and the extent to which they can apply outside of the conventional conceptualization of self.

Background: The self in cognition

The attention-capturing properties of the self were among the earliest robust findings of cognitive psychology, being established in dichotic listening tasks by Cherry (1953) and Moray (1959). In these early experiments and a multitude of subsequent studies, it has been shown that when task-irrelevant self-cues (e.g., one's own name, face, hometown, etc.) are presented aurally or visually, attention tends to be drawn towards them, sometimes to the detriment of concurrent tasks (e.g., Alexopoulos, Muller, Ric, & Marendaz, 2012; Bargh, 1982; Brédart et al., 2006; Tacikowski & Nowicka, 2010). This pattern is argued to reflect the functional value of self-cues: If a cue in the environment concerns oneself directly, then there is an adaptive advantage in having systems that ensure the cue is not ignored (Cunningham, 2016; Cunningham, Brady-Van den, Bos, Gill, & Turk, 2013; Klein, 2012).

A separate line of inquiry has focused on the memorial advantages associated with self-relevant information, known as the self reference effect (SRE) on memory. The SRE describes the tendency for information encoded with reference to self to be better remembered than information encoded about other people, or at a semantic level (Rogers et al., 1977; Symons & Johnson, 1997). Typically, this pattern is assessed with a trait evaluation paradigm in which people are asked whether a series of trait attributes is true of themselves or a well-known other-referent (e.g., "*Are you* [*Is Brad Pitt*] *calm?*"), fits a semantic category (e.g., "*Is 'calm' a positive word?*") or matches a superficial processing criteria (e.g., "*Is 'calm' written in upper or lower case?*"). A range of recognition, recall, and source memory measures consistently show that processing the attribute with reference to the self results in a robust memory advantage for the trait word, relative to the other encoding conditions (for meta-analytic review, see Symons & Johnson, 1997).

Theoretical explanations for the SRE have focused on the self-memory system, the extensive body of self-knowledge stored in long-term memory that has the capacity to scaffold incoming information to which it is relevant (Conway & Dewhurst, 1995; Klein & Kihlstrom, 1986; Klein & Loftus, 1988; Symons & Johnson, 1997). The self-memory system comprises a

CONTACT Sheila J. Cunningham s.cunningham@abertay.ac.uk Division of Psychology, Abertay University, Bell Street, Dundee DD1 1HG, UK

bi-directional partnership between the working self and the autobiographical knowledge base (Conway, 2005; Conway & Pleydell-Pearce, 2000). The retention of information is dependent on the goal hierarchy of the working self—when incoming information is consistent with goals, either long term (e.g., coherent identity maintenance) or short term (e.g., pay a bill), then it is likely to be remembered. If it is not goal-relevant it is unlikely to be subsequently retrievable. In terms of self-referent processing, the need to monitor for self-relevant information could be seen as a perpetual goal of the working self, so self-related information should be more memorable. Importantly, this would lead to the prediction that SREs should not just be found when information is being scaffolded by autobiographical knowledge, such as that accessed in the trait evaluation task. Rather, SREs should be found for any information encoded in association with self; items that are relevant to self are important, so should not be forgotten (see also Bluck, 2003).

In line with this reasoning, more recent research has moved away from the trait evaluation paradigm through which the SRE was originally established, to more naturalistic ways of associating the self with external stimuli. One productive method utilized in this new wave of research has been to create associations through ownership. When one owns an object or stimulus item, that item is processed with the same attentional and memorial biases as those that characterize the processing of other self-relevant stimuli (Cunningham, Turk, MacDonald, & Macrae, 2008; van den Bos, Cunningham, & Turk, 2010). From a cognitive perspective, the self is "extended" to encompass owned objects (Belk, 1988, 2013). Developing the ownership paradigm, Cunningham et al. (2008) asked participants to imagine they owned a series of items sorted into a shopping basket, with another participant "owning" a similar set of items. A subsequent recognition memory test showed that self-owned items were more likely to be remembered than those owned by the other person, even if the ownership was completely arbitrary and imagined. In other words, even though participants knew the ownership was not real, the process of encoding these items in self-relevant context gave rise to enhanced encoding. This suggests that the SRE extends beyond the trait evaluation paradigm to everyday connections between the self and external stimuli.

Supporting this position, neuroimaging studies examining the cortical network activated by ownership reveal key overlaps with areas associated with self-processing. Turk, van Bussel, Waiter, and Macrae (2011) showed that when participants were processing "self-owned" items in the shopping task, there was increased activation in the medial prefrontal cortex (mPFC) relative to when "other-owned" items were being processed. Activation in this area predicted the magnitude of the memory advantage for self-owned items. This pattern corresponds with findings from the trait evaluation paradigm, in which self-evaluation trials elicit higher mPFC activation than those evaluating other people (Kelley et al., 2002), and the level of mPFC activation predicts the subsequent self-memory advantage (Macrae, Moran, Heatherton, Banfield, & Kelley, 2004). Further, event-related potential (ERP) research on the ownership effect showed that perception of the self-ownership cue triggered automatic attentional responses including the capture of visuospatial attention (Turk, van Bussel, Brebner, et al., 2011; see also Gray, Ambady, Lowenthal, & Deldin, 2004), mirroring other self-processing findings (e.g., Brédart et al., 2006; Sui, Zhu, & Han, 2006). As these comparisons illustrate, one value of the ownership paradigm is to highlight the link between the cognitive consequences of minimal self-item associations and the memory effects associated with the traditional SRE elicited by self-evaluation, confirming that SREs are not limited to encoding contexts in which self-knowledge is linked to incoming information. Rather, self-cues trigger a range of processing biases that impact on memory, which have been the primary focus of the new wave of studies on self-processing in the past 10 years.

A highly influential example of this new wave of studies is a line of work exploring the effect of self-biases that impact very early in the processing stream on initial item perception. Sui, He, and Humphreys (2012) showed that when participants learn shape–name associations (e.g., *you are the triangle, your friend is the circle, a stranger is the square*), they subsequently perceive shape–name pairs involving self more quickly, and their recognition is less affected by perceptual blurring than the friend- and stranger-associated shapes. The self-associations are also formed more easily and are more difficult to break in subsequent tasks (Wang, Humphreys, & Sui, 2016).

Based on evidence including neural responses to the shape-association task, Humphreys and Sui (2016) have proposed that self-relevant stimuli activate a neural "self-attention network" (SAN), with perception of self-relevant stimuli triggering responses in

areas such as ventromedial prefrontal cortex (vmPFC) and the left posterior superior temporal sulcus (LpSTS). Humphreys and Sui suggest that the vmPFC's robust link with self-referential processing (Kelley et al., 2002; Macrae et al., 2004; Northoff et al., 2006) is a result of its role in cascading information that stimuli are self-relevant to the LpSTS attentional system, which then elicits attentional and perceptual biases. The SAN is based on the new line of self-bias research in which methodologies like the ownership paradigm and shape association task have developed our understanding of the multifarious ways in which the self influences cognition. The articles that follow continue this approach, using these new methodologies and other similar approaches to shed new light on the form, extent, and limitations of self-biases in cognition.

The current issue

As discussed above, one of the key features of the recent resurgence in self-processing biases is a focus on low-level, automatic responses to cues of self-relevance, particularly attention and perception. While these biases are clearly fundamental to the effects of the self on cognition, a number of papers in the current issue deal with a third automatic response to self-relevance: increases in positive bias. It is widely accepted that self-processing elicits a positivity bias, such that self-esteem is protected by a rose-tinted perspective in self-evaluations and autobiographical memory (D'Argembeau & van der Linden, 2008; Walker, Skowronski, & Thompson, 2003). This also extends to owned objects, which are perceived to have more positive characteristics than similar objects owned by others (the "mere ownership" effect; Beggan, 1992).

One example of the positive skewing of self-owned items is the endowment effect, the tendency to perceive self-owned items as having heightened monetary value (Kahneman, Knetsch, & Thaler, 1990; Krigolson, Hassall, Balcom, & Turk, 2013; Morewedge & Giblin, 2015; Thaler, 1980). Hassall, Silver, Turk, and Krigolson (2016) explored the neural correlates of the endowment effect by recording electroencephalography (EEG) data while participants were gambling in a task that assigned rewards and losses either for the participant themselves or for another person. The magnitude of rewards was varied to assess whether neural sensitivity to reward was predicated on self-relevance. ERPs showed that this was the case—there was differential medial frontal activation for high and low rewards when gambling for self, but not when gambling for another. Providing further depth to Humphreys and Sui's (2016) SAN proposal, this suggested that the self-processing biases linked to mPFC activation may not be limited to attention. Rather, items associated with self also elicit affective responses linked to reward circuitry that may also impact on subsequent processing.

The affective enhancement of self-relevant (self-owned) items was explored in a very different context by Gregg, Mahadevan, and Sedikides (2017). In self-processing paradigms, the enhancing effects of ownership are typically explored by assigning concrete objects to self and others (Cunningham, Brebner, Quinn, & Turk, 2014; Cunningham et al., 2008). However, Gregg et al. explored whether mere ownership effects could be extended to abstract constructs, testing the processing of *ideas* assigned to participants. They created an encoding context in which participants formed opinions about the validity of theories proposed to explain fantasy alien behaviour. For some participants, these theories were associated with self (*"You have a theory, based on . . . "*) whereas others had theories associated with an unknown person (*"Alex has a theory, based on . . . "*). Participants' judgements of the likelihood that each statement was true showed that self-owned theories were more likely to be endorsed. Gregg et al. suggest that this spontaneous preference for own theories (or "*SPOT*" effect) reflects both an inherent confirmation bias and mere ownership effect, leading to enhancement of abstract information associated with self. Again this bias has an affective quality—rather than simply attracting attention, the "self-owned" ideas were subject to a positivity bias.

Looking at the links between positive bias and self-processing in more depth, Stolte, Humphreys, Yankouskaya, and Sui (2017) amended Sui et al.'s (2012) shape task to distinguish between positive processing and self as sources of bias. They compared the same participants' performance on two versions of the task—a standard version in which shapes were paired with self, friend, or stranger labels, and an emotional version in which the shapes were paired with sad, neutral, or happy faces. A combined analysis of reaction times in the two versions revealed that while there was a significant self-bias and positive bias (i.e., faster reaction times, RTs, to shapes associated with self and with happy faces, respectively), the level of bias did not correlate at an individual level. This suggests that the two biases are

independent from one another, and that the cognitive influence of the self is not a direct result of the positivity bias associated with self-relevant stimuli.

Despite this evidence that affective biases towards self-referential stimuli impact on automatic processing, there may be limits to the extent that positive biases are consciously expressed. Shi, Sedikides, Cai, Liu, and Yang (2017) show that priming constructs whose influence runs counter to that of the self can modulate self-bias. They tested Chinese participants who had been primed with a culturally relevant trait of modesty (or a control trait, punctuality). Reaction times to self-descriptiveness judgements showed that participants in both conditions were faster to endorse positive characteristics than negative characteristics. However, there was evidence of modulation in the conscious endorsement decisions, in that participants primed with modesty tended to give more negative self-evaluations, with less endorsement of positive traits than those in the control condition. Participants modulated the positivity of their projected self-image, even though their reaction time data were consistent with the typical self-bias. This modulation is interesting given the recent increase in understanding of cultural variation in the proclivity of self-biases. Most research is conducted on participants from individualistic cultures such as the North America and Europe, for whom self-biases seem automatic. However, responses such as increased attention to self-cues and retention in memory of stimuli associated with self can be modulated by immersion in collectivist cultures such as China (Markus & Kitayama, 2010; Sparks, Cunningham, & Kritikos, 2016; Zhu, Zhang, Fan, & Han, 2007). Shi et al.'s findings are consistent with the notion that self-biases can be attenuated if they are inconsistent with activated goals like cultural values.

Flexibility of self-biases

As cultural variation indicates, there is a degree of flexibility in the extent to which self-biases are likely to influence cognition. Given the automaticity of the processes activated (e.g., perceptual and attentional biases conceptualized in the SAN, positive affective biases discussed above), it seems rational to predict that self-cues activate the processes regardless of task relevance (Turk, Cunningham, & Macrae, 2008). However, as with most processing biases, there seems to be a degree of contextual weighting whereby tasks in which self-relevance is consistent with goals or task demands elicit higher degrees of self-bias than those in which referent cues are not relevant. This was neatly demonstrated by Lui and Sui (2016), who contrasted response latency in the shape-matching task under conditions of varying self-relevance. In Lui and Sui's first experiment, following the label–shape matching training (i.e., learning whether each shape matches self, friend, or stranger) participants were presented with global shape outlines formed of contrasting smaller local shapes, such as a global triangle composed of local squares. Perceptual salience was also manipulated by presenting either blurred mono-coloured shapes (providing global perceptual salience) or clear, bi-coloured small shapes (giving rise to local perceptual salience). Response latencies showed that both perceptual salience and social salience (i.e., whether the shape was associated with self, friend, or stranger) influenced cognition, with global and self-referent discriminations eliciting fastest RTs. However, a second experiment showed that when the task-relevance of social salience was eliminated by changing the shape–label matching task to a simple shape discrimination task, RTs were only influenced by perceptual salience. In this case, the recently learned association between shape and self was not sufficient to interfere with performance when the association was not task relevant. This suggests that when social salience is low, the potentially distracting effects of self-referential processing biases can be modulated.

This contextual modulation is consistent with a conceptualization in which self-processing biases are a default position, whose operation is only dampened when task demands can affect an inhibiting response (e.g., see Devue & Brédart, 2009). Supporting this position, Mattan, Quinn, Acaster, Jennings, and Rotshtein (2017) contrasted the abilities of young and older adults to suppress inappropriate self-prioritization in a perspective task. Mattan et al. asked older (M_{age} 71 years) and younger (M_{age} 19 years) participants to take either a first-person or a third-person perspective of an avatar associated with self or another, to report the number of dots visible from that perspective. Consistent with previous research (Mattan, Quinn, Apperly, Sui, & Rotshtein, 2015), Mattan et al. found an advantage for the self-avatar over the other avatar, and for first-person over third-person perspectives. However, an interesting age difference emerged in that older participants showed a greater self-advantage, regardless of other manipulations. The egocentricity of older adults reflects the default position of

a general self-prioritizing processing bias. In line with the decline in cognitive flexibility in this age group, however (e.g., Dempster, 1992; Raz, Gunning-Dixon, Head, Dupuis, & Acker, 1998; van der Linden, Brédart, & Beerten, 1994), they were less able than the younger group to suppress self-bias when it interfered with task performance.

The proposal that self-processing biases are the default position echoes the widely recognized "default network" (Raichle et al., 2001; Shulman et al., 1997), the resting cognitive state strongly associated with self-referencing (Kelley et al., 2002; Moran, Kelley, & Heatherton, 2013). Neuroimaging studies suggest that when participants are not occupied in task-specific processing (e.g., while waiting for a task to begin, or while mind wandering), activation in the mPFC is similar to the level associated with self-referencing (i.e., higher than the activation elicited while processing other people). During this time, thought-probes suggest that participants tend to be engaged in self-reflection, such as rumination or preparation for future events (for review see Smallwood & Schooler, 2006). Thus it is argued that the default cognitive state (i.e., the contents of cognition in the absence of contrary task demands) is focused on self (Kelley et al., 2002).

One consequence of the relationship between self-focus and the default mode is that priming the self results in more future-thinking-based mind wandering, impacting upon performance on tasks that require sustained attention (Smallwood et al., 2011). Mind-wandering paradigms assess failures of the suppression of the system that should keep participants on task, detecting when attention wanders back to default processing (Smallwood & Schooler, 2006). To assess the efficacy of strategies to counter mind wandering, Sanders, Wang, Schooler, and Smallwood (2017) primed participants with either self or non-self, before presenting a reading comprehension task to be completed. External prompts or an internal monitoring instruction provided reminders to stay on task. Sanders et al. found that the self-primes increased levels of mind wandering, but this could be successfully countered by internal monitoring to stay on task. However, the cost of this effortful monitoring reduced reading comprehension performance. These findings are consistent with the idea that mind wandering serves a *current concerns* hypothesis (Klinger, 2009, 2013) in that the self-prime creates a context in which mind wandering is appropriate, so suppressing this becomes an effortful task that can detract from concurrent processing.

Mind wandering is a goal-dependent self-bias that may play a very functional role in personal preparation (Baird, Smallwood, & Schooler, 2011; Smallwood & Schooler, 2006). Mental rehearsal and preparation for upcoming situations are self-referent pre-occupations, but the content of self-reflection may also reflect other self-goals such as identity stability. While we experience complex and contradictory events, our recollections tend to err on the side of coherence and identity stability. Linking to the default network purpose, Conway (2005) argues that the working self is a dynamic system designed to ensure that information relevant to current goals is preferentially accessed. Thus the contents of both mind wandering and directed self-reflection should reflect the identity-supporting organization of access to information within the self-memory system. Testing the importance of this organization, Rathbone and Moulin (2017) explored participants' ability to switch between time periods in autobiographical recall. Participants were asked to list autobiographical memories in response to identity statement cues that were either similar (e.g., "I am active"/"I am a runner") or contradictory (e.g., "I am competitive"/"I am caring"), within a time limit. Memory production data showed that switching between contradictory statement pairs had an inhibitory effect, with fewer memories being retrieved within the time limit relative to those retrieved for similar statement pairs. This re-affirms the hierarchical structure of the autobiographical memory system, which functions to maintain a stable self-image as well as allowing goal-dependent retrieval.

The flexibility at all levels of self-processing, from perception and perspective taking to accessing identity information, speaks to the complexity and dynamism of the self-processing system. While self-cues can be considered binary in the sense that they are either present or absent, the self-processing system is much more analogue; there is a perpetual tendency for self-cues to attract additional processing even if this distracts from current goals, but nonetheless the degree to which self-biases influence subsequent processing and access to memories does vary according to current task demands.

Extending the self?

The flexibility of self-processing biases covers not just the attenuation of their influence, but also the extent to which they can be extended beyond the self (Belk,

1998; Cunningham et al., 2008). Thus self-biases can encompass external objects (e.g., ownership and endowment effects) and even other people, such that individuals who are close to self (e.g., mother, best friend) produce attenuated SREs. Specifically, patterns of performance in memory, perception, and attention for cues of close others tend to be somewhat lower than those for self, but higher than those for strangers (Bower & Gilligan, 1979; Sui et al., 2012). This may be a result of two factors. First, there is a greater knowledge structure associated with close others (e.g., one is likely to have more rich and detailed information concerning one's mother than Brad Pitt), so consideration of close others can be richly encoded and organized within an existing structure (for review see Symons & Johnson, 1997). Secondly, close others may also be priority cues and elicit attentional and affective processing biases, although to a lesser degree than self (Sui et al., 2012).

Disentangling these factors is difficult because other referents tend to elicit both knowledge and affect, but Allan, Morson, Dixon, Martin, and Cunningham (2017) adopted the novel approach of creating a referent for whom self had knowledge but no affective ties. Specifically, participants processed a stranger who was very like themselves (a "similar other") and a stranger who was very different (a "dissimilar other"). Allan et al. reasoned that participants could access a relatively high quantity of knowledge about the similar other through simulation (a process that activates self-processing areas in the brain—Benoit, Gilbert, Volle, & Burgess, 2010), but not the dissimilar other. In a modified ownership paradigm, participants chose objects to be owned by themselves, the similar other, and the dissimilar other. A subsequent surprise recognition memory test for the objects revealed highest memory for items chosen for self-ownership, followed by those chosen for the similar other, then the dissimilar other. However, in an interesting analysis Allan et al. also measured source memory (correct identification of the item owner). Source memory is particularly associated with self-referent memory because it utilizes episodic recollection of information about the encoding event (see Conway & Dewhurst, 1995; Conway, Dewhurst, Pearso, & Sapute, 2001). Indeed, Conway and colleagues (Conway & Dewhurst, 1995; Conway et al., 2001) go as far as to suggest that the SRE is re-named the self-reference recollection effect (SRRE) because any self-referential memory should be episodic in nature. Allan et al. found that in their experiment, participants' source memory was significantly better if the owner was self, but did not differ between items belonging to the similar and dissimilar other. This suggests that while simulation allowed the similar other to benefit from some level of self-processing, there remained a distinctive processing level for memories that directly involved the self.

Going a step further than simulation, the final paper in the current issue sought to determine whether others can actually be incorporated into the self concept. Payne, Tsakiris, and Maister (2017) asked participants to complete Sui et al.'s (2012) shape–label matching task, but replaced the shapes with strangers' faces. In the task, labels (self, friend, stranger) were associated with each of three gender-matched unfamiliar faces, and participants were required to determine whether label–face combinations were correct or incorrect. Response latencies suggested that the self-face association was learned more quickly than that of the friend or stranger, mirroring Sui et al.'s (2012) shape findings. However, while the unfamiliar face was rapidly associated with self and elicited the typical self-processing biases, a second experiment suggested that this association did not impact on participants' physical self construct. Participants completed a follow-up self-recognition task in which they were presented with morphed images of their own face and the self- or stranger-associated unfamiliar face. No difference was found between participants' rating of the similarity of the two unfamiliar faces with their own face. Thus while an unfamiliar face could quickly become associated with self and subject to self-processing biases, it did not become incorporated into the participants' self-image.

Both Payne et al.'s and Allan et al.'s findings suggest that there are limits to the flexibility of the self system; while context-specific associations (shapes, faces) may be sufficient to trigger the SAN and elicit a range of self-processing biases, these temporary "extensions of self" are part of a dynamic, goal-driven system and are not incorporated into the self construct itself.

Concluding comments

The papers presented here extend the study of self-processing effects by highlighting flexible biases in positive valence, perceptual processing, and memory. "New wave" methodologies such as Cunningham et al.'s (2008) ownership paradigm and Sui et al.'s (2012) shape association task have allowed

the exploration of the self's influence on cognition to move beyond memory effects to a striking array of automatic self-processing biases and the dynamic goal-dependent system through which their operation can be modulated. Importantly, the current issue highlights nuances in the application of self-processing bias. While self-cues tend to automatically attract attention and preferential processing, contrary task demands or priming can modulate this influence. Similarly, while external objects and people can activate a level of self-processing bias if they are associated with self, these effects are attenuated relative to "true" self-processing. The influence of the self in cognition may be notably wide ranging and easily activated, but the ability to dampen this influence when required shows the complexity and goal sensitivity of the self-system, which is perhaps its most impressive functional property.

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ORCID

Sheila J. Cunningham http://orcid.org/0000-0001-6380-4581

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