

COGNITIVE OVERLOAD AND SUBJECT-VERB AGREEMENT ERRORS: AN ON-LINE APPROACH

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During the writing of a sentence, the agreement between two grammatical units seems to be accomplished without difficulty. However, occasionally, this operation fails. When a second task was added to increase the memory load, Fayol and Got (1991), as well as Fayol, Largy and Lemaire (1994) showed that errors were all of a "proximity concordance" nature. Hupet, Schelstraete, Demaeght & Fayol (1996) as well as Hupet, Fayol and Schelstraete (1998) emphasized the impact of some semantic properties of nouns next to the verb in reverse-order sentences. When this noun is a plausible semantic subject, it induced agreement errors because the writer made a misassignment of the subject's role. After having performed several experiments, these authors invoked a complex processing around the verb with control operations. Hupet et al. (1998) considered that control operations are likely to take place just before writing the verb or when writing the verb. If these assumptions are correct, length of pauses at these locations would be indicative of an increase of processing. This augmentation would be superior precisely when the participant makes an other task like mentally adds a series of digits.

MAIN GOALS

The first aim of this experiment is to get more information on this processing with chronological variables, namely the pauses made by a writer during the executing of the dictated sentence.

The second aim of the study is to get information concerning the influence of the secondary task. Are frequency and duration of pauses modified by the additional task which consumes attentional resources?

In order to concretize these goals, the experiment of Hupet, Schelstraete, Demaeght & Fayol (1996) was duplicated. The same dependent variables were used. Moreover, pauses were used as novel indicators of the writer's processing.

METHOD

Materials

Materials were the same as in Hupet, Schelstraete, Demaeght & Fayol (1996) study. Thirty-two experimental sentences were used in this research. In half of these sentences, the preverbal noun N1 and the subject N2 matched in number. Eight sentences were of the SS type (i.e., N1 singular, verb, N2 singular). Eight sentences were of the PP type (i.e., N1 plural, verb, N2 plural). In the other half, the preverbal noun (N1) and the subject (N2) did not match in number. Eight sentences were of the SP type (i.e., N1 singular, verb, N2 plural). Eight sentences were of the PS type (e.g. N1 plural, verb, N2 singular).

Examples:

Match SS sentence with implausible NI:

" Dans l'étang penche le peuplier " = Into the pond hangs the poplar.

Match PP sentence with plausible NI:

" Avec les jeunes parlent les vieux " = With the young talk the old.

Mismatch PS sentence with plausible NI

" Pendant des heures tourne le disque " = For hours play the record.

Mismatch SP sentence with implausible NI:

" Sous les étoiles rêve la mariée " = Under the stars dreams the bride.

Within each sentence type, four sentences had a preverbal noun N1 that could have constituted a semantic plausible subject for the verb ("jump, sheep, flea ") and four other sentences had one that could not ("cry, night, cat ").

Both the plausible and the implausible sentences were randomly assigned to the four number order conditions (i. e., SS, PP, SP, PS).

For each sentence, a series of six digits (from 1 to 9) was prepared with the only constraint that the addition of the first two digits of the series had to give a result higher than 10. These series were not the same than those of Hupet et al. (1996) because they were not included in the materials of their study.

Participants

40 native French speakers, who were undergraduate students at the University of Provence (Aix-en-Provence), volunteered to participate in this experiment.

Procedure

The participants were all run individually and were asked to write down a sentence and add mentally at the same times a series of digits that would be orally presented at different points in their transcription.

The digits were dictated by the experimenter in the following standardized way. The first digit was dictated when the participant began to write the determinant 1. A second digit was dictated when the participant was writing the last syllable of N1. A third digit was dictated when the participant began to write the determinant 2. Additional digits were dictated at the end of a sentence whenever participant paused before writing down the result of the addition. A training was used to get the participant accustomed to this double-task paradigm. Participants wrote on a sheet of paper which was fixed on a digital tablet with a electronic pen. The software " G-STUDIO " (Chesnet, Guillaibert & Espéret, 1994) was used to record and to analyze the temporal characteristics of sentences' produced.

Scoring

Dependent variables were the percentage of agreement errors and the percentage of addition errors per sentence type.

The chronological dependent variables were the duration and the frequency of three types of pauses. Type of pauses was determined by the location of the pause : (a) after the N1 and before the verb; (b) within the verb; (c) after the verb and between the subject N2. Only pauses > 250 milliseconds were considered.

RESULTS

Agreement verb errors were more important in dual task condition (14,55%) than in single task condition (3,59%; $F(1,38) = 9,54, p < .004$; Figure 1). These errors were more important with mismatch sentence type (15,62%) than with match sentence type (4,1%; $F(1,38) = 29,59, p < .0001$; Figure 1). This phenomenon was more important in the load memory condition ($F(1,38) = 7,37, p < .01$).

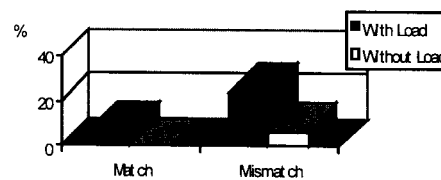


Figure 1: Mean percentages of erroneous verb agreements in reverse-order sentences (match versus mismatch) as a function of the memory load (with or without secondary arithmetical task)

There was no significant effect of plausibility of preverbal noun ($F > 1$). No other interaction (Figures 2 & 3) were significant.

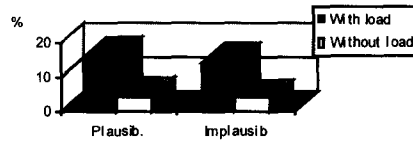


Figure 2 : Mean percentages of erroneous verb agreements in the subject role plausibility of the preverbal noun (plausibility versus implausibility) as a function of the memory load (with or without secondary arithmetical task)

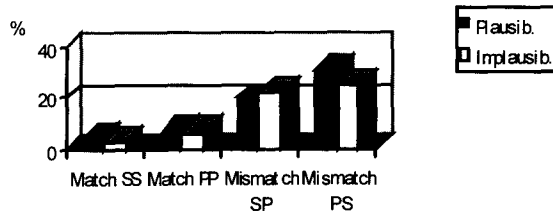


Figure 3 : Load memory condition: Mean percentages of erroneous verb agreements in reverse-order sentences (match versus mismatch) as a function of the subject role plausibility of the preverbal noun (plausibility versus implausibility) (SS = singular preverbal noun, singular postverbal noun; SP = singular preverbal noun, plural postverbal subject, etc.)

In the dual task condition, the plural preverbal (17,23%) noun significantly incited to make more agreement errors than the singular preverbal noun (11,86%; $F(1,19) = 7,25$, $p = .014$; Figure 4).

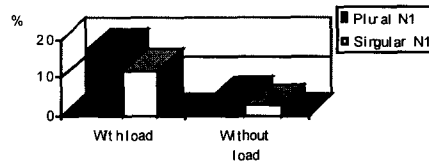


Figure 4 : Mean percentages of erroneous verb agreements in the memory load conditions (with or without secondary arithmetical task) as a function of the number of preverbal noun (plural N1 versus singular N1)

The mean percentage of addition errors were not influenced by the plausibility of the preverbal noun ($F < 1$; Figure 5) even by the sentence type (match sentence type = 17,81%; mismatch sentence type = 13,12%; $F(1,19) = 2,02$, $p = .17$; Figure 5).

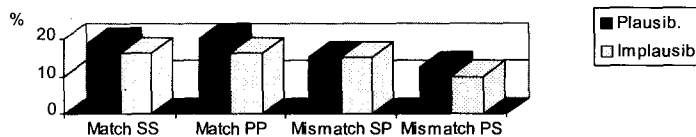


Figure 5 : Mean percentages of erroneous arithmetical operation in reverse-order sentences (match versus mismatch) as a function of the subject role plausibility of the preverbal noun (plausibility versus implausibility) (SS = singular preverbal noun, singular postverbal noun; SP = singular preverbal noun, plural postverbal subject, etc.)

Figure 6 shows that participants made more pauses before (88,75%) and after (80,62%) than within the verb (22,58%).

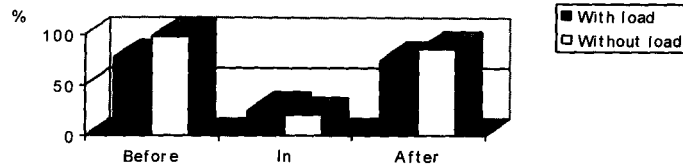


Figure 6 : Percentages of pauses before, within and after the verb as a function of the memory load (with or without secondary arithmetical task)

For both the pauses before and after the verb, participants made more pauses in the without load condition than in the with load condition ($F(1,38) = 16,36, p < .0001$; $F(1,38) = 3,93, p = .054$). This was not the case for the within pauses ($F < 1$).

Percentages of pauses before the verb were not significantly modified by the match or mismatch sentence types ($F < 1$), or by the plausibility of the preverbal noun ($F < 1$). Percentages were more important when the preverbal noun was plural (89,65%) than singular (87, 82%; $F(1,38) = 11,67, p < .002$). Percentages of pauses within the verb were significantly modified by the syntactic and semantic factors (Match/mismatch factor: $F(1,38) = 6,06, p < .02$; Plausibility factor: $F(1,38) = 4,75, p < .035$; Interaction between Match/mismatch and Plural/singular: $F(1,38) = 12,83, p < .001$). Percentages of pauses after the verb were significantly modified by the syntactic and semantic factors (With/without load factor x Match/mismatch factor : $F(1,38) = 5,14, p = .029$; other three factors interactions: $F(1,38) = 4,73, p = .035$; $F(1,38) = 5,41, p = .025$). More precisely, in the without load condition, an interaction between Match/mismatch factor x Plausibility factor was significant $F(1,19) = 4,39, p < .049$).

Figure 7 shows that the duration of before (373,5 ms) and after (342,45 ms) pauses seems to differ and that they perhaps in interaction with the degree of load. The statistical analysis of covariance is in progress.

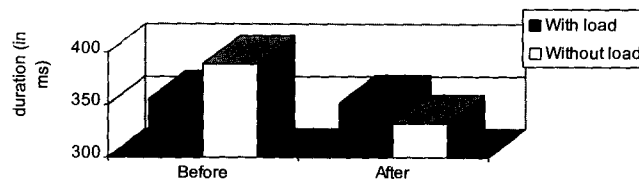


Figure 7 : Mean duration of pauses before and after the verb as a function of the memory load (with or without secondary arithmetical task)

Experimental factors have no significant effect on the “before” and “after” duration of pauses. The double task did not improve the duration of pauses in comparison with the single task condition for both localization of pauses. Only Match/mismatch factor did modify significantly the before pauses in interaction with the degree of load ($F(1,38) = 4,4, p = .04$; Cf. Figure 8).

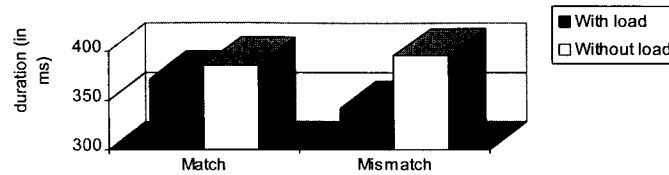


Figure 8 : Mean duration of pauses before the verb in reverse-order sentences (match versus mismatch) as a function of the memory load (with or without secondary arithmetical task)

This effect was not significant for after pauses

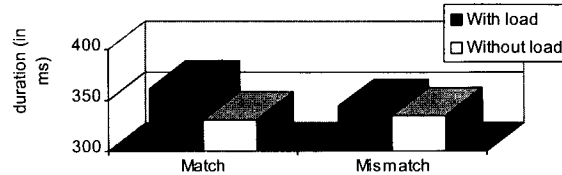


Figure 9 : Mean duration of pauses after the verb in reverse-order sentences (match versus mismatch) as a function of the memory load (with or without secondary arithmetical task)

CONCLUSION

Results of Hupet, Schelstraete, Demaeght and Fayol (1996) as well as Hupet, Fayol and Schelstraete (1998) are not totally duplicated in this experiment. The effect of the preverbal noun's plausibility does not provide information to writers that can be used to control the procedures which underlie the construction of the agreement. By contrast, the effect of the number of this preverbal noun is more consistent for the participants. A plural preverbal noun seems to warn writers more than a singular noun.

Results concerning chronological data are promising. Writers use a economical strategy when they have a double task to perform : they make less pauses and the duration of these pauses are not longer. It is necessary to verify with others experiments if the distribution of pauses is also different between the single and the double task.

By contrast, pattern of pauses' utilization is very interesting. Around the verb, writers process differently. Before the verb, writers allocate a strong attention on the plural of the preverbal noun (augmentation of pauses) but are indifferent to the other factors (plausibility of preverbal noun and mismatch between the preverbal noun and the subject). The simultaneous semantical plausibility of the preverbal noun and of the subject seems to be compared to each other. The comparison of the number (mismatch) of the preverbal noun and of the subject is also processed. When they wrote the verb and after they have written the verb, these features of the sentence began to be important and the plural of preverbal noun lost importance. Consequently writers made more frequent pauses. The hypothesis of Hupet et al. (1998) is consistent with these observations.

Results concerning the duration of pauses are no informative in this research. Others experiments are necessary to understand the interactive effect between the degree of load (single or double task) and the sentence type (Match or Mismatch). Perhaps it is necessary to analyze shorter pauses (< 250 ms). Data about the editing of the verbal flexion during the task offer potentially interesting variables for future studies.

REFERENCES

- Chesnet, D., Guillaibert, F. & Espéret, E. (1994). G-Studio : un logiciel pour l'étude en temps réel des paramètres temporels de la production écrite. *L'Année Psychologique*, 94, 283-294.
- Fayol, M. & Got, C. (1991). Automatisation et contrôle dans la production écrite; Les erreurs d'accord sujet-verbe chez l'enfant et l'adulte. *L'Année Psychologique*, 91, 187-205.
- Fayol, M., Largy, P. & Lemaire, P. (1994). When cognitive overload enhances subject-verb agreement errors: A study in French written language. *Quarterly Journal of Experimental Psychology*, 47A, 437-464.
- Hupet, M., Schelstraete M.A., Demaeght N. & Fayol, M. (1996). *L'Année Psychologique*, 96, 587-610.
- Hupet, M., Fayol, M & Schelstraete M.A. (1998). Effects of semantic variables on the subject-verb agreement processes in writing. *British Journal of Psychology*, 89.