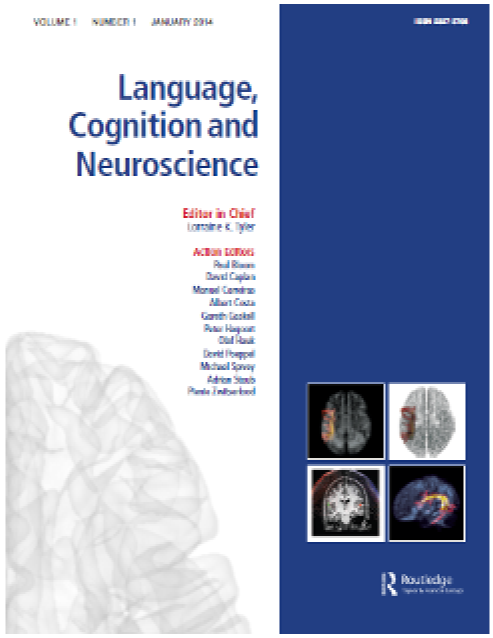

'Words and emotions in sentence context': a commentary on Hinojosa, Moreno and Ferré (2019)

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'Words and emotions in sentence context': a commentary on Hinojosa, Moreno and Ferré (2019)

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Hinojosa and colleagues provide the reader with an excellent and comprehensive review of the interactions between language and emotional processing. They frame their proposal within the field of affective neurolinguistics, since they specifically address open questions concerning how neurobiological processes underpinning language interact with internal representations of emotions. This paper offers a starting point for future research since it provides the reader with a critical review of the state of the art, focusing on both the single-word lexical processing level and the more complex combinatorial aspects that are crucial for language comprehension. Critically, the overall picture that emerges from this review is that research at the single-word processing level has produced stable and replicated effects, and there is already considerable consensus regarding their interpretation. However, these consistent findings have to be properly translated into research at the level of combinatorial processing.

The authors point to two critical emotional dimensions that have been not been consistently addressed in the field, i.e., arousal (how the emotional properties of words influence language processing) and valence (whether positive and negative connotations are processed differently). With respect to single word processing, it appears that word recognition is influenced at an early stage by arousal (~200 ms), as consistently evidenced by the EPN (Early Posterior Negativity) ERP component, and at a later stage (>500 ms) by the positive/negative valence of the emotion, as evidenced by research on the LPN (Late Positive component). The earlier effect, related to arousal, likely reflects a task-independent processing stage related to the implicit automatic processing of the emotional features of words. Here, the overall idea is that emotional words are associated with richer semantic representations that facilitate lexical access in a top-down manner. The later valence-related effect reflects an evaluative analysis of the

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emotion, required to accomplish the goals of the neurocognitive system (such as, for instance, performing an experimental task). Research on the neurophysiological correlates of emotional valence has resulted in contrasting findings and more studies are needed to better determine how non-emotional factors (task demands, attentional load and other experimental properties) interact with the reported effects. The key point here is that valence appears to be analyzed after arousal.

This emerging picture from single-word processing studies now needs to be integrated with sentence processing proposals. While there is evidence that semantic and syntactic combinatorial processes are affected by the emotional content of words, it is not clear if emotion is a special feature of words, or if other semantic properties (such as animacy, concreteness, etc.) have similar effects. If it turns out that emotion is a special case, it would be important to mechanistically frame the link between compositional processes and the emotional content of language materials. Here, it is worth underscoring the suggestion advanced by Hinojosa and colleagues that the relation between emotion and other non-emotional semantic properties to be further investigated in order to clarify the relevance of the two emotional dimensions (valence and arousal) in semantic composition.

Along these lines, the available research on semantic integration of emotional words has either mainly focused on the brain response of participants who encounter an emotional word in a sentence context or has employed the semantic violation paradigm. It would be more informative to use a paradigm that considers more natural expressions employed in natural conversations that tax the reader's comprehension process. An approach we recently developed (Molinaro et al., 2012, 2015) indicates it is important to evaluate the compositional cost of combining atypical (but non-anomalous) expressions (such as *smart table*) with variable levels of emotional load to better

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understand if semantic composition is facilitated or inhibited. In other words, does emotional content interact with semantic composition (for instance in *happy table*) in a different way than other semantic dimensions do? And if so, do arousal and valence play different roles?

An additional interesting resource for addressing these questions comes from recent studies that employ multivariate approaches to evaluate brain activity reflecting the processing of different properties of individual words in continuous and natural text comprehension (see, for example, Armeni et al., 2019). Multiple emotional dimensions of individual words can be extracted from these passages and then used to evaluate how brain activity is modulated by such continuous parameters. Crucially, it is important to evaluate what amount of variability in brain activity is explained by emotional properties compared to other semantic parameters.

Sentence processing is largely shaped by predictive mechanisms that continuously estimate the content of incoming words. In this domain, influential studies have shown how emotional content affects predictive processing. Moreno and Vázquez, (2011; see also Moreno & Rivera, 2014) have highlighted the finding that participants tend to make stronger predictions for emotionally negative outcomes to protect themselves from the harm of negative surprises. This "defensive pessimism" does not, however, provide any information concerning how emotional arousal and valence influence predictive processing mechanisms. Recent proposals, for instance, underscore the relation between predictive processing and motor activation, proposing that predictive processing "recycles" neural networks, originally designed to interact with the motor periphery, in order to develop predictions for incoming words (Pickering & Garrod, 2013; see also Martin et al., 2018; Molinaro et al., 2016; Molinaro & Monsalve, 2018). How would emotional content interact with such processing mechanisms? It has

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been proposed that abstract emotional words involve motor representations (see Action-Perception theory; Pulvermuller & Fadiga, 2010). Is linguistic *production* facilitated by these motor representations? And if so, does such facilitation extend to mechanisms at work in linguistic *prediction*? Answering this type of question would help to better specify the nature of the motor activation evoked by the emotional content of words: is such activation related to the neural representation of the word itself or does it reflect motor reactions pursuant to processing the word? Can the semantic representation of emotions be separated from their psychophysiological correlates? More studies on both prediction and production during emotional processing should help to shed more light on these issues.

Such discussions on the role of emotions in semantic combinatorial processing during sentence comprehension have focused on lexical-semantic aspects, but can also be extended to syntactic processing. The underlying question that should probably be addressed overall is: how can the evidence from single-word processing studies on emotional processing best be integrated with the sentence processing literature? Are combinatorial operations affected by the emotional properties of words mainly because of enhanced word-level lexico-semantic operations? Should we also consider interactions between emotion parameters and combinatorial operations that go beyond word recognition? Is this true for both emotional valence and arousal? Answering such questions has great potential to inform ongoing research focused on determining the neurophysiological mechanisms supporting language processing. The picture provided by Hinojosa and colleagues provides a solid basis for planning these more in-depth studies, in which the rising field of affective neuroscience could profitably interact with research on the neurobiology of language.

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