Agreement attraction and cognitive load in the aging brain: eye-tracking evidence from Spanish

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Language processing in aging is understudied, especially in grammar. [1]. This study examines (1) how aging affects agreement processing in Spanish and (2) how cognitive abilities like working memory capacity, inhibitory control and monitoring and updating capacity modulate these effects. Prior research shows older adults (OAs) take longer to process ungramm. sentences and make more agreement attraction errors than younger adults (YAs) [2, 3, 4]. We recorded the eye-movement patterns of 44 YAs (18-34 years; M=28.5, SD= 7.7) and 48 OAs (≥60 years; M=64.0 SD= 5.6) healthy native Spanish speakers. Participants read 60 sentences (normed via a likert scale study) in 4 experimental conditions: with subject noun phrases whose head matched (pl.) or mismatched (sg.) in number with the pl. verb (Grammaticality: gramm./ungramm.) and attractor nouns that matched (sg.) or mismatched (pl.) the verb (Attractor: sg./pl.) (Figure 1). Cognitive abilities were assessed using the automated reading span task (working memory)[5], an adapted stroop task (inhibitory control) [6] and the keep track task (monitoring and updating capacity) [7]. We expected (1) OAs to show larger grammaticality effects (Prediction 1.1) and commit more grammatical attraction errors than YAs (Prediction 1.2). In addition, (2) the potential age-related effects in cognitive abilities could modulate these patterns.(G)LME analyses at the critical verb region revealed main effects of group, grammaticality and attractor showing larger fixations and more regressions for OAs vs. YAs, in ungramm. than gramm. sentences, and in sing. vs. pl. attractors. An interaction of grammaticality by group appeared at *Regression Path Durations* showing larger grammaticality effects (longer regression-path durations in ungramm. than gramm. sentences) for OAs vs. YAs (confirming Prediction 1.1: see Figure 2). Another grammaticality by attractor interaction appeared at *Regressions-in* and *Total Time Durations,* showing that attraction effects were only significant in ungramm. sentences and unveiling a grammatical asymmetry of attraction effects [8]. Importantly, a 3-way interaction at *Total Time Durations* showed that this grammatical asymmetry of attraction effects was only significant for OAs at this measure (confirming prediction 1.2: see Figure 3) [2]. Finally, the keep track task showed a 4-way interaction of group, grammaticality, attractor and keep track values at *Regression Path Durations* (see Figure 4), with grammatical asymmetry of attraction effects only in OAs with larger keep track scores. Group differences in *Total Time* suggest that OAs may reanalyze more often than YAs, particularly in ungrammatical-mismatch (SSP) sentences (confirming prediction 1.1). However, in the ungrammatical-match (SPP) sentences, OAs fall down more into the grammaticality illusion (confirming prediction 1.2). Finally, the age-related increase in attraction effects seems to be mostly related to the OAs' ability to keep track of information.

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Figure 1. *Sample sentences of an item in the four experimental conditions resulting from the manipulation of the attractor number (singular vs. plural) and grammaticality (grammatical vs. ungrammatical sentences). The two elements involved in the attraction relation are bolded across all conditions, and the critical region for analysis (the verb) is framed in squares.*

(i) Grammatical-Mismatch (Plural subject-Singular attractor-Plural verb; PSP):

Los pasteles$_{PL}$ *con el dibujo*$_{SG}$ *nunca* ***ganaron***$_{PL}$ *un premio de repostería debido a la calidad de la masa.*

(ii) Grammatical-Match (PPP):

Los pasteles$_{PL}$ *con los dibujos*$_{PL}$ *nunca* ***ganaron***$_{PL}$ *un premio de repostería debido a la calidad de la masa.*

(iii) Ungrammatical-Mismatch (SSP):

****El pastel***$_{SG}$ *con el dibujo*$_{SG}$ *nunca* ***ganaron***$_{PL}$ *un premio de repostería debido a la calidad de la masa.*

(iv) Ungrammatical-Match (SPP):

****El pastel***$_{SG}$ *con los dibujos*$_{PL}$ *nunca* ***ganaron***$_{PL}$ *un premio de repostería debido a la calidad de la masa.*

The cake(s)$_{MASC.SING./PL}$ with the design(s)$_{MASC. SING./PL}$. never won$_{V^{o}PL}$. a prize bakery due to quality dough.

Gloss: The cake with the designs never won a bakery prize due to its dough quality.

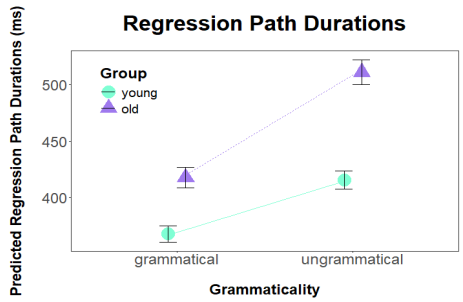

Figure 2. Graph plotting the two-way interaction of grammaticality by group in *Regression Path Duration* at the verb region with larger grammaticality effects in the ungrammatical than grammatical sentences for the OAs compared to YAs

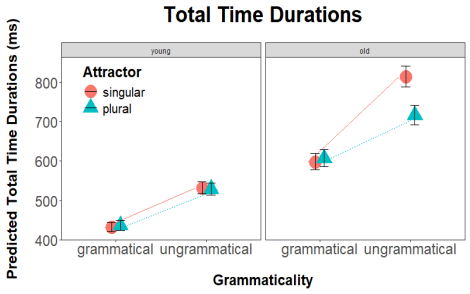

Figure 3. Graph plotting the triple way interaction of grammaticality by attractor by group in *Total time Durations* at the verb region with a significant effect of attraction only for the older adults in the ungrammatical-mismatch (SPP) condition.

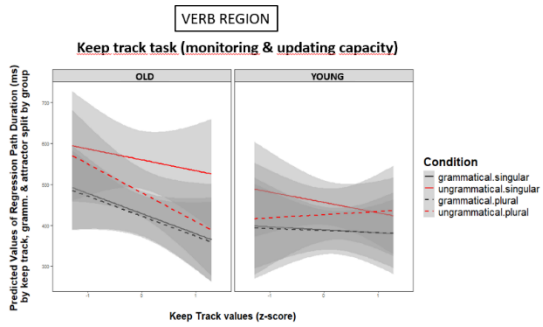

Figure 4. Graph plotting the four way interaction of keep track by grammaticality by attractor by group at *Regression Path Duration* at the verb region, with the grammatical asymmetry of attraction effects only for OAs (in the ungrammatical sentences).