Cognitive abilities and prosody in question-response interactions: A clinical study

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In question-response interactions, short latencies (~200 ms) require that listeners grasp relevant information from their interlocutors' questions as soon as it becomes available in order to plan their responses before the ongoing turn is finished [e.g., 1, 2]. However, strategies for speech production planning vary with cognitive abilities. For instance, speakers with a high speed of processing plan their speech in a more incremental way and begin speech more quickly [3].

This study investigates the effects of cognitive abilities in question-response interactions from a clinical perspective, by comparing French healthy controls (HC) and individuals with cognitive disorders related to Multiple Sclerosis (MS). MS is an autoimmune disease characterized by the production of widespread demyelinating lesions in the brain and spinal cord. Cognitive impairment (CI) affects 40–65% patients with MS [4] and includes deficits on specific cognitive capacities involved in speech planning [5].

In a question-response game, we monitored eye movements to lexical competitors (**ca**nard/**ca**non, "duck/cannon") during question comprehension as well as latencies of speech responses. Participants orally replied to 24 trials consisting of a sequence of two prerecorded questions (Q1 and Q2). Q1 asked whether the location of one object was above or below a geometric shape (e.g., *Est-ce que le canard est au dessus du rond?*, "Is the duck above the circle?"), and the following Q2 (e.g., *Et est-ce que le canard/canon est en dessous du carré?* "And is the duck/cannon below the square?") asked the location either of the previously mentioned object (anaphoric condition) or of a new object (non-anaphoric condition). Participants responded to Q2 keeping the form of their response constant (e.g., "No, the duck is above the square"). Questions were all parsed into 3 Accentual Phrases (the basic prosodic unit in French). The object name could either carry a focal accent on the ambiguous syllable or not [6]. We expected for HC that the focal accent on the ambiguous syllable should facilitate a non-anaphoric interpretation, while the lack of the accent should induce higher fixations to the just-mentioned object [7]. Given their cognitive impairment, MS patients were predicted to have more trouble in immediate, parallel processing of intonation information, resulting in smaller effects of prosody on eye movements and increased speech latencies.

A sample of 26 patients of early stages of relapsing-remitting MS (< 12 years) and 18 HC (matched in age, sex, and education) has participated so far in the experiment. (Among the inclusion criteria: no relapses at the time of the study; no history of optic nevritis; optimal vision; absence of dysarthria, assessed through tests from the BECD [8]). Participants underwent a series of standard neuropsychological tests, with the two populations differing only in semantic and phonemic fluency, speed of information processing (WAIS IV), and vocabulary (Mill Hill Vocabulary scale) ($p<0.05$). Logistic models with mixed effects showed a bias for fixating "old" pictures, i.e., that were already referred to in Q1 ($t=-2.3$, $p=0.02$) in both HC and MS patients. For HC, in the non-anaphoric condition, the likelihood of fixations to the already mentioned object was higher when the word was deaccented than when the word was focused ($t=1.9$, $p=0.04$), with phonetic material *preceding* the ambiguous syllable already guiding listeners' interpretation ($t=2.3$, $p=0.01$). No effects of prosody were found in the anaphoric condition. For MS patients, prosody had no effects on eye movements. MS (386 ms) than in HC (202 ms), indicating that cognitive deficits might be strongly disruptive in a real interaction ($t=2.5$, $p=0.01$). Hence, cognitive abilities affect dialogic interactions, with patients at early MS stage having more difficulty both in question comprehension and response planning. This is also in line with the hypothesis that speech production planning is flexible [9]. We aim to further enlarge the number of participants and to investigate the correlations between neuropsychological scores and individual eye movements and verbal performances.

Figures

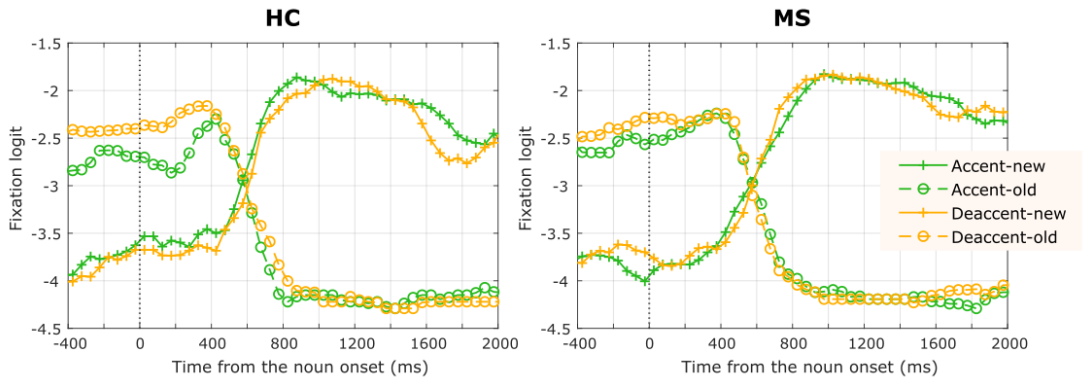

Figure 1. Fixation logits for Q2 in the non-anaphoric condition (canard -> canon): Trials with vs without focal accent are signaled by different colors (green vs. yellow). Fixation logits for Q2 in the non-anaphoric condition (canard -> canon): Trials with vs. without focal accent are signaled by different colors (green vs. yellow). Dots = fixation to the old object, ie, to the object already mentioned in Q1; crosses = fixations to the new object.

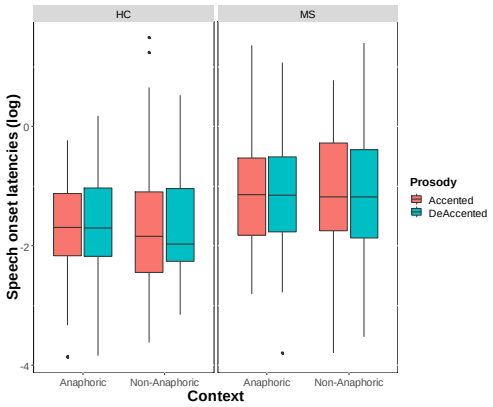

Figure 2. Latency of speech reponses (log) across discourse contexts and prosody in Healhy Controls (left) and MS patients (right).

References

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