Is bilingual lexical access influenced by language context?

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Using primed lexical decision, we measured reaction times and event-related brain potentials to targets that had German meanings (*boss*) of German–English interlingual homograph primes (*chef*). In an all-English experiment, we tested the effects of (1) global language context created by a first- or second-language film before the experiment, and (2) context over time, by analyzing the first and second experimental halves. We report significant reaction time and event-related potential priming of first-language meanings in the second-language experiment. The effects obtained despite block and context manipulations support and extend the nonselective access theory of bilingual word recognition. *NeuroReport* 17:727–731 © 2006 Lippincott Williams & Wilkins.

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Introduction

When learning a second language, speakers quickly notice that some words look familiar because they are spelled in the same way as words in their mother tongue, but the meanings completely differ between the first language (L1) and the second language (L2). An example of such a word – a so-called interlingual homograph – is the word *chef*, which means 'boss' in German and 'cook' in English. Researchers have been interested in whether the L1 meaning of an interlingual homograph is activated during L2 processing in order to test how cognitively controlled access to the L1/L2 mental lexicon is (here, the term cognitive control refers to how well or how poorly a bilingual can activate the needed language at the appropriate point in time and to the appropriate degree [1]). Therefore, semantic priming studies involving interlingual homographs have received a fair amount of attention in the bilingual literature (e.g. [1–6]). The central question of such studies is whether bilinguals have fundamentally selective or nonselective access to entries in the L1/L2 lexicon. While some early behavioral studies [7] suggest selective access, more recent electrophysiological evidence supports nonselective access [1,4] in which both L1 and L2 meanings are activated simultaneously at first. Only later is one language selected (see [8] for related data on English homographs).

The current study used interlingual homographs with a novel approach to language context manipulations in order to: (1) contribute to the ongoing debate about selective vs. nonselective lexical access; and (2) to investigate whether so-called global language context effects have an influence on bilingual access mechanisms in an all-L2 experiment. By global language context, we refer to the language we hear or read before we perform an experiment, analogous to real-life situations in which we are interacting exclusively in one language and then, suddenly, we need to use our second language exclusively. To manipulate the global language context, we showed the same film in either German or English before the English experiment. It should be noted that several studies that report nonselective access have used a so-called switch paradigm, meaning that the participants switch between trials in the L1 and L2 (e.g. [4]). The constant switching in such tasks may lead to a certain degree of activation of both languages, causing cross-language effects. Even some all-L2 lexical decision experiments using priming have reported semantic priming of L1 meanings [3,5]. Such data support nonselective access more strongly, but one still does not know how a more global language context affects the bilingual word recognition system in general and over time. Semantic priming is reflected behaviorally in reaction time (RT) differences and in event-related brain potentials (ERPs), in the so-called N400 component, a negativity peaking at about 400 ms post-stimulus onset and linked to ease of semantic integration [9]. In semantic priming studies, primed targets have less negative amplitude than control targets [10], and the difference in amplitude is called the N400 semantic priming effect. Previous studies have reported N400 semantic priming in the L2, although such effects can sometimes be delayed [8] or have an extended latency with a broad scalp distribution [11].

Both the bilingual interactive activation (BIA +) model [12] and the language mode framework [13] have incorporated the role of language context in cognitive control. In principle, the BIA + model assumes an integrated L1/L2 lexicon with initial nonselective access. The model, however, makes a distinction between the identification systems *per se*

and the so-called task context effects that might influence lexical access through control regulation [14]. Crucially, the model allows linguistic context and task effects to develop over time as decision thresholds can be recalibrated with new input. In the present study, we take up this idea by analyzing the first and second halves of the experiment to observe possible changes over time as the system calibrates on the basis of the preceding language context (L1 or L2), and then recalibrates on the basis of the increasing number of all-L2 trials.

A second framework helpful in addressing global context effects is that of language mode, defined by Grosjean ([13], p. 3) as 'the state of activation of the bilingual's languages and language processing mechanisms at a given point in time'. He suggests that there is a continuum in which the state of activation of a bilingual's languages can be situated, ranging from a monolingual to a bilingual mode. Bilinguals can be influenced by their expectations and can activate either one or both languages on the basis of such expectations. This, of course, implies that bilinguals have a choice between nonselective and selective access. In the present experiment, we test whether this is really the case by manipulating the language (L1 or L2) of a film shown to participants before the experiment proper. If, despite expectations created by the L2 film that the L1 is irrelevant, participants show L1 activations, a strong language mode proposal can be ruled out and a nonselective access view of the type proposed in the BIA + model can be supported.

On the basis of previous all-L2 priming studies (e.g. [15]), we predict that L1 activations of interlingual homographs will be observed in L2 single word processing, that is, priming of the target *boss* after the prime *chef*. This will be realized by faster RTs to targets after related primes and by an attenuation of the N400 component in the ERPs. If the language mode idea is correct, then such RT and ERP effects should not be obtained after viewing the English (L2) film, but only after viewing the German (L1) film. If nonselective access is correct, then we should obtain effects in both language contexts, but the effects will change over time, that is, effects will be strongest in the first half of the experiment after viewing the German film before the system has had time to 'zoom into' a new English task setting (see [1] for a discussion).

Materials and methods

Participants

Sixty native German speakers (37 female and 23 male participants, mean age 24 years, range 18–28 years) participated in the experiment. They started to learn English as a foreign language at school at the age of 10–11 years, were proficient in English, and had spent a mean of 17 months (range 2–22 months) in an English-speaking country. All were right-handed, had normal or corrected-to-normal vision, and were paid for their participation.

Stimuli

The film

We made a 20-min compilation of the silent crime film series 'Les Vampires' (1915–1916) by Louis Feuillade [16]; for details, see [1]. Before the start of the actual experiment, this film was shown to the participants. Half of the participants saw the movie narrated in English (L2 context), whereas the other half saw the German version (L1 context).

The language material

Experimental stimuli were 54 interlingual homographs with very similar spellings across English and German. All were normed in previous studies and taken from a list provided in [17]. The interlingual homograph (e.g. *bald*) always served as the prime. Control primes (e.g. *tan*) were frequency- and length-matched to test primes. Targets always reflected the German meaning of the interlingual homograph (e.g. *soon* referring to the German meaning of *bald*). All critical items were balanced on two presentation lists based on the item-by-item matching described above. To control for order effects in the block analysis, each presentation list was presented in two orders, with first and second halves switched. Each of the resulting four presentation lists consisted of 432 trials comprising 108 critical trials, 132 filler trials, and 192 pseudoword trials, divided into 12 short blocks. After every block (36 trials), a memory recall task was included in which participants indicated whether they had read certain words in the experiment.

Procedure

Participants were placed in a sound-attenuated room and seated in a comfortable chair at a distance of 100 cm from a computer monitor with a button panel placed before them. Half of the participants pressed the 'yes' button with their right hand and the 'no' button with their left hand. The other half proceeded vice versa. Directions in English, with examples, asked participants to read both presented words on the screen and to make a lexical decision for the target as accurately and quickly as possible. Participants were not aware that the film and the experiment were related in any way. After practice, the English or German version of the film was presented, and immediately afterwards the English lexical decision experiment began. The task was constructed as follows. Within each trial, a fixation cross was presented for 200 ms, followed by the prime (e.g. *chef*) that flashed on the screen for 200 ms. Then, the target (e.g. *boss*) was presented immediately until the participant made a lexical decision (3000 ms cutoff). The intertrial interval was 800 ms. After the experiment, a post-test containing all critical items was given to the participants so that they could mark any word or meaning they did not know in English. Participants also filled out a multiple-choice comprehension test on the film. The experiment lasted about 145 min, used for electroencephalogram preparation, filling out a language questionnaire, the actual experiment (40 min), and the post-tests.

Event-related potential recording procedure

The electroencephalogram was recorded with 60 Ag–AgCl electrodes, each referred to the left mastoid, and re-referenced to linked mastoids offline. Bipolar horizontal and vertical electrooculograms were recorded for artifact rejection purposes. Electrode resistance was kept below 5 kΩ. The signals were recorded continuously with a band pass between DC and 70 Hz and digitized with 250 Hz. ERPs were filtered offline with a 7 Hz low pass for graphical display. All statistical analyses were computed on nonfiltered data. Electroencephalogram recordings were scanned for artifacts (7% of trials were rejected). Trials to unknown words were removed from the analyses. Separate ERPs for each condition at each electrode site were averaged for each participant with a 100 ms prestimulus baseline.

Statistical analyses

Mean RTs for correct responses and percentage correct were calculated for each participant and corrected by 2.5 SD of the mean. Analyses of variance for repeated measures were carried out on these RT data using the within-subject factors Block (first vs. second block) and Rel (related vs. unrelated target) and the between-subjects factor Film (English vs. German film).

Analyses of variance for the ERP analysis were carried out for correctly answered trials in a latency window of 300–500 ms, the typical N400 time window. In addition to the factors Block, Rel, and Film, the factor scalp regions of interest (LF, RF, LC, RC, LP, RP, and ML) was included. Each scalp region of interest defined a critical region of six scalp sites (see Fig. 3, below). Main effects and interactions at $P<0.05$ were followed up by simple effects analyses and pairwise comparisons. The Geisser–Greenhouse correction [18] was applied to all repeated measures with greater than one degree of freedom in the numerator.

Results

Behavioral data

Results from the multiple-choice comprehension test on the film revealed high comprehension results with participants answering 97.9% (SD 4.8) of the questions correctly.

The analysis of errors revealed that, in general, participants carried out the task well (approximately 6% errors). The analysis revealed a main effect of Block [$F(1,57)=8.48$, $P<0.01$], indicating that participants made slightly more errors in the first half of the experiment (Fig. 1). No other significant effects were observed.

In the analysis of correct RTs, there was a significant main effect of Block [$F(1,57)=17.84$, $P<0.0001$], indicating faster RTs in the second half of the experiment than in the first half (695 vs. 730 ms). In addition, a significant Rel effect [$F(1,57)=3.87$, $P=0.05$] indicated that responses to related targets were faster than to unrelated targets (708 vs. 715 ms; Fig. 2). This Rel effect did not interact with Film or Block (all $Ps>0.05$). Overall, RTs revealed a classical priming effect irrespective of experimental half or language context established before the experiment.

Event-related potential data

In the N400 time window, a main effect of Rel was observed [$F(1,57)=5.23$, $P<0.05$], indicating that unrelated targets showed a more negative ERP component than related targets (Fig. 3). This Rel effect did not interact with Film or Block (all $Ps>0.05$), suggesting a classical N400 priming effect independent of experimental block and film version.

Discussion

Both RT and ERP measurements revealed priming effects that were observed regardless of the language context established before the experiment and independent of the experimental block. The RT and ERP measures provide strong evidence that the L1 was indeed active during the all-L2 task. Accordingly, the present results support the view that there is automatic, initial parallel activation of both L1 and L2 entries in the L1/L2 lexicon on presentation of an interlingual homograph. This occurs despite variations in the task setting at the most global level, so the data challenge the selective access view. Furthermore, the

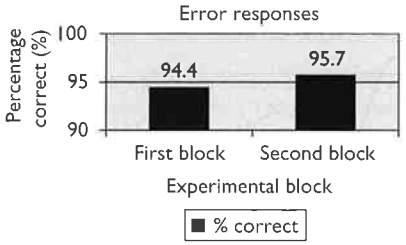

Fig. 1 Mean percentage correct (PC) for target responses divided by block.

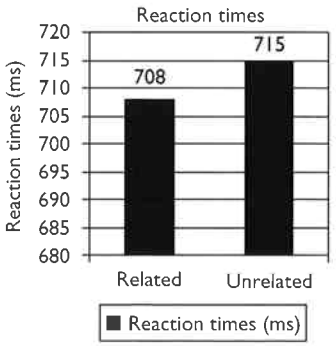

Fig. 2 Mean reaction times (RTs) of correctly answered targets.

predictions based on the language mode framework by Grosjean [13] in which the previous film version would affect priming could not be confirmed by the current ERP and behavioral data.

It is worth mentioning that the current experiment differed from previous task switching studies as it was conducted in English only. Therefore, in an all-L2 setting, we can confirm that the activation of the L1 during the present experiment is not due to the experiment itself setting a bilingual mode or switch-task setting as may have been the case in previous studies (e.g. [4,14]).

The present single word results are also in contrast to a study by Elston-Güttler *et al.* [1] in which full sentence contexts preceded prime-target pairs. In this study, which used the same prime-target pairs, film manipulation, and block design, priming effects were observed only for participants who saw the German film (not the English version), and only during the first half of the experiment. The authors suggested that in the first experimental half, the task setting as defined in the BIA+ model suddenly changes from 'monolingual L1' to 'monolingual L2', and that there is a residual influence from the L1 as the system attempts to 'zoom into' the new L2 language setting. By the second half of the experiment, time and additional L2 input have helped the system to recalibrate fully, thereby raising decision thresholds high enough to eliminate L1 influence. In the present single word study, no such block effect, alone or in interaction with film and/or semantic priming, was observed. As both experiments made use of the same prime-target pairs, we suggest that the additional sentence context provided in the Elston-Güttler *et al.* [1] study helped to recalibrate the system more effectively. The BIA+ model of word recognition presumes that access to the bilingual lexicon is nonselective, but theoretically allows this access to

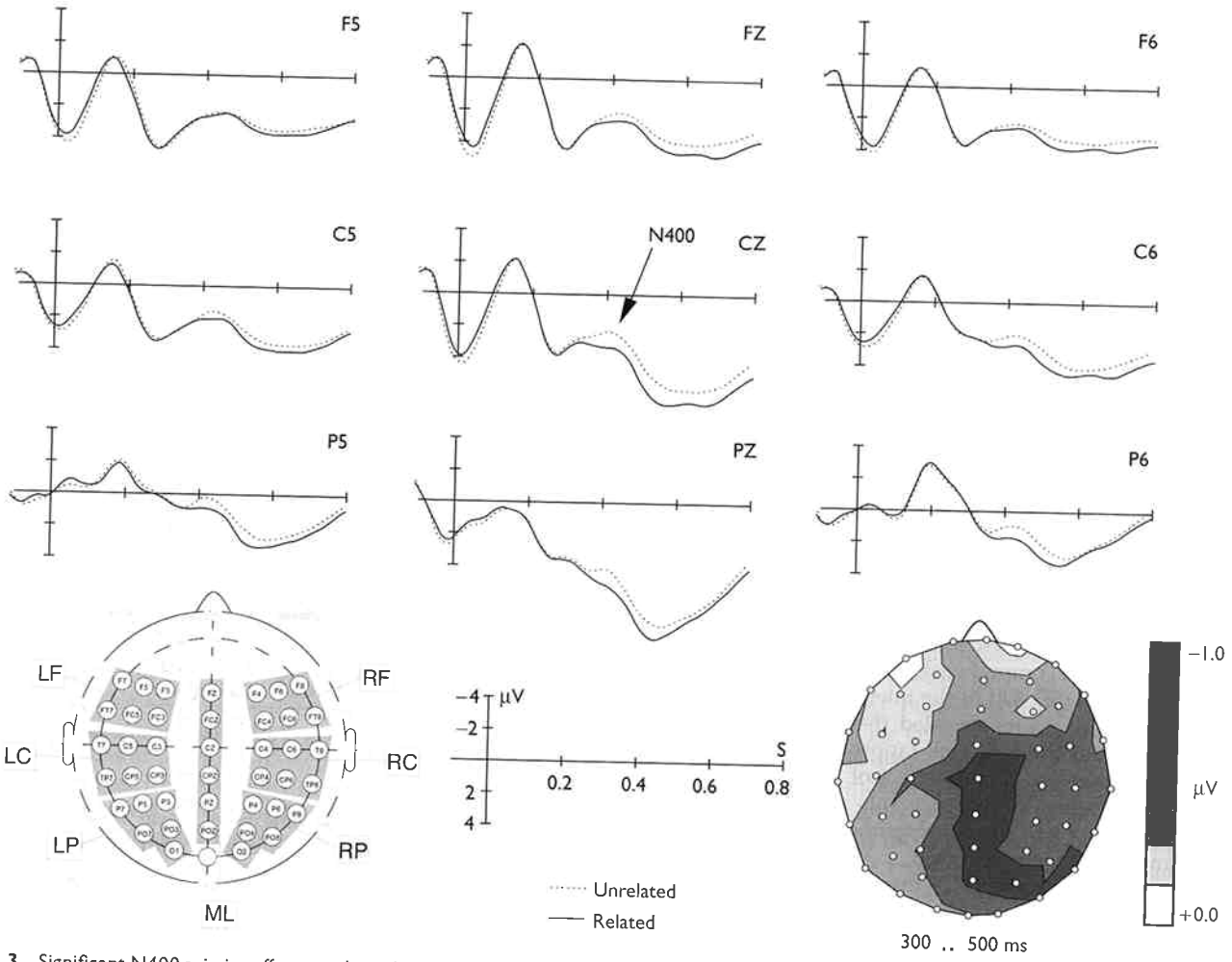

Fig. 3 Significant N400 priming effect at selected electrode sites. The map on the right shows the distribution of the priming effect and the head on the left shows regions of interest (ROIs) used in the statistical analysis.

be influenced by linguistic (e.g. sentence context) and nonlinguistic (e.g. task-oriented factors such as the film) contexts. Without the additional layer of sentence context, the L1 influence: (1) remains comparable over both halves of the experiment; and (2) is observed regardless of the global language context created before the experiment itself. Even though the BIA + model assumes that linguistic and nonlinguistic effects influence the bilingual word recognition system differently, the current results in conjunction with the sentence data in [1] suggest that there may indeed be instances in which both linguistic and nonlinguistic contexts work together to affect a fundamentally nonselective system.

Conclusion

The present results suggest that L2 learners are not able to consciously or subconsciously suppress L1 influence even in an all-L2 task preceded by a global L2 language setting. Specifically, within a single word paradigm, bilingual lexical access cannot easily be influenced by global language context effects established before the experiment. This strongly supports the idea proposed in the BIA + model that bilingual word recognition is fundamentally nonselective.

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