Manipulating difficulty at different levels of language production elicits distinct patterns of disfluency

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To reveal the underlying cause of disfluency, several authors attempted to relate the pattern of disfluencies to difficulties at specific levels of production, using a Network Task (e.g. Oomen & Postma, 2002). In this task, participants describe a route through a network of pictures (Fig. 1). This allows for the manipulation of the items to create difficulties at specific stages (e.g. conceptual generation) while holding others constant (e.g. lexical selection). We conducted two experiments to examine the pattern of disfluency related to lexical selection difficulty (i.e. low name agreement), grammatical selection difficulty (i.e. neuter gender, which occurs less frequently than common gender in Dutch), and conceptual difficulty (i.e. blurriness). We also examined whether, by contrast, the manipulated difficulty could be predicted based on the pattern of disfluency associated with it, using multivariate pattern analyses (MVPA, Haynes & Rees, 2006).

In Experiment 1, 20 native Dutch speakers performed 20 network tasks. To examine the initial stage of lexical access we manipulated name agreement; to examine grammatical selection we manipulated grammatical gender. Linear-mixed effects models were performed with name agreement (low/high), gender (neuter/common), and their interaction as fixed effects. In Experiment 2, we examined the conceptual generation of the message, by manipulating the visual identification of some items. Twenty further native Dutch speakers performed 20 network tasks. We ran linear-mixed effects models with conceptual difficulty (blurred/non-blurred items) as a fixed effect. In both experiments, we analyzed: self-corrections, silent pauses, filled pauses, and prolongations. We then used MVPA, training classifiers on disfluency features for each participant, to predict whether s/he was about to mention a low or high name agreement item, a common gender or neuter gender item, or a blurred or non-blurred item.

In Experiment 1, low name agreement items induced more self-corrections and silent pauses than high name agreement items, while common gender items elicited more prolongations than neuter gender items. MVPA demonstrated that lexical selection difficulty is predictable from disfluency patterns, and that silent pauses are the most reliable feature across participants (Fig. 2). Classification accuracies were also above chance when classifying items' gender and only prolongations were consistent across participants. In Experiment 2, contrary to what was expected, blurriness did not induce more disfluency. MVPA yielded complementary findings. They revealed that the classifier could predict whether each participant was about to name blurred or control pictures, but that none of the features was affected in a consistent way across participants. In other words, impeding the conceptual generation of a message affected the pattern of disfluencies of each participant, but this pattern differed from one participant to another.

We replicated the finding that lexical access difficulties elicit self-corrections and pauses (Hartsuiker & Notebaert, 2010). However, contrary to what was expected, neuter gender did not elicit more disfluency than common gender. This effect could be related to the phonological form of the common gender determiner ('de' in opposition to the neuter one 'het'), which is more likely to encourage prolongations. MVPA reinforced these findings, by showing their consistency across participants. On the contrary, these analyses showed that conceptual difficulty manifests itself differently from one participant to another. They therefore point to a need for current models of language production to capture inter-individual variability.

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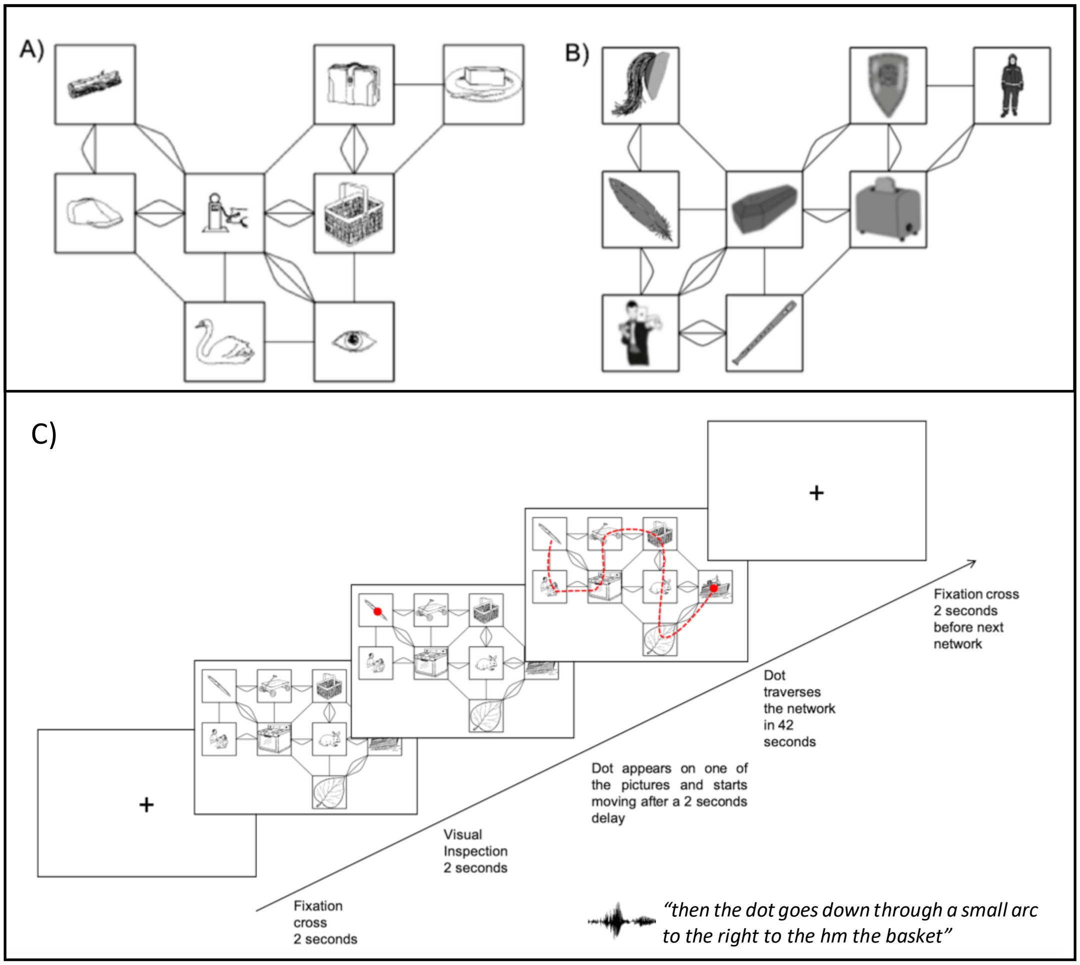

Figure 1. Example of a network for A) Experiment 1 and B) Experiment 2. Panel C) represents the procedure of each experiment. The arrow represents the time course of the experiment. Instructions were given to provide an accurate description of the network using complete sentences and to synchronize the description with the dot that moved through the network.

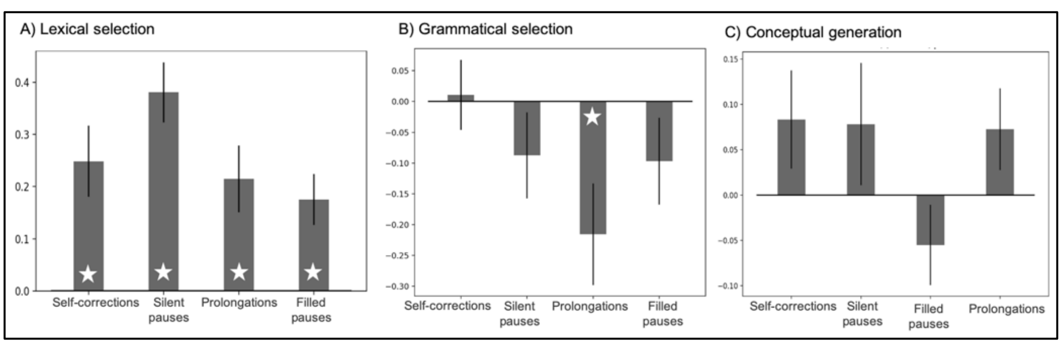

Figure 2. Contribution of each feature when classifying the pattern of disfluency related to each manipulation. White stars indicate significance. On the y-axis, positive values indicate the predicted difficulty (i.e. A) low name agreement; B) neuter gender; C) blurriness).
A) Lexical selection: self-corrections ($t(19)=3.6$, $p<.01$); silent pauses ($t(19)=6.5$, $p<.0001$); prolongations ($t(19)=3.2$, $p<.01$) filled pauses: $t(19)=3.5$, $p<.01$).
B) Grammatical selection: prolongations ($t(19)=-2.5$, $p<.05$).