Understanding over-specification: A visual-world ERP study

Elli N. Tourtouri, Francesca Delogu & Matthew W. Crocker (Saarland University)
elli@coli.uni-saarland.de

Grice's second maxim of Quantity [1] stipulates that speakers' utterances encode the minimal amount of information necessary for the communicative purposes. According to that, redundancy may engage listeners in unintended pragmatic inferencing [2]. Past research has, nevertheless, shown that speakers frequently use redundant information to specify a target object in a visual domain [3-7]. For example, while 'blue' is required to identify the target (ball) in Fig.1A and B, it is unnecessary yet likely to be mentioned in C and D. It is, however, unclear whether such over-specifications (OS) hinder comprehension [7,8] or not [9,10]. Previous ERP studies have found contrasting evidence. OS was associated both with an increased [7] and an attenuated [10] N400 compared to minimally-specified expressions (MS). Both findings are subject to alternative explanations, however. In [7], visual displays were highly simplified, which may have emphasised that redundant information was unnecessary, while in [10], specificity was confounded with the reduction of referential ambiguity (entropy): in OS, the redundant adjective identified exactly one object, thereby minimising surprisal on the subsequent noun [11]. In this study, we manipulated Specificity and Entropy reduction as orthogonal factors, to assess their independent influence on the comprehension of referring expressions, and whether they interact.

In an ERP experiment, we presented participants (N=32) with either of four versions of a visual display (cf. Fig.1) paired with a single audio instruction like 'Find the blue ball' in German. The experimental manipulation crossed Specificity (MS vs. OS) and Entropy reduction rate (high reduction, HR vs. low reduction, LR). That is, when a shape competitor was present (cf. Fig.1A and B) the expression was MS, while it was OS when the target was singleton (cf. Fig.1C and D). Further, the adjective ('blue') reduced entropy at a higher (1.58 bits in Fig.1A and C) or lower (0.58 bits in Fig.1B and D) rate, leaving a smaller (1 bit) or larger (2 bits) amount of entropy, respectively, to be eliminated at the noun. Based on previous findings, we expected referential specificity to modulate the N400, with OS amplitude being higher if it is hindering for comprehension [7], or lower if it is facilitatory [10]. The rate of entropy reduction was also expected to exert an influence (possibly additive) on comprehension, with higher reduction being more beneficial.

We found that OS led to higher response accuracy (p<.01) and faster times (p<.01) for listeners to identify which side of the screen (left or right) the target object was on, while HR also resulted in faster responses (p<.01). Regarding the ERPs, none of the comparisons in the adjective region reached significance (p>.05). In the noun region, we observed two main effects: a biphasic N400-P600 effect for OS vs MS (Fig.2), and an N400 effect for LR vs HR (Fig.2). In line with previous research [2,7], results indicate that listeners employ pragmatic inference online to interpret the incoming adjective, when the context supports both a contrastive and a non-contrastive reading (cf. the blue ball and the mitt in Fig.1). Based on this interpretation they then predict the upcoming noun. When their prediction fails (OS), noun retrieval is hampered (larger N400), and listeners need to revise their representation of what is being communicated (larger P600) [12]. Nonetheless, response speed and accuracy are increased for OS vs MS, replicating previous findings [9] and highlighting the intricate relationship between ERPs and behavioural measures. Lastly, entropy reduction was also found to be a significant factor in referential language processing, with a high reduction of entropy on the (necessary or redundant) adjective resulting in a facilitation on the noun (attenuated N400).

References. [1] Grice 1975 [2] Sedivy et al. 1999 [3] Deutsch & Pechmann 1982 [4] Koolen et al. 2011 [5] Tarenskeen et al. 2015 [6] Rubio-Fernandez 2016 [7] Engelhard et al. 2011 [8] Davies & Katsos 2013 [9] Arts et al. 2011 [10] Tourtouri et al. 2015 [11] Hale 2003 [12] Brouwer et al. 2012
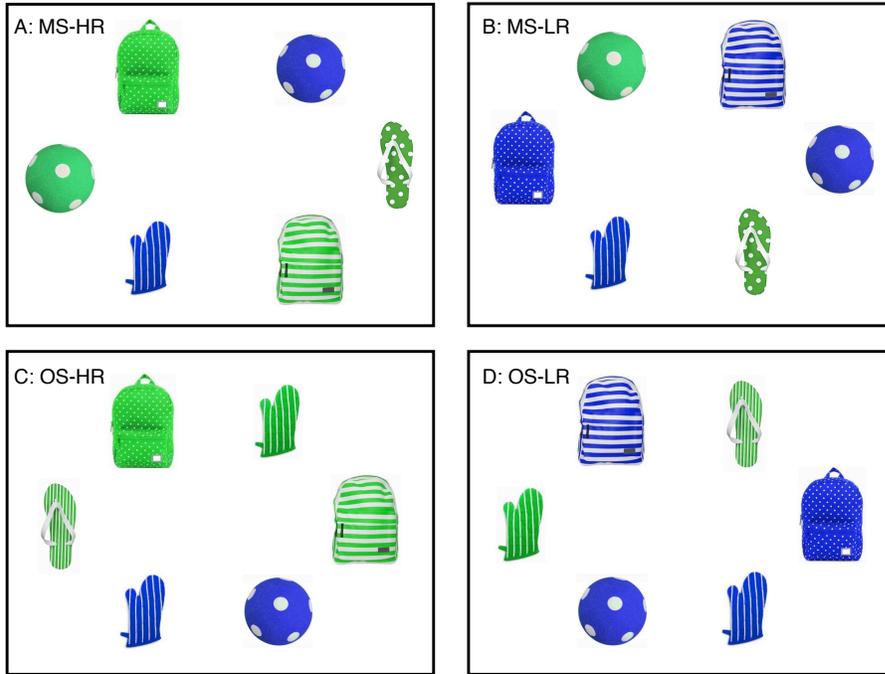
Figure 1. Sample visual stimuli for the four conditions paired with the audio instruction 'Find the blue ball'. In panels A and B the adjective was necessary to identify the target object, and the expression was therefore minimally-specified (MS). In panels C and D the adjective was redundant rendering the expression over-specified (OS). Additionally, the adjective reduced the amount of referential entropy (ambiguity of potential referents) at a higher rate (high reduction, HR) in panels A and C, and at a lower rate (low reduction, LR) in panels B and D.
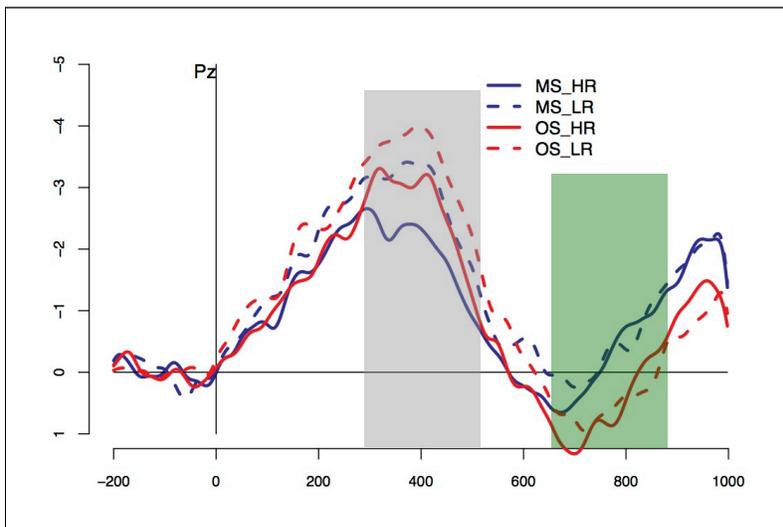

Figure 2. ERP waveforms at electrode Pz time-locked to the onset of the noun ('ball'). Negative amplitude is plotted upward. The OS conditions (red lines) a more negative amplitude compared to the MS conditions (blue lines) in the N400 time window (grey-shaded area), and more positive in the P600 time window (green-shaded area). LR (dashed lines) also resulted in a higher N400 compared to HR (solid lines) in the N400 time window.