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# Self-reference is a fast-acting automatic mechanism on emotional word processing: evidence from a masked priming affective categorisation task

Ana P. Soares[a], Joana Macedo[a], Helena M. Oliveira[a], Alexandrina Lages[a], Juan Hernández-Cabrera[b] and Ana P. Pinheiro [c]

[a]Laboratório de Cognição Humana, Centro de Investigação em Psicologia (CIPSI), Universidade do Minho, Braga, Portugal;
[b]Laboratorio de Neurociencia Cognitiva y Psicolingüística, Facultad de Psicología, Universidad de la Laguna, Tenerife, España;
[c]Laboratório de Voz, Afeto e Fala, Faculdade de Psicologia, Universidade de Lisboa, Lisboa, Portugal

**ABSTRACT**

This study examined the impact of self-referential information at early stages of emotional word processing using an affective masked-priming paradigm in which positive (e.g, espetacular[awesome]) and negative (e.g., horrível[awful]) trait-adjectives were preceded by briefly primes that could be self-related (Eu sou[I am]), other-related (Ela é [She is]), or a control (%%%%%). Trait-adjectives were selected from female norms and only females participants were used to control for sex differences. Results showed that positive words were categorised faster when preceded by self-related primes than by other-related primes, though not control primes. Negative trait-adjectives were not modulated by the type of prime, even though participants were slower when they were preceded by other-related than by control primes. These findings demonstrate that taking the other-perspective entails a cost, and that the amount of priming produced by self-related and control primes was virtually the same, thus suggesting that assuming the self-perspective is a cognitively effortless process.

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Self-reference effect; implicit self-referential processing; self-positivity bias; emotional word processing; affective categorisation task

Previous studies have consistently demonstrated that emotional words are better remembered, more rapidly recognised, and more effectively categorised than non-emotional or neutral words (see Soares, Comesaña, Pinheiro, Simões, & Frade, 2012 for a review). Several proposals have been advanced to account for this advantage. For instance, Lang, Bradley, and Cuthbert (1997) claim that emotional stimuli benefit from a preferential allocation of attention because they assume a privileged role both for individuals' well-being and survival, which may justify the behavioural and brain differences observed when comparing emotionally salient vs. emotionally non-salient (neutral) stimuli. Recent theories of embodied and grounded cognition (e.g. Barsalou, Santos, Simmons, & Wilson, 2008) also state that the advantage of emotional over neutral words relies on the fact that emotional words trigger internal sensory/perceptual information more strongly than neutral words, hence providing more cues for word retrieval. Specifically, it has been argued that, when reading words such as "fear" or "happiness", individuals activate not only the concept of fear and happiness in their minds, but also all the personal experiences, actions, and physiological reactions related to them, which might reinstate feelings associated with these concepts even in the absence of any concrete situation that elicit it. Even though none of these theoretical accounts make clear predictions about the degree to which the self is engaged in the processing of emotional versus vs. non-emotional stimuli, it is possible to anticipate that emotionally salient stimuli might activate self-referential information to a larger extent than neutral ones.

Indeed, recent research has demonstrated that individuals encode information differently depending on the extent to which the self is implicated in the information to be processed, an effect known as self-reference effect. This term was coined by Rogers, Kuiper, and Kirker (1977), who found that participants' performance in a memory task was improved when, at the encoding phase, they were

**CONTACT** Ana P. Soares asoares@psi.uminho.pt
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asked to decide whether a given word (trait-adjective) was or not self-descriptive (i.e. "does it describe you?") Relative to conditions in which they were asked to make semantic (i.e. "does it mean the same as … .?"), Phonemic (i.e. "does it rhyme with … .?"), Or structural judgments (i.e. "is it written in capital letters?") about the same trait-adjectives. After this seminal work, several studies replicated the self-reference effect, not only when participants were explicitly asked to judge whether a given word was or not self-related (e.g. Craik et al., 1999; Kuiper & Rogers, 1979; Watson, Dritschel, Obonsawin, & Jentzsch, 2007; Yoshimura et al., 2009), but also in tasks relying less on explicit self-evaluations (e.g. Fields & Kuperberg, 2012, 2016; Herbert, Herbert, & Pauli, 2011; Herbert, Pauli, & Herbert, 2011; Zhou et al., 2017). This is an important issue because in most everyday situations individuals are not asked to engage on conscious and intentional self-reflections, hence being important to clarify whether the self-reference effect observed in explicit self-related conditions is also observed when participants are not asked to focus their attention on the self. It is also important to clarify whether the self-reference effect observed in the abovementioned studies extends beyond tasks involving encoding and retrieval processes (memory tasks), and might also affect the processes involved in visual word recognition and reading. This is a particularly interesting issue because current models of visual word recognition (e.g. Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Davis, 2010; Grainger & Jacobs, 1996), do not assign any particular role to the self in the processes involved in accessing and using lexical representations, although there are growing demands in the literature to include variables associated to the individuals, and not only variables associated to the characteristics of the words per se, in ascertaining the factors that might affect visual word recognition at early stages of processing (see Yap, Balota, Sibley, & Ratcliff, 2012 for an example).

In an attempt to introduce a more implicit mode of self-reference processing and to analyse the stage at which self-referential information impacts emotional word processing, Herbert, Pauli, et al. (2011) asked participants to silently read positive, negative, and neutral nouns that were preceded either by the possessive pronoun "my" (self-related condition) or the definite article "the" (no reference or control condition; see also Herbert, Herbert, et al., 2011, for the use of the additional other-related condition). During the task, event-related potentials (ERP) were collected to provide a more fine-grained analysis of the time course of word processing, i.e. to determine which stage (from earlier and more sensory-based to higher-level cognitive processing) is influenced by self-referential information. Participants were then asked to perform an unexpected free recall task and to rate the valence ("completely unpleasant" to "completely pleasant") and arousal ("completely calm" to "completely excited") of each emotional word by using the Self-Assessment Manikin (SAM; Bradley & Lang, 1994). Note that, according to appraisal theories of emotion (see Moors, Ellsworth, Scherer, & Frijda, 2013 for a more recent review), the evaluation of a stimulus self-relevance is expected to occur early in processing, though only after a pleasant-unpleasant check of the incoming information has been completed. Consistently, Herbert, Pauli, et al. (2011) observed early modulations of word valence in the early posterior negativity (EPN) component, irrespective of whether the preceding word was a possessive pronoun or an article. Self-reference only affected emotional word processing at later time windows (i.e. in the N400 and late positive potential [LPP] components). Specifically, in the N400 time window (~300–450 ms after noun onset), amplitudes were reduced for unpleasant relative to both pleasant and neutral words preceded by personal pronouns, whereas in the LPP time window (~450–600 ms after noun onset) amplitudes were larger for unpleasant relative to both pleasant and neutral words in the self-related condition. These results were interpreted as indicating that self-reference affects emotional word processing only after an initial rapid attention capture by emotional content has been completed, in line with the predictions of the appraisal accounts of emotion (see Herbert, Pauli, et al., 2011 for details).

Nonetheless, other studies using other experimental procedures found modulations of the self-reference effect on early ERP components. For example, Fields and Kuperberg (2012) presented participants with two-sentence social vignettes in which pleasant, unpleasant, or neutral words were embedded and referred either to the participants themselves or to an unknown third person (e.g. "A man knocks on your/Sandra's hotel room door. You see/she sees that he has a gift/gun/tray in his hand"). After reading the sentences, participants were instructed to verbally produce a third short sentence to continue the story in a plausible way to ensure that participants were reading for

comprehension. ERP data showed modulations of self vs. other referential contexts before ~200 ms post-word onset (P1, N1, and P2), evoked brain potentials components usually associated to primary sensory/perceptual processing. These findings suggested that self-reference impacts emotional word processing earlier than previously observed by Herbert, Pauli, et al. (2011), i.e. in perceptual and pre-semantic stages of emotional word processing (see also Fields & Kuperberg, 2016 for similar results). Using an affective priming paradigm, Chen et al. (2014) instructed participants to judge the emotional content of target trait-adjectives (i.e. "positive or negative?") That were preceded by 150 ms primes that could be either self- ("I") or other-related ("He/She") while reaction times (RTs) and ERP responses were collected. At the behavioural level, the authors found faster responses to self-related positive adjectives than to other-related negative adjectives, hence extending the self-positivity bias (i.e. the tendency to evaluate positive traits as more self-related than negative traits) observed in previous studies with explicit self-evaluation conditions (e.g. Watson et al., 2007) to more implicit conditions (see however Herbert, Pauli, et al., 2011 for an advantage of self-related vs. other-related information for negative words). Moreover, the ERP data showed, in line with Fields and Kuperberg (2012, 2016) results, early modulations of self-related information in the P300 component, indicating larger amplitudes for positive words preceded by self- than other-related primes, as well as modulations in the N400 component, indicating larger amplitudes for words inconsistent with a self-positive view. Similar findings were also reported by Zhou et al. (2017) in a recent study using a modified version of the affective priming task of Chen et al. (2014). In Zhou et al. study, participants were asked to judge whether a second target (a Chinese character) shared the first or the second character with the first target (a positive or negative trait-adjective), which was preceded either by a self- ("I") or by an other-related ("He/She") prime presented for 1,000 ms. Self-reference effects were observed on the early N1 and P1 ERP components, whereas a main effect of emotion and an interaction between emotion and self-reference were only observed in later time windows, in the N2 and LPP, respectively.

Hence, although recent studies have been conducted to determine the stage at which self-reference information impacts emotional word processing by using online techniques (ERPs) with more implicit modes of self-referential information, the findings are mixed. Whereas early self-reference effects tend to be observed in tasks involving self vs. other discrimination, late self-reference effects tend to be observed in tasks requiring self vs. no reference discriminations. Nevertheless, the use of a control baseline condition in addition to the self- and other-related conditions is lacking. This control condition would allow examining whether the self-reference effects reported in previous studies with explicit and more implicit self-reference conditions are of facilitation or inhibition (contrasting self- vs. other-related conditions only allows to determine differences between the two conditions). Moreover, it is also important to note that, even though some of the previous studies have used more implicit modes of self-referential information (e.g. Chen et al., 2014; Fields & Kuperberg, 2012, 2016; Herbert, Herbert, et al., 2011; Herbert, Pauli, et al., 2011; Zhou et al., 2017), it is still possible that the nature of the tasks used might have not completely prevented participants from engaging in conscious self-reflections. Indeed, although in these studies participants were not asked to engage in self-referential processing, the fact that the stimuli were presented in a conscious and clearly self-related or other-related way by the use of personal or possessive pronouns, might have encouraged participants to engage in self-reference evaluations, which might have inadvertently affected the results.

The current study aimed to clarify the role that self-referential information plays at early stages of emotional word processing by using a procedure that tapped into more implicit and automatic stages of self-referential processing. Specifically, we rely on the use of the affective masked priming paradigm in which positive (e.g. *espetacular*[awesome]) and negative (e.g. *horrível*[awful]) trait-adjectives used as targets were preceded by briefly presented primes (50 ms) that could be either self-related (*Eu sou*[I am]), other-related (*Ela é*[She is]), or a control (%%%%%). Note that primes with a 50 ms duration are assumed not to be consciously processed by the participants, hence making the processes of interest (self-referential information in this case) to be primarily automatic (see Forster, 1998; see also Perea, Marcet, Lozano, & Gomez, 2018 for recent evidence of the automatic nature of effects masked priming effects). Trait-adjectives were selected from female affective norms and only females were used as participants to control for sex differences. Indeed,

although the studies conducted so far have used both female and male as participants, and do not clarify the extent to which the stimuli were controlled for sex differences, there is an increasing body of evidence revealing differences in the way males and females perceive and process emotional evocative stimuli, which could have also contributed to confound the results. For example, in response to emotional evocative stimuli (including faces, images, words, sounds) females tend to show greater responsiveness as assessed both at behavioural and brain levels (see, for instance, Kret & de Gelder, 2012; Pinheiro, Dias, Pedrosa, & Soares, 2017; Soares et al., 2012, 2013, 2015; Vasconcelos, Dias, Soares, & Pinheiro, 2017), thus making the control for sex differences in emotional and self-referential processing critical. If self-reference impacts emotional word processing at later stages of processing, the brief presentation (50 ms) of self-related primes relative to other-related or to control primes was not expected to affect the speed with which positive and negative trait adjectives were affectively categorised (i.e. "positive or negative?"). Nevertheless, a main effect of valence was still hypothesised as positive words were predicted to be categorised faster than negative words (e.g. Kuperman, Estes, Brysbaert, & Warriner, 2014 for a review). Conversely, if the processing of self-reference information relies on a relatively fast-acting and automatic process, responses to positive and negative words were expected to be modulated by the self-reference contexts provided by the previous exposition to 50-ms primes. Specifically, in that situation, we expected to observe a self-positivity bias as self-related information should influence the processing of positive targets in a larger extent than negative targets.

## Method

### Participants

Fifty-four undergraduate female participants ($M = 20.97$ years; $SD = 5.12$) took part in the experiment in exchange of course credits. All were native speakers of European Portuguese, right-handed and with normal or corrected-to-normal vision. All participants presented normal mood and anxiety scores as assessed by the Portuguese adaptation of the second edition of the Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996; Coelho, Martins, & Barros, 2002) and by the Portuguese adaptation of the State Trait Anxiety Inventory (STAI-Y; Silva, 2006; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Written informed consent was obtained from all the participants. The study was approved by the local Ethics Committee (University of Minho, Braga, Portugal).

### Materials

One hundred and two target trait-adjectives were selected from female norms of the Portuguese adaptation of the Affective Norms for English Words (ANEW-PT, Soares et al., 2012), and also from a previous pilot study conducted with an independent sample of 206 female participants ($M = 22.79$ years; $SD = 1.53$). This pilot study aimed to increase the number of words with available affective norms in Portuguese (note that the ANEW-PT provides affective ratings for a limited number of trait-adjectives). Data collection in the pilot study followed the same on-line procedure described by Soares et al. (2012). From the total number of words included in the pilot study ($N = 325$), affective ratings for 44 words were already available in the ANEW-PT. They were intentionally included in the pilot study to allow for cross-validation of the affecting ratings from both datasets (see Soares, Costa, Machado, Comesaña, & Oliveira, 2017 for a similar procedure). As expected, high Pearson product-moment correlations were obtained both for valence ($r = .690$, $p < .001$) and arousal ($r = .678$, $p < .001$) affective dimensions, suggesting that both datasets captured basically the same information.

Half of the words selected ($n = 51$) were positive valenced (e.g. *espetacular*[awesome]), while the other half were negative valenced words (e.g. *horrível*[awful]), (7.32 vs. 2.60, $p < .001$). Positive and negative words were matched for arousal (5.68 vs. 5.79, $p = .57$), as well as for other psycholinguistic variables shown to affect Portuguese word processing (see Soares et al., In press), such as per million word frequency (4.97 vs. 5.23, $p = .83$), length (in number of letters) (8.98 vs. 9.04, $p = .89$), neighbourhood size ($N$) (0.47 vs. 0.90, $p = .31$), and orthographic Levenshtein distance (2.70 vs. 2.69, $p = .93$), as obtained from the P-PALavras (P-PAL) database (Soares et al., 2014, 2018). Additionally, three types of primes were selected for the self-reference manipulation: *Eu sou*[I am] (self-related condition); *Ela é*[She is] (other-related condition); and %%%% % (control condition). This control condition was

chosen since in the Portuguese language none of the other personal pronouns could act as a real no-reference condition.[1] Three lists of materials were created to counterbalance items across prime conditions. Participants were randomly assigned to each list, although the same number of participants was assured per list ($n = 18$). Six additional adjectives (three positive and three negative) were selected for practice trials.

### Procedure

The experiment was run individually in soundproof booths. Stimulus presentation and recording of responses were controlled with DMDX software (Forster & Forster, 2003). Participants were instructed to decide as quickly and accurately as possible if each of the trait-adjectives presented in uppercase at the centre of a 15″ computer screen with a 60 Hz refresh rate, was positive or negative by pressing the "M" or the "Z" key of the keyboard. Response keys were counterbalanced across participants in each of the three lists of materials. The task comprised 102 trials that were randomly presented to the participants. Each trial consisted of a sequence of four visual events presented in black 18-pt Courier New font: (i) a forward mask (######) presented for 500 ms; (ii) the prime presented in lowercase for 50 ms; (iii) another mask (######) presented for 16.67 ms; and (iv) the target, presented in uppercase letters, and that remained on the screen until the participants' response or until 2,500 ms had elapsed. Participants were not informed about the presence of the primes. Prior to the experimental trials, six practice trials were presented to familiarise participants with the task. At the end of the task, participants were also asked to rate each of the trait-adjectives presented in the experiment in terms of valence and arousal using the SAM scales, and to indicate if they did not know the meaning of any of them. After the experiment, participants responded to a set of questions about their experience during the experiment to examine whether they noticed the presence of the primes. None of the participants reported having perceived the primes even when informed about its presence in the debriefing. The experimental session lasted for about 30 min per participant.

## Results

Data from unknown words, from non-responses, as well as from responses that were inconsistent with the manipulation adopted in the experiment were excluded from the analyses. For example, if the positive word *espetacular*[awesome] was rated as negative in the affective rating task, or if the negative word *horrível*[awful] was rated as positive in the same task, the latency data from these items were removed since these responses did not correspond to a "correct" response. With these trimming procedures, we aimed to ensure that the responses included in the latency analyses corresponded to the manipulation adopted in the experiment. Additionally, potential outliers were eliminated by implementing a two-step procedure, following previous studies (see Soares et al., In press for a recent example). First, reaction times (RTs) below 300 ms or above 2,000 ms were excluded from the dataset. Then, RTs above or below 2.5 *SD*s of the mean response times of each participant in each experimental condition were also removed. The number of outliers excluded was very low (1.6%) and did not differ across conditions, $F(5,265) = 0.700$, $MSE = 0.197$, $p = .624$. Altogether, these trimming procedures led to the elimination of 10.2% of the original raw data. The mean and standard deviations of RTs for positive and negative words preceded by self-related, other-related, and control primes are displayed in Table 1.

RTs for word targets were analysed with linear mixed effects (lme) models using R software (Bates, Maechler, & Bolker, 2011). Participants and items were included in the model as crossed random factors with a random intercept and the two repeated-measure factors (Valence: positive|negative; and Reference: self|others|control), with a random slope per subject but not per item (see Barr, Levy, Scheepers, & Tily, 2013; for further discussion see Matuschek, Kliegl, Vasishth, Baayen, & Bats, 2017), since the comparison of the simplest model including only a random intercept vs. the most complex model that added random slopes by subjects for the two factors of repeated measurements was significant in favour of the most complex model $\chi^2(9) = 91.35$ $p < 0.001$ (see Baayen, Davison, & Bates, 2008; see also Barr et al., 2013). Data were

[1]Unlike English, in Portuguese there is no such a thing as a "neutral" personal pronoun. In English, for instance, there is a specific pronoun to refer to inanimate things ("It"), which does not have a direct equivalent in Portuguese. In Portuguese, third person pronouns are the same for animate and inanimate entities. For this reason, we opted to use a control condition that was composed of a set of percentage symbols ("%%%%%") as in many other studies, as this will always works as a no-reference (control) condition.

**Table 1.** Mean and standard deviation of RTs for positive and negative words per prime condition.

| Valence of the target | Type of prime | | |
|---|---|---|---|
| | Self-related | Other-related | Control |
| Positive | 838.7 (251.50) | 881.2 (286.64) | 854.4 (274.24) |
| Negative | 936.4 (295.73) | 943.8 (287.3) | 918.5 (282.81) |

Note. Standard deviation is shown in parentheses; RT: Reaction Times.

not averaged prior to the analyses. For the effects that reached statistical significance, the second degree of freedom of the *F* statistic was approximated with Satterthwaite's method. The *p*-values were adjusted with Hochberg's method for all the post-hoc comparisons equal or below .05.[2]

The model revealed a main effect of valence, $F(1,120.2) = 6.806$, $p = .01$, indicating that participants were faster at categorising positive than negative words (858.1 vs. 932.9 ms, respectively). A significant main effect of reference was also observed, $F(2,107.7) = 8.341$, $p < .000$, indicating that participants were faster at categorising words preceded by self-related primes than other-related primes (887.9 ms vs. 913.1 ms, $p = .003$), but not control primes (887.9 ms vs. 887.2 ms, $p = .729$). However, words preceded by other-related primes elicited slower responses than words preceded by control primes (913.1 vs. 887.2, $p = .001$). The two-fold valence x reference interaction also reached significance, $F(2,4908.8) = 2.567$, $p = .071$, though only at a marginal significant level. Planned post-hoc comparisons indicated that participants were faster at categorising positive words preceded by self-related primes than by other-related primes (838.7 vs. 881.2, $p = .001$), but not by control primes (838.7 vs. 854.4, $p = .248$). In addition, the interaction also revealed that positive words preceded by control primes were categorised significantly faster than positive words preceded by other-related primes (854.4 vs. 881.2, $p = .037$). However, in the case of negative words, neither the differences between self-related and other-related primes (936.4 vs. 943.8, $p = .265$), nor the differences between self-related and control primes (936.4 vs. 918.5, $p = .184$), reached statistical significance. Nevertheless, participants were still faster responding to negative words preceded by control primes than by other-related primes (918.5 vs. 936.4, $p = .012$).

## Discussion

The current study examined whether self-reference information impacts emotional word recognition at early stages of processing by using an affective categorisation task combined with a masked priming paradigm to induce a more implicit mode of self-referential processing. Even though previous studies attempted to minimise the impact of deeper self-referential processes on emotional word processing, the way in which self-referential information was manipulated in those studies may not have prevented participants from engaging in explicit self-reflections, which might have confounded the results. Moreover, although an increasing number of studies have shown that males and females differ in the way they perceive, process, and react to emotional stimuli, none of the previous studies have accounted for these differences, which could have also contributed to confound previous results. To control for sex differences, the current study used negative and positive trait-adjectives selected from female affective norms, and only females as participants.

The results obtained here were clear-cut and extend previous findings on self-referential emotional word processing. First, they demonstrate that, even under more implicit and controlled (e.g. participants' sex, stimuli used) conditions, self-referential information modulates emotional word processing. Specifically, the results obtained suggest that self-related information is rapidly activated, thus supporting the view that self-reference is a fast-acting and automatic mechanism, "filtering" the way individuals perceive and process words' emotional content (e.g. Chen et al., 2014; Fields & Kuperberg, 2012, 2016; Zhou et al., 2017). Moreover, they also demonstrate that, at early stages of processing, self-referential information only affects the

[2]How to get *p*-values has been much debated in mixed models estimation. The degrees of freedom are unfortunately a non-trivial issue, as Douglas Bates (probably one of the most important authors in the field) pointed out in his blog (https://stat.ethz.ch/pipermail/r-help/2006-May/094765.html). However, in recent times, two approaches have been implemented in the lmerTest package in R, which have a reasonable balance between Type I and Type II errors, improving the more liberal normal approximation (most frequently used until now), since *t* distribution converges with *z* distribution as degrees of freedom increase. The Satterthwaite approximation, which is implemented in the lmerTest package, is based on SAS proc mixed approach, and the Kenward-Roger approximation, implemented in pbkrtest package. Both approaches provide more conservative *p*-values than the normal procedure does. These two procedures are the only available ones when estimating the *p*-value associated with the different fixed effects from mixed models (see Bates, Machler, Bolker, & Walker, 2015; Halekoh & Højsgaard, 2014; Kuznetsova, Brockhoff, & Christensen, 2017).

processing of positive valenced words as the differences between self-related primes and other-related primes (indicative of the self-reference effect) only reach statistical significance for positive trait-adjectives (for negative trait-adjectives the differences between self-related and other-related conditions failed to reach statistical significance). These results are in line with our predictions and confirm in our data the self-positivity bias observed in previous studies even with less implicit modes of self-referential processing (e.g. Chen et al., 2014; Fields & Kuperberg, 2015; Watson et al., 2007).

The current results also revealed that participants were significantly slower at categorising words preceded by other-related primes than by control primes both for positive and negative trait-adjectives, hence indicating an inhibitory other-reference effect for both types of words. This result is interesting and clearly shows that, at early stages of processing, taking the other perspective entails a processing cost. Even though previous studies that used explicit self-referential conditions revealed better performance for the other-related condition when semantic or structural conditions were used as controls (e.g. Kuiper & Rogers, 1979; Yoshimura et al., 2009), others failed to show this advantage. For instance, in the study of Craik et al. (1999), participants were asked to judge whether trait-adjectives described themselves (self-related condition), the prime-minister Brian Mulroney (other-related condition), as well as to judge, as controls, how socially desirable each adjective was (general condition) and how many syllables each adjective had (syllable condition). Results showed that participants were slower in the other-related condition than in any of the other conditions, although these differences were not further explored and discussed in the paper. Although future studies should explore why taking the "other perspective" slows down processing, it is possible that the use of "She is" in the present study, or the "Prime Minister" in Craik et al. (1999) study, might represent a more abstract and/or a less familiar entity than the self-related conditions used ("I am"), hence explaining the inhibitory other-reference effect observed. Therefore, future studies should clarify whether the abstractedness/unfamiliarity of the other-related condition can account for the inhibitory other-related effect by using, for instance, other familiar entities as a better proxy for the other-related condition.

Nevertheless, it is also worth noting that, even though participants were slower at categorising positive and negative trait-adjectives preceded by other-related primes than by control primes, the differences between self-related primes and control primes did not reach statistical significance both for positive and negative trait-adjectives. The lack of differences reveals that the amount of priming produced by self-related and control primes is virtually the same, thus demonstrating that, unlike other-related primes, the processing of self-related primes did not entail any processing cost to the emotional word processing. This finding seems also to suggest that, at early stages of processing, the cognitive system might assume a more "egocentric" or a "self-centred" perspective by default. Although care should be taken with this interpretation, it is worth noting that this interpretation is also consistent with previous studies showing later self-reference effects on emotional word processing when the self-related condition was compared with neutral or control conditions (e.g. Herbert, Pauli, et al., 2011), and also with the recent accounts of embodied cognition (e.g. Barsalou et al., 2008) claiming that, even without an explicit self-reference context, individuals tend to process external stimuli (as emotional words) as self-related as they reinstate an internal simulation of the concept to which they are referring to. Future studies should be conducted to support this view and also to examine whether the effects observed in the current study can be observed with other types of stimuli, namely for non-emotional words. Note that, in a standard affective categorisation task as the used in the present work, participants are typically asked to decide whether the stimuli presented are positive or negative. Including neutral words in the task would only force participants to categorise them as "positive" or "negative", thus not providing compelling evidence to analyse whether the self-reference effect observed in this study for positive valenced words could be also observed for neutral words, or to what extent it would vanish as in the case of negative trait-adjectives. Hence, future studies should use other tasks (e.g. lexical decision) to test if these results could be generalised to other (non-emotional) word stimuli. This line of research may also offer valuable insights on whether the input coding schemes of computational models of visual-word recognition (e.g. Coltheart et al., 2001; Davis, 2010; Grainger & Jacobs, 1996) should be amended to account for the role that self-referential information might

play at early stages of visual word recognition and reading.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## ORCID

*Ana P. Pinheiro* http://orcid.org/0000-0002-7981-3682

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