# The Influence of Gender Information on Written Language Production

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(Paper presented at the DFG-Workshop on Gender Language Production, Leipzig 2000.)

*The authors report on a gender priming experiment in German using typewritten language production in a picture naming task. The experiment was conducted with 20 native speakers of German with a wide range of typing skills. In the gender primed condition, gender information was provided by presenting and naming the definite German determiner before the picture naming task. The unprimed condition consisted only of the picture naming task. Picture naming was done by producing the bare noun. In the analysis of the initial latencies, no difference between the primed and the unprimed condition was found. However, in the analysis of the writing time (e. g. the time needed from the first to the last keystroke of word production – excluding the initial latency and the <enter> key) a significant priming effect (55 ms faster writing times in the primed condition) was obtained. We argue that this effect might be due to facilitation in lexical retrieval processes during word production in the gender primed condition. The source (whether facilitation stems from gender or from context information) and the localization of the effect (in terms of syllable and morpheme boundaries) within the word still has to be identified.*

## Introduction

The processing of syntactic gender is a topic of strong interest in psycholinguistic research (see Comrie, 1999; Friederici & Jacobsen, 1999; Schriefers & Jescheniak, 1999 for recent reviews). Priming of syntactic gender is a topic approached in the context of language production (Jescheniak, 1999) as well as in the context of language comprehension (Frederici & Jacobsen, 1999). The general question guiding gender priming experiments is the following: Does providing gender information in advance of a picture naming task influence the picture naming process? Depending on the theoretical background the experiment is based on, a wide range of predictions and explanations for effects can be found, for instance a facilitatory effect due to a restriction of the search space to gender congruent nouns located at the level of picture identification (for a comprehensive list of theoretical approaches see Frederici & Jacobsen, 1999 and Jescheniak, 1999). A facilitatory effect of gender information is assumed to show in shorter initial naming latencies in gender primed picture naming tasks.

Picture naming involves a whole series of processes, ranging from picture identification (which is more a language comprehension task) to lexical access, word form encoding and articulation (which are language production tasks) (Levelt et al., 1999). That makes it hard to decide whether to attribute an obtained gender priming effect to the picture identification or to the production procedures. Therefore, to identify gender priming in language production, a task or a measurement is needed that is specific to language production. The use of written instead of spoken language enables to measure not only the naming onset, but as well the time course of word production. This enables to analyze production processes separate from the initial picture identification processes: Whereas all processes are reflected in the initial naming latencies, only genuine production processes are reflected in the time course of word production.

In the following, we first present results supporting the view that the time course of language production reflects lexical processes. Then we present a gender priming experiment using written language production.

## *Typewritten Language Production*

Analyzing (type)written language in the context of language production has one major advantage compared to spoken language: Not only the initial response latency, but as well the time course of language production is readily available for analysis. The temporal pattern of keystrokes during the production of a word does not only reflect motor processes, but as well lexical and phonological processes, as has been shown by Will and colleagues (Will et al., submitted). In this section, we give a short overview of the main findings obtained concerning the dynamics in the production of typewritten language.

Written language production allows to measure the exact point in time for every single keystroke executed within the production of an utterance. The time needed until the first key stroke is executed is called the initial (or naming) latency. This variable is interpreted in the same way as the corresponding initial latencies measured in spoken language production. The additional variables available in typewritten language are measurements of the exact point in time for every key stroke following the initial key stroke. These further key strokes reflect the time course of language production. As they each measure the time interval from the preceeding to the pressed key, those measurements are called Inter Key Intervals (IKIs).

The size of the IKIs depends to some extent on the letter pairs (digraphs) involved: some combinations of keys are more frequent than others. But a much greater influence on the time course stems from lingusitic units. We distinguish between different IKI types according to linguistic units (syllables and morphemes). IKIs occurring at syllable boundaries are called syllable IKIs (S IKIs). IKIs occurring at morpheme boundaries are called morpheme IKIs (M IKIs). Whenever syllable and morpheme boundaries occur together, the corresponding IKI is called a SM IKI. Default IKIs (where neither syllable nor morpheme boundary occur) are called letter IKIs (L IKIs).

The different IKI types can be distinguished in the time course of word production: they show significantly different sizes. L and M IKIs are the smallest (and between letter and pure morpheme boundaries no significant difference has been obtained). Significantly larger are S IKIs, and signifiantly larger than the pure S IKI are SM IKIs. With these findings, a hierarchy between the different linguistic units has been established. On the bottom, no unit boundaries or a morpheme boundaries are found, above syllable borders, and on top the combination of syllable and morpheme boundaries. This hiearchy is independent of the digraph involved: It still shows when the same digraph occurs at different border types.

The large size of SM IKIs is assumed to reflect lexical processes on the basis of two findings: First, in the comparison of word production after picture or visual word presentation, SM IKIs are significantly larger for picture presentation than for written word presentation. No significant difference between picture and written word presentation is obtained for S, M, or L IKIs. The argument is that in the picture presentation condition, lexical retrieval is not completed when word production begins, but at SM borders the lexicon has to be reaccessed to retrieve the remaining information. Second, unlike S, M or L IKIs, SM IKI sizes are dependent on word frequency. The word frequency effect is known to be a lexical process (Jescheniak & Levelt, 1994).

## Gender Priming Experiment

The experiment reported here had a dual character. We tested the general gender priming hypothesis that gender priming will facilitate picture naming. But what does facilitation mean? The dual character comes into play in the interpretation of the facilitatory effect we were looking for. On the one hand, we expect a facilitatory effect to be reflected in shorter initial naming latencies. On the other hand, we expect that a

facilitatory effect of gender priming might be reflected in the writing time as well (e.g. the time needed from the first to the last keystroke of word production – excluding the initial latency and the <enter> key). As there are no studies available using this measure, we used the experiment as a pilot study trying to identify effects of gender information on the writing time.

Based on results obtained in a pretest, we tested the following hypotheses, splitting the general gender priming hypothesis by the order of stimulus presentation: For the first presentation of a picture, when the picture still has to be identified, the preactivation of gender information will facilitate picture naming. In this view, gender information restricts the search space to nouns of the same gender. For the second (and all following) picture presentations, no effect of gender priming will be found, as the picture has already been identified. The restriction of the search space expected for the first picture presentation will show in shorter naming latencies in primed compared to unprimed conditions.

As there are no results available yet concerning the writing time, we did not make explicit predictions concerning this variable.

According to our hypothesis, which distinguishes between responses to unknown and known pictures, we presented each picture twice to each participant. Each item occurred the same number of times in the primed and the unprimed condition, couterbalanced across participants.

# Methods

## *Participants*

Twenty students of the University of Osnabrück took part in the experiment. They received DM 10 for participation. All were native speakers of German. There were no specific requirements concerning typing skills for participation, so the participants showed a wide range of typing fluency.

## *Material*

Thirty-six pictures, twelve for each gender, were used as experimental items. They were selected from the appendix of Snodgrass & Vanderwart (1980) by the criterion of high name agreement, following the normation of those pictures for the German language by Genzel and colleagues (1995). The picture source shows a very uneven distribution of pictures corresponding to the different genders. This made it impossible to strictly control word frequency and word length.

Experimental items were presented in gender primed or in unprimed condition. Each item was presented twice to every participant. Half the items were shown with changed priming condition (primed and unprimed), the other half with the same priming condition in each trial (primed–primed or unprimed–unprimed). Gender priming was accomplished by presenting the definite determiner before presenting the experimental item. The unprimed condition lacked the definite determiner. To avoid changing the immediate context of picture presentation, the definite determiner was shown more than a second before the picture naming task (for details see below). This allows comparison between the unprimed and the primed condition.

For each participant, an individual presentation order of the experimental items was created. The order was pseudorandomized, where the following constraints were obeyed: Presentation of primed and unprimed items was blocked into four experimental blocks (two for the primed and two for the unprimed condition in alternating order). The same number of items occurred in the primed and in the unprimed condition. Across participants, each item occurred the same number of times in each block and in each priming condition.

## *Procedure*

Participants were tested individually. A 19 inch monitor was used. The monitor was split into two parts. In the upper half, picture stimuli were presented as black-on-white line drawings. In the lower half, all letters typed by the participants appeared. Participants responded to the stimuli by typing on a keyboard with German key layout. They were instructed to name the pictures as accurately and as quickly as conveniently possible by typing the name on the keyboard, and to activate the next trial by pressing the <return> key. They were asked not to correct typing errors, but to continue with the next trial.

A trial was designed as follows: In the unprimed condition, for 400 ms each the blank screen, a fixation cross and a blank screen was shown. Then the picture was presented. In the primed condition, 400 ms each the blank screen, the fixation cross and again the blank screen was shown. Then the definite determiner was shown. Participants named the determiner by typing the determiner on the keyboard. The picture presentation was triggered by hitting the <return> key. Picture presentation was the same as in the unprimed condition. After the picture appeared, the participants named the picture by typing the item name on the keyboard. The point in

time of each keystroke during the naming task was recorded by the experimental program.

After studying written instructions, participants received 5 practice trials with items not used in the experiments. These practice items were repeated between blocks (when primed and unprimed conditions changed).

# Results

Observations were discarded if a picture was named other than expected, or if a typing error occurred. The remaining data was analysed using an unpaired t-test. Two different measures were analyzed: The initial latencies and the writing time. The results will be discussed seperately for each.

## *Initial Latencies*

As mentioned before, the initial latency (IL) is the time between picture onset and the first letter keystroke of the response word.

The research hypothesis tested was, that providing gender information in advance will result in faster responses to a picture naming task. Especially, naming latencies were expected to be shorter when a picture was seen for the first time than when the picture was known already. The results do not support the research hypothesis. Altogether, mean response latencies in the primed (1223 ms) and the unprimed (1225 ms) condition differed by 2 ms only. Separate analyses of the first and the second picture presentation yielded a difference of 8 ms and –9 ms respectively between the pimed (first presentation: 1322 ms, second presention: 1128 ms) and the unprimed condition (first presentation: 1314 ms, second presention: 1137 ms). Neither of these differences were significance.

With this finding, we replicated results by Jescheniak (1999). Priming gender information does not seem to have any kind of influence on the initial lexical access processes in picture naming.

## *Writing time*

The writing time is the time elapsed between the first and the last keystroke of a response word. In terms of IKIs, it is the sum of all IKIs occurring within a word. Neither the initial latency nor the final press of the <return> key are included in this measure.

We checked if providing gender information will decrease the writing time. Other than in the analysis of initial latencies, there was an overall effect of condition

(primed vs. unprimed). The primed condition (1044 ms) and the unprimed condition (1099 ms) differed significantly by 55 ms ($t(1291) = -2.022$; $p < .05$).

Separate analyses of the first and the second picture presentation were run. For the first picture presentation, the difference of 37 ms between primed (1080 ms) and unprimed (1117 ms) condition was not significant ($t(638) = -.969$, $p = .33$), but for the second picture presentation, the difference of 71 ms between primed (1008 ms) and unprimed (1080 ms) conditions was marginally significant ($t(651) = -1.873$, $p = .06$).

## Discussion

The results of the experiment are as follows: There is no difference between the gender primed and the unprimed condition when naming latencies are considered, but when writing time is considered, a significant speed-up of 55 ms is obtained in the primed compared to the unprimed condition.

As reviewed above, lexical processes not only occur before the onset of word production (lexical access), but as well within the production of a word (lexical retrieval). The obtained results seem to suggest a dissociation between lexical access and lexical retrieval: whereas gender priming shows no effect on lexical access, there are significant effects of gender priming on lexical retrieval.

In earlier experiments (Will et al., submitted), lexical retrieval processes have been identified at syllabomorphemic IKIs. As the experiment was designed to test hypotheses concerning lexical access (reflected in the initial latencies), the material were selected according to the needs of an analysis of initial latencies. The material used in the reported experiment does not contain any SM IKIs, as SM IKIs mainly occur in noun-noun compounds, where gender information is only relevant for the second noun of the compound. Neither are the number of syllables and the position of syllable boundaries controlled across items, as this was neither possible (due to the limitations of the picture source) nor necessecary for the analysis of initial latencies. Therefore the data does not allow a localization of the fazilitatory effect within a word. Thus, the localization has to be examined in further experiments.

It is unclear, whether the differential effect on lexical access and lexical retrieval should be attributed to the gender information provided. Recall that priming was obtained by presenting the definite determiner in the trial preceeding the target trial. We argued that this procedure enabled us to compare directly between primed and unprimed conditions, as the direct surround of the target did not change between

primed and unprimed conditions. But still, showing the definite determiner in the preceeding trial provided not only gender information, but as well context information. The words “der” and “Elefant” of the primed condition, even though separated by a pause of 1.2 seconds, constitute a definite noun phrase (“der Elefant”), whereas in the unprimed condition the word “Elefant” is a bare noun with no context. Further experiments are needed to test if gender information or context information are responsible for the obtained effect in writing time.

Priming effects that show in the overall time needed to produce a word have, to our knowledge, not been reported before. This might be due to the fact that the time needed to speak a word, which we consider the counterpart of the writing time in spoken language production, is not easily available to analysis. A localization of the facilitatory effect within a spoken word seems altogether impossible, as the speech signal is continuous, and segment border cannot be exactly identified. Typewritten language enables theses analyses by providing an easily available, discrete measure of the time course of word production .

Concluding, we presented an experiment on gender priming using typewritten language production. We did not find a gender priming effect in the naming latencies, neither for unknown nor for known pictures. However, we did obtain significantly faster writing times in the primed than in the unprimed condition. The conclusion that providing gender information speeds up word production (for instance by supporting lexical retrieval processes during word production) can not be drawn yet, though: The facilitatory effect might reflect the influence of context information (production of a full NP versus production of a bare noun), as compared to the influence of only gender information. This issue has to be decided in further experiments, as well as the localization of the effect (in terms of IKI-types) within the production of the word.

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