Individual differences in the processing of pronominal ambiguity in English and Spanish: An ERP investigation

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INTRODUCTION

Variability has been attested in the processing of *referential dependencies* in both native and learner populations (Daneman & Carpenter, 1980; Sorace & Filiaci, 2006). Resolving a referential dependency (e.g.: *David shot at John as he*...) requires tracking linguistic information over the span of the sentence and integrating that information upon encountering the pronoun.

In ambiguous contexts, recent studies using ERPs have shown Nref, a component that indexes the inability to assign a unique referent (Van Berkum et al., 1999), but only in some participants:

• Nref observed only in participants with high working memory, suggesting that only high span individuals detect the ambiguity (Nieuwland & Van Berkum, 2006).
• Nref observed only in a subset participants. Other participants showed a positivity, which may index processing of grammatical violations (Nieuwland & Van Berkum, 2008).

Variability has also been observed in the processing of 'referential failure' (*Mary told Lisa that he...*). These contexts have typically been shown to give rise to a positivity (Osterhout & Mobley, 1995; but see Nieuwland, 2014).

We use ERPs to examine the relationship between working memory and referential processing in English and Spanish to better understand whether the nature of this variability is qualitatively similar across different languages.

STIMULI

Experiment 1: Referential Ambiguity
English
Tyler grabbed **Eric** because *he* was falling down the stairs. (2 referents)
Janet grabbed **Eric** because *he* was falling down the stairs. (1 referent)

Spanish
Miriam aceptó a **Natalia** porque *ella* estaba en una situación similar. (2 referents)
Álvaro aceptó a **Natalia** porque *ella* estaba en una situación similar. (1 referent)
'Miriam/Alvaro accepted Natalia because *she* was in a similar situation.'

Experiment 2: Referential Failure
English
Nicole believed **Alice** because *he* was a very genuine person. (no referent)
Nicole believed **Steven** because *he* was a very genuine person. (1 referent)

Spanish
Pablo conoció a **Rodrigo** porque *ella* estaba en la clase de matemáticas. (no referent)
Catalina conoció a **Rodrigo** porque *ella* estaba en la clase de matemáticas. (1 referent)
'Pablo/Catalina met Rodrigo because *she* was in math class.'

• 40 items per condition, plus 80 filler sentences (all grammatical sentences)
• Selected verbs without strong 1st or 2nd NP bias using ratings from Ferstl et al. (2011) for English and Goikoetxea et al. (2008) for Spanish. Ambiguity manipulation confirmed using online judgment task (n=90 native English; n=108 native Spanish).

METHOD

Participants
• 35 native English speakers recruited from university population (21 females, mean age 20, range: 18-26)
• 30 native Spanish speakers (data collection ongoing) recruited from university population (18 females, mean age 26.6, range: 19-38), from various L1 backgrounds (Colombia, Costa Rica, Dominican Republic, Ecuador, Honduras, Mexico, Paraguay, Peru, Spain, Uruguay, Venezuela). Tested in the U.S., no significant exposure to English before the age of 12.

Procedure
• Sentences presented one word at a time using RSVP (450ms word/300ms pause), with a fill-in-the-blank recall question following 1/3 of the sentences
• Stimulus presentation: Paradigm (Tagliaferri, 2005)
• EEG continuously recorded using Synamps2 amplifier (Compumedics Neuroscan, Inc.) and 32-channel Ag/AgCl electrode cap (Electro-Cap International, Inc.)
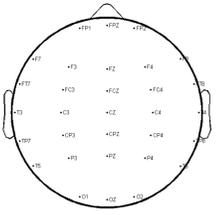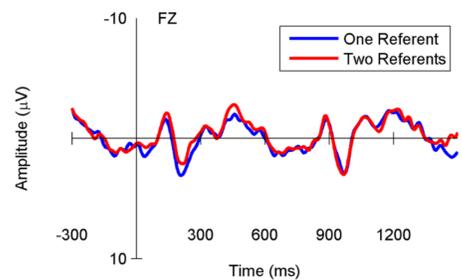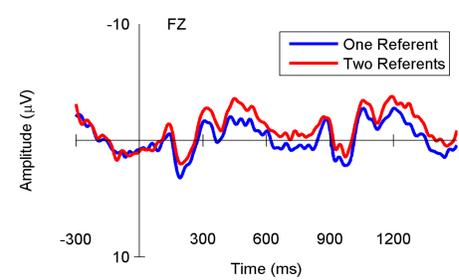
Individual Differences
• Participants were also tested on two measures of working memory:
  • Reading Span (Conway et al., 2005)
  • Counting Span (Conway et al., 2005)
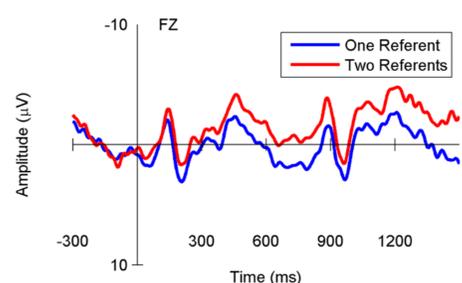
EX. 1 RESULTS: REFERENTIAL AMBIGUITY

All English Participants (n=35): No Effect
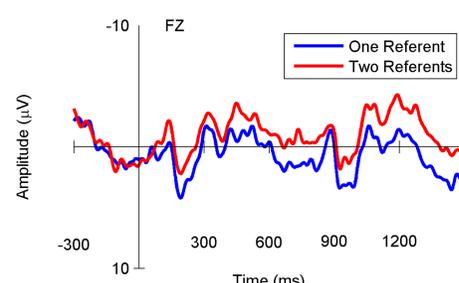

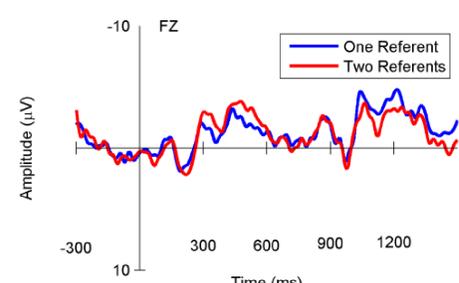**All Spanish Participants (n=30): Nref**

Group 1 English (n=18): Nref

Group 1 Spanish (n=17): Nref

• Group 1 English: Higher working memory related to larger negativities
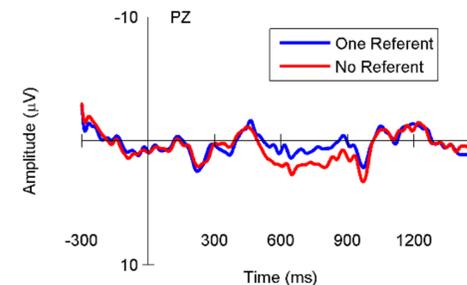
Group 2 English (n=17): Positivity
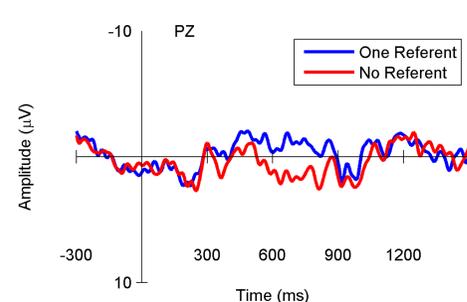

Group 2 Spanish (n=13): No Effect

• Group 2 Spanish: Higher working memory related to larger negativities
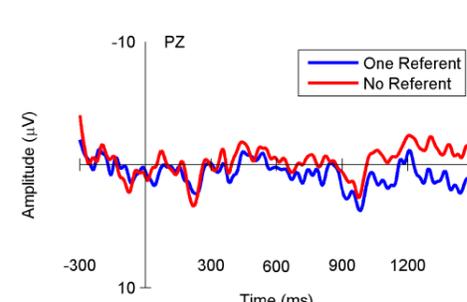
EX. 2 RESULTS: REFERENTIAL FAILURE

All English Participants (n=35): Positivity

Group 1 Spanish (n=17): Positivity

Group 2 Spanish (n=13): No Effect

RESULTS AND DISCUSSION

Summary of Results

Experiment 1: Referential Ambiguity (500-1400ms)
English
• Nref did not emerge in the overall analysis, but follow-up analyses were conducted following Nieuwland and Van Berkum (2008).
• Nref was observed only for a subset of participants; in Group 1, higher working memory is related to larger negativities.
• Group 2 showed a significant positivity.

Spanish
• Nref (*p*=.084) emerged in the overall analysis (n=30) but the effect was robust only for some participants (Group 1).
• Group 2 showed no significant effects of referential ambiguity. However, within this group, higher working memory is related to larger negativities.

Experiment 2: Referential Failure (600-900ms)
English
• A posterior positivity emerged in the overall analysis (n=35).

Spanish
• A significant positivity for referential failure emerged only in the group who was sensitive to referential ambiguity (Group 1).

Discussion

• In both English and Spanish, sensitivity to referential ambiguity emerges in only a subset of participants and is related to working memory. The ability to track and integrate the linguistic information relevant to evaluating multiple candidates during referential processing is related to individual differences in processing skills.

• In Spanish, sensitivity to referential failure emerged only in those participants who were also sensitive to referential ambiguity.

• As a first step, we have shown that the variability in the processing of referential ambiguity in English and Spanish native speakers is similar. Our next step is to examine variability within-brain, examining the processing of the L1 (English/Spanish) and L2 (English/Spanish) within the same individuals in order to better understand whether variability in the L1 is predictive of successful comprehension in the L2.

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