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GENDER DIFFERENCES DURING WORD PROCESSING: EFFECTS OF QUESTION LINGUISTIC PROSODY ON ATTENTION UNDER EMOTIONAL CONTEXTS

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A much debated question is whether gender differences exist in the functional organization of the brain for language, and which factors might be responsible for such differences (e.g. Hellige, 1993; Laccino, 1993). The present work attempts to study variables that underlie the way in which communication is perceived, and by which part of social interactions are constructed.

1.1 Emotions in speech. Daily life interactions require us to be sensitive to emotions of others, and in speech, emotions can be expressed at a word level and through the tone of voice (Schirmer et al. 2004). This non-verbal vocal expression of emotion is called Emotional Prosody (EP) and carries salient acoustic – phonetic cues (i.e., fundamental frequency, duration, and intensity) (Kotz & Paulmann, 2007). In the word processing literature in particular, context is usually conceived as “*the semantic structure established by the words in a sentence*” (Schirmer et al., 2002, pp. 228). However, as the authors point out, context is not limited to semantics. Sources of both linguistic and non-linguistic information are also revealed by prosody (the ability to express variations of different parameters of the speech, such as pitch contour, intensity and duration). It can be said that two types of prosody play a major role in communication: Linguistic prosody (LP) tells us whether the sentence is declarative, imperative or interrogative, and EP gives out clues about the emotional state of a person. Therefore, to understand the emotional signal embedded in speech, listeners have to attend to both prosodic and word information.

1.2 Unveiling gender differences. To understand the time course of the relationship between EP and word recognition, Schirmer et al. (2002) carried out a study using ERPs and reaction times (RTs), and included Gender as a factor in their data analysis. Under the idea that “*if emotional-prosodic context modulates word processing in a similar fashion as semantics context, then it should elicit priming effects comparable to those obtained for semantic prim-*

ing” (Schirmer et al. 2002, pp. 228) the authors designed a cross-modal priming experiment. Results showed significant differences between men and women in the processing of emotional congruence, in this case understood as when the valence of prime sentence and the target word are the same (e.g. happy prosody followed by a positive word, or sad prosody followed by a negative word). Also, when the interstimulus interval (ISI) between sentences and words was short (200-ms), women responded faster to matching targets than to targets that did not match the sentence prosody. Moreover, the N400 component of the ERPs, which is known to reflect word expectancy, was smaller for targets that matched compared with those that did not match the sentence prosody. The results indicate that women base their linguistic expectations on emotional prosody as early as 150-ms following the visual target onset. By contrast, men do not show any electrophysiological priming effect, but respond faster to positive target words than negative target words, indicating that men process word meaning independent of the sentence emotional prosody. A second experiment with an ISI extended to 750-ms established that men are not impervious to emotional prosody, but they are slower than women to process it as they showed the effect with a 750-ms ISI.

In a second article Schirmer et al. (2005) looked at whether these gender differences prevail when attention is directed towards the emotional content of prosody and word meaning. The stimuli and procedure were equal to the first study (ISI=200-ms). The lexical judgment did not reveal differences in emotional-prosodic priming, suggesting that the presence of sex differences in emotional-prosodic priming depends on whether or not participants are aware of the EP.

The studies mentioned have shown that gender differences in word processing primed with non-linguistic information (EP) exist. However, not only non-verbal cues reveal additional sources of information, but also LP is an important factor in communication. They complement each other and so far no study available has analyzed the interaction of emotional and linguistic prosody with the gender effect simultaneously. One difficulty encountered for this purpose would be the presence of syntactic cues (like auxiliary verbs), which let people know about the forthcoming use of linguistic prosody in languages like English (see the example below). In Spanish, however, if we have a sentence like (1) it would be considered as a statement in written or spoken language, but if a question is to be made with the same sentence, only changing the LP would be enough, so prosody is sufficient to distinguish whether a sentence is a question or a statement. However, if we want to do the same with a sentence in the English language, a series of syntactic changes have to be made, as shown in sentence (2):

1. La niña pasó corriendo a través del parque
‘The little girl went running across the park’

2. ‘*Did* the little girl *go* running across the park?’



To determine if the findings on gender differences under inattention and attention conditions to the emotional prosody during word processing hold, or if they are affected by the interaction of emotional and linguistic prosody and the gender effect in the Spanish language, two experiments were developed. In the first one there is an explicit instruction of inattention to the prime, contrary to the second experiment. In both, the use of question LP improves the ecological validity of the studies carried out so far.

2.1 Participants. 73 undergraduate participants (37 females) with a mean age of 24.6, all right-handed native speakers of Spanish with normal or corrected to normal vision and no hearing impairment were paid to take part in the study. Due to low levels of accuracy in the experimental task (below 72 %) and to counterbalancing procedures, only 32 participants were assigned to the first experiment (16 females) and 20 to the second one (10 females). This number of participants matched the amount used in each attention condition in the previous studies.

2.2 Common Variables, Experiments I & II

- Stimuli A: 240 auditory semantically neutral priming sentences originated from a set of 30. 120 sentences were experimentally relevant and 120 were fillers. The relevant were all recorded with question LP combined once with happy and once with sad EP, for a subtotal of 60. Each sentence was presented to the subjects twice in the experimental relevant condition, followed either by a match or a mismatch target word according to the valence of both the prime sentence and the word, which sums up to a set of 120 relevant sentences. All fillers were recorded either with happy or sad EP and statement LP. Each of the original 30 referred to different contexts, and all four combinations of EP-LP per sentence were rated accurately by three judges. As sentences were played four times (two in the relevant condition) each participant was provided with a new randomized list of items, so repetitions effects should become relative.
- Stimuli B: 240 visual target words composed by 120 experimentally relevant ‘legal’ words, either with positive or negative valence (e.g. ‘success’/‘failure’) and by 120 fillers, from which 90 were pseudowords, and 30 were words with positive or negative valence to prevent subjects from developing a response strategy to the relevant condition (LP-EP). Words were semantically related to the final word of the prime sentences. Prior ratings ensured that positive and negative words did differ in valence but their strength was similar and were well known to control for frequency. Pseudowords followed word construction and syllable segmentation rules.

- Word length effect in lexical decision tasks: Spanish differs from languages like English in that not only a word frequency effect is observed but also a word length effect (Ardila, 1997). In words, the correlation with the number of syllables ('phonological length') is bigger than the correlation with the number of letters (Ardila, Roselli & Lecours, 1993), so it is reasonable to suppose that 'the reading unit' in Spanish could be the syllable, while in languages like English it could be the morpheme (Ardila, 1997). Thus, all visual targets had 3 syllables and 7 letters.
- Interval between sentence offset and target onset (ISI) = 200 ms.
- Reaction time and Accuracy: half participants had to press the left Ctrl button when the emotional valence of a word was congruent with the EP of the preceding sentence, and the right Ctrl button if incongruent. Reaction times and accuracy were measured with DMDX.

2.3 General Procedure, Experiments I and II. Subjects seated in an isolated classroom facing a computer monitor at a distance of approx 0.6m. To familiarize participants with the task, each one interacted with a block of eight practice trials. Sentences were presented over headphones. In the first experiment participants were told that auditory primes (semantically neutral Spanish sentences either with EP, LP or EP-LP) were not relevant to the task, that they just had to listen to them. Following each prime, a visual target appeared in the centre of the computer screen 200 ms following sentence offset and was displayed until the subject responded or for 2500 ms if not response was given. Participants were asked to perform a lexical decision task. Responses to real words were given by pressing the left Ctrl button for half the participants. With exception of participants' inattention to the prime sentence, the procedure of the second experiment was comparable to the first one, as participants were then told that auditory primes were relevant to the task. This sums up to four experimental conditions in each experiment: match and mismatch conditions for positive target words regarding the prime's prosody, and match and mismatch conditions for negative target words.

6.1. Results for Experiments 1 and II. Reaction times were standardized within each subject, and a repeated measures ANOVA was conducted for reaction times with TARGET (positive / negative) and MATCH (mismatch / match conditions between the valence of both prime and target) as repeated measures factors and GENDER was treated as a between-subjects factor. There was a main effect of TARGET ($F(1,30) = 48.479$, $P < 0.001$) and MATCH ($F(1,30) = 22.807$, $P < 0.001$) as well as a TARGET by MATCH interaction ($F(1,30) = 8.663$, $P = 0.006$). With attention over the prime's prosody, there was a main effect of TARGET ($F(1,18) = 83.308$, $P < 0.001$) and MATCH ($F(1,18) = 11.214$, $P = 0.004$) as well as a TARGET by MATCH interaction ($F(1,18) = 5.716$, $P = 0.028$), and a marginal main effect for GENDER

($F(1,18) = 3.644$, $P = 0.072$) as well as TARGET by GENDER ($F(1,18) = 4.611$, $P = 0.046$), and MATCH by GENDER ($F(1,18) = 5.218$, $P = 0.035$) interactions.

Discussion. A better performance by women was observed when attention was directed towards the context. This finding goes against the literature, as the gender differences were previously found in the inattention condition. In order to reconcile the results with findings from previous research, any methodological differences had to be addressed. It is concluded that the inclusion of question linguistic prosody in the emotional prosody/word valence paradigm affected word processing in men and women. After careful literature consideration and discussion with one of the original authors, it is suggested that when a sentence is charged with question prosody, attention might be automatically directed towards it.

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