ACQUISITION AND PROCESSING OF A NON-TRANSPARENT GENDER SYSTEM: EVENT-RELATED BRAIN POTENTIALS IN FRENCH CHILDREN

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As in many romance languages, French exhibits gender marking on adjectives, and other structures. However gender marking on adjectives is characterized by three different patterns: (1) those bearing derivational morphology with inherent gender marking, (2) variable adjectives with what is traditionally called *inflectional* morphology, and (3) no distinction between masculine and feminine forms in the auditory (and often written) modality.

    1. *Un charme* + -ant/e → *charmant* [ʃaʁmã] or *charmante* [ʃaʁmãt]
     'a charm'   'charming.m'   'charming.f'
    2. *Vert* 'green.m' [vɛːʁ] vs. *verte* 'green.f' [vɛʁt]
    3. *Rouge* 'red.m/f', *bleu/e* [blœ] 'blue.m/f'

The second case (*vert/e*) interests us, as it leads to difficulties in extracting morphological patterns or rules (Royle, 2011). Feminine adjectives can carry various final consonants such as /n/, /d/, /s/, /ʃ/ and /j/, and it could be argued that these adjectives are not computed as morphologically complex forms but rather stored whole (as *chunks*) in the lexicon. Elicitation data from French children shows that feminine forms are more difficult to produce than masculine ones at least up to age 5 (Roulet-Amiot & Jakubowicz, 2006), and that some younger children (around age 3) do not understand the feminine forms of some high-frequency adjectives even if they know their masculine counterparts (see 4).

    4. *La grenouille verte* [lagʁœnujvɛʁt] 'the.f frog green.f' (from Royle & Valois, 2010)

Errors on French adjectives can also be observed in older children and adults who prefer the masculine default (Boloh & Ibernon, 2010). Experimental data support the interpretation that, in French, adjectives involve *no change*, i.e. adults maintain the same form for a novel adjective in feminine and the masculine (e.g., *bravais/e*), similar to (3) above (Fink, 1985).

    Another issue in acquisition is that of agreement processing. Although French adjectives as in (2) arguably do not bear regular and parsable morphology, French children are still able to produce and process appropriate nominal agreement, but this is only evidenced by a restricted set of adjectives in spontaneous speech corpora. The corpus really only supports agreement mastery for determiners and nominative clitics (Valois & Royle, 2009), thus the need for elicitation tasks to test adjective agreement mastery.

    However, an important issue that elicitation and corpus studies cannot directly address is whether children produce adjective agreement errors because they have not learned the specific phonological form (lexeme) of a given variable adjective, or rather because they do not fully master agreement (i.e. phi-feature checking, Kerstens, 1993). Most acquisition studies assume that the production of variable adjectives in appropriate contexts is support for agreement checking and its cognitive underpinnings, and that adjective agreement is acquired at the same time as other types of agreement. In fact we do not know whether this is true. Alien learner paradigms assess the existence of linguistic rules using grammaticality judgment tasks where children have to 'help' an alien learn their language by giving it positive or negative feedback on utterances. However, this approach reveals little about the underlying cognitive processes involved. Electroencephalographic (EEG) recording of electrical activity on the scalp's surface can track the time course of language processing in exquisite detail. It can measure voltage changes with millisecond accuracy during language processing. These changes are called event related potentials (ERPs). ERPs can track agreement errors in adults without grammaticality judgement tasks, using auditory visual stimuli as in (5), where the adjective does not agree in gender with the noun, compared to semantic-error conditions where the picture does not match the noun –e.g. a picture of a [CHAIR] on the table– and grammatically-correct control conditions.

    5. *Je vois une cuillère *vert sur la table*   [picture of green spoon on table]
     'I see a.f spoon *green.m on the table'

French adults show typical ERP patterns for gender errors (a LAN followed by a small P600

in agreement error conditions, Molinaro et al, 2011), while semantic errors elicit a classic semantic N400 (Kutas & Federmeier, 2011) followed by a sentence-repair P600 (Royle et al, 2013).

Our study of 40 native French children aged 4;05–8;11 aimed to establish at what age they start to show adult-like neurocognitive patterns for adjective agreement. Stimuli were created using high frequency and early-acquired nouns and adjectives as in (5). Children participated in two sessions that lasted 1.5 hours each. Children were also screened on hearing and linguistic tasks. A meta-linguistic task asking children to identify and correct semantic (SE) or agreement (AE) errors provided the highest variability in the group, and thus was used as a predictor for ERP patterns, in addition to age.

For both semantic and agreement errors we found ERP differences with the control (correct) conditions. A comparison of agreement and semantic errors established differences in timing of the ERP effects, with semantic processing occurring more rapidly than agreement ones in children (contrary to adults who showed similar timing for both). SE meta-linguistic abilities correlated with semantic processing: children with better SE scores showed a more adult-like N400 / P600 pattern and a larger and more sustained N400 to semantic errors. Furthermore, AE meta-linguistic abilities modulated adjective-agreement error processing, which elicited anterior and central N400s. Baseline-independent peak-to-peak analyses revealed that the difference between the N400 and the subsequent positivity was larger at frontal sites in children with lower AE scores, and larger in posterior sites in children with higher AE scores, similar to adults.

Our data establish that French children aged 4 to 9 are processing gender errors, but that differences can be observed 1) between low and high AE children and 2) with adults, as high AE children have not yet converged on the adult ERP pattern (a LAN followed by a small P600). The ERP data suggest that children may be processing adjective agreement errors as lexical errors (as indicated by N400s rather than LANs). It thus seems that acquisition of phi-feature checking for French adjectives can be protracted in French, even though children make relatively few speech errors on these structures. We argue that this lengthy acquisition process could be linked to the irregularity and lack of transparency of agreement marking in underived French adjectives.

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