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Brief article

## The effects of late acquisition of L2 and the consequences of immigration on L1 for semantic and morpho-syntactic language aspects

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### Abstract

It has been hypothesized that some aspects of a second language (L2) might be learned easier than others if a language is learned late. On the other hand, non-use might result in a loss of language skills in one's native, i.e. one's first language (L1) (language attrition). To study which, if any, aspects of language are affected by either late acquisition or non-use, long-term German immigrants to the US and English native speakers who are long-term immigrants to Germany as well as two additional control groups of native German speakers were tested with an auditory semantic and morpho-syntactic priming paradigm. German adjectives correctly or incorrectly inflected for gender and semantically associated or not associated with the target noun served as primes. Participants made a lexical decision on the target word. All groups of native German speakers gained from semantically and morpho-syntactically congruent primes. Evidence for language attrition was neither found for semantic nor morpho-syntactic priming effects in the German immigrants. In contrast, English native speakers did not gain from a morpho-syntactic congruent prime, whereas semantic priming effects were similar as for the remaining groups. The present data suggest that the full acquisition of at least some syntactic functions may be restricted to limited periods in life while semantic and morpho-syntactic functions seem to be relatively inured to loss due to non-use.

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## 1. Introduction

There is some evidence for critical periods of language acquisition. For example, studies in deaf people's proficiency in American Sign Language (ASL) depends on early exposure (Mayberry, Lock, & Kazmi, 2002). Moreover, Mayberry et al. (2002) compared English language skills between deaf people who had and who had not acquired a sign language on schedule. They found that the first group outperformed the second and did equally well as a group of hearing adults, who had learned English as their second (oral) language (L2). However, even L2 learning in people who learned an L1 on schedule hardly reaches native level if L2 is acquired late in life (after the age of 8 years or later) (for a review see Fabbro, 1999). Nevertheless, some aspects of language seem to be more affected by late acquisition than others: Weber-Fox and Neville (1996) showed that vocabulary, i.e. semantic language aspects, are learned by Chinese/English bilinguals to a higher proficiency than syntactic aspects of language after late exposure to English. Moreover, event-related potentials in the same individuals revealed different brain activation patterns for the detection of syntactic but not for the processing of semantic violations suggesting that the development of neural subsystems that mediate syntactic processing are more susceptible to late exposure to a language (see also Hahne, 2001).

Another possibility to address the plasticity of language functions is to investigate effects of non-use, e.g. due to the continuous exposure to a second language (L2) after immigrating to a foreign country. Such an approach was recently taken by Pallier et al. (2003) who tested adults who were born in Korea and adopted by French families when they were children between the age of 3 and 8 years. They were all fluent in their L2 and were not able to consciously recollect their native language. Korean adoptees and native speakers of French displayed similar brain activation patterns when they listened to French. Nevertheless, the extent of these activations was less in the adoptees. Pallier et al. (2003) discussed these results in light of the critical period hypothesis for language acquisition. The loss of skills in L1 due to non-use is referred to as "language attrition". However, it is still controversial which, if any, aspects of language are subject to attrition (for a review see Seliger & Vago, 1991). While the use of experimental paradigms from psycholinguistic research has been fruitful in the area of second language acquisition, particularly because reaction time measures are often more sensitive than accuracy measures, this approach has rarely been taken in the field of language attrition (e.g. Liu, Bates, & Li, 1992; Major, 1992). Moreover, studies have not controlled for "transient" loss and in some investigations it was not clear if L1 had been learned up to a native like level.

In an initial exploratory study, Flaisch, Neville, and Röder (unpublished) used an experimental paradigm that systematically manipulated syntactic processing demands in German (Pechmann, Uszkoreit, Engelkamp, & Zerbst, 1996). They investigated a group of long-term German immigrants who entered the US after their 12th year of life and who had lived there for at least 10 years (on average 25 years). Their data were compared to those of a group of German exchange students to the US who had lived there for 7 months. Flaisch et al. found that with increasing syntactic processing difficulty the disadvantage of the long-term immigrants compared to German exchange students in comprehension times increased. Unfortunately, the exchange students were on average 26 years younger than

the immigrants. Possible language attrition effects were therefore confounded with age-related effects.

The present study investigated semantic and morpho-syntactic aspects of language comprehension in both *German immigrants* to the US (L1 = German, L2 = English) and *Native speakers of English* who were immigrants to Germany (L1 = English, L2 = German) in order to compare effects of non-use of an L1 (German) and effects of late acquisition of an L2 (German as well) with the same experimental paradigm. A group of native German speakers who had never stayed abroad for a longer period of time (not longer than 2 months) served as age- and education-matched control for the group of *German immigrants*. A group of German exchange students to the US was tested to control for short-term effects of L1 non-use. Their results were compared to the German student sample from Röder, Demuth, Streb, and Rösler (2003). The semantic and morpho-syntactic priming paradigm with a lexical decision task on the target noun was used. The paradigm had been evaluated in a group of native German speakers (Röder et al., 2003). The more “natural” and more usual form of spoken rather than written language was investigated. Adjectives were presented as primes, nouns, and pseudo-nouns as targets. Adjectives and nouns were either highly semantically associated or not semantically associated at all (semantic priming). Moreover, the adjective was either correctly or incorrectly inflected for gender with respect to the noun (morpho-syntactic priming). In German, grammatical gender (neuter, masculine, feminine) is in most cases assigned arbitrarily to nouns which are themselves generally not inflected for gender (with rare exceptions; see Comrie, 1999). Röder et al. (2003) have reported that both congruent semantic and congruent morpho-syntactic context reduce lexical decision times.

## 2. Method

### 2.1. Participants

Four groups participated in the study: The first three groups comprised native speakers of German whereas the fourth comprised *Native speakers of English*. Participants of the first group were short-term *German visitors* to the US enrolled in an US University for two terms. The participants of the second group were the long-term *German immigrants* to the US, whereas group three consisted of native speakers of German who had always lived in Germany. This group was matched with the second group according to age and educational level (see Table 1 for details) and will be referred to as *Control group for German immigrants*. Finally, the fourth group comprised long-term immigrants to Germany, who were *Native speakers of English* and who had learned German as L2 after the age of 12 years. *German visitors* (mean age 22.3 years) were significantly younger than all the other participants ( $F(3, 47) = 11.05, P < 0.0001$ ). The mean age (23.4 years) at which the groups had their first L2 contact was significantly later for *Native speakers of English* compared to the other groups ( $F(3, 47) = 15.68, P < 0.0001$ ). The four groups did not differ in educational level.

Additionally, German and English proficiency was screened with subtests of a language assessment for foreign students developed at the University of Marburg (Germany)

Table 1  
Analysis of participant's characteristics (means and ranges in parentheses)

Group	<i>n</i>	Age	Age of first L2 contact	Time since arrival	Leaving country <sup>a</sup>	Female	Right handed	Level of education <sup>b</sup>
German visitors	12	22.3 (18.0–26.0)	10.2 (10.0–14.0)	1.3 (0.0–2.0)	1.2 (0.0–7.0)	6	11	2.0 (2.0–2.0)
German immigrants	15	40.6 (29.0–68.0)	10.6 (9.5–15.0)	18.3 (6.0–49.0)	4.7 (0.0–10.0)	10	12	2.1 (1.0–3.0)
Control group for German immigrants	14	40.5 (28.0–63.0)	10.0 (9.0–13.0)	39.6 (28.0–63.0)	0.2 (0.0–3.0)	9	13	2.2 (1.0–3.0)
Native speakers of English	10	44.3 (33.0–57.0)	23.4 (12.0–49.0)	15.5 (6.0–33.0)	5.4 (0.0–20.0)	7	9	2.1 (1.0–3.0)

<sup>a</sup> Leaving country: mean number of times within the last 10 years that a participant went to her/his home country (long-term immigrants)/L2 country (others) for a period longer than 1 month.

<sup>b</sup> Level of education (high-school, 1; college degree, 2; advanced degree, 3).

and with TOAL-3, written vocabulary, respectively. Proficiency was compared to self-reports accessed with a standardized questionnaire for language history. *German immigrants* and *Native speakers of English* did not differ, neither in German vocabulary, grammar, and production nor in English vocabulary demonstrating high explicit proficiency in the L2 for both groups. Due to ceiling performance in sub-samples the German tests were not administered to the other groups.

## 2.2. Stimuli

The stimuli consisted of 91 German adjectives; for each adjective there were four legal German nouns and four pronounceable pseudo-words in which one or more letters were rearranged compared to the legal nouns (for a detailed description of the material see Röder et al., 2003). Since in German each noun has a gender, no neutral gender inflection exists. A manipulation of the adjective's suffix leads to gender agreement or disagreement with the target nouns—the morpho-syntactical manipulation. The semantic relatedness between adjectives and nouns had been evaluated by means of cloze probability determined in a series of pretests (see Röder et al., 2003). One of the four nouns was semantically and morpho-syntactically (sem + /syn +), one was semantically but not morpho-syntactically (sem + /syn -), one was morpho-syntactically but not semantically (sem - /syn +) and one was neither semantically nor morpho-syntactically related (sem - /syn -) to the adjective (see Table 2). Target nouns of the four conditions did neither differ in duration nor in word frequency. When presented in

Table 2  
Two examples for adjective–noun/pseudo-word pairs

Condition	Prime <sup>a</sup>	Target
sem + /syn +	<b>faltiges</b> <i>neuter</i> (wrinkled)	Gesicht <i>neuter</i> (face)
sem + /syn -	''	Haut <i>feminine</i> (skin)
sem - /syn +	''	Gerücht <i>neuter</i> (rumor)
sem - /syn -	''	Lohn <i>masculine</i> (reward)
Pseudo 1	''	Giscthes
Pseudo 2	''	Tahu
Pseudo 3	''	Tügrech
Pseudo 4	''	Holn

English translations are given in parentheses (from Röder et al., 2003).

<sup>a</sup> The gender inflection of the adjective is marked in bold.

isolation (without primes) lexical decision times did not differ across “conditions” (i.e. sort of target nouns, see Röder et al., 2003).

### 2.3. Procedure

There were eight blocks with 91 trials each and one practice block with 16 trials. Each adjective was repeated eight times but only once in each block and it was always followed by a different target (noun or pseudo-noun). The arrangement of trials within a block was randomized and the order of blocks was counterbalanced across participants. Each trial started with a warning tone (1000 Hz, 100 ms duration); the adjective was presented 500 ms later followed by the target after another 1100 ms. Participants had to decide within 2000 ms whether the target was a legal German noun or a pseudo-noun. The decisions were indicated by pressing one of two mouse-buttons. Reaction times and error rates were measured. The experiment lasted for about 1.5 h; the additional language tests took about 1.5 h. Participants received monetary compensation.

### 2.4. Data analysis

Trials with reaction times shorter than 150 ms and longer than 2000 ms were discarded. Error rates and mean lexical decision times for correct trials were calculated for each participant and condition. Each dependent variable was submitted to an analysis of variance (ANOVA) with between-participant factor GROUP (*German visitors*, *German immigrants*, *Control group for German immigrants*, *Native speakers of English*) and within-participant factor CONDITION (*sem + /syn +*, *sem + /syn -*, *sem - /syn +*, *sem - /syn -*). Performance in the pseudo-noun condition was evaluated by means of an ANOVA with between-participant factor GROUP. Violations of the sphericity assumption were corrected according to the suggestions of Huynh and Feldt (1976). Corrected *P*-values are reported. As the same result pattern was obtained for both the by-participant and an by-item analyses, only the latter are reported. No significant differences were obtained in the comparisons between the *German visitors* and the age-matched control group of students from Experiment 1 in Röder et al. (2003) and thus these results are not reported.

## 3. Results

### 3.1. Error rates

#### 3.1.1. Words

The four groups differed in their overall error rates ( $F(3, 47) = 2.89$ ,  $P = 0.0453$ ) which was due to somewhat lower error rates for the *Control group for the German immigrants* than for the remaining groups; pairwise comparisons were found not significant. There was also an effect of CONDITION ( $F(3, 141) = 30.12$ ,  $P < 0.0001$ ,  $\epsilon(H-F) = 0.877$ ) (see Fig. 1). However, due to the significant GROUP by CONDITION interaction ( $F(9, 141) = 2.89$ ,  $P = 0.0056$ ,  $\epsilon(H-F) = 0.877$ ) specific contrasts were calculated separately for the four groups (see Table 3, upper corner).

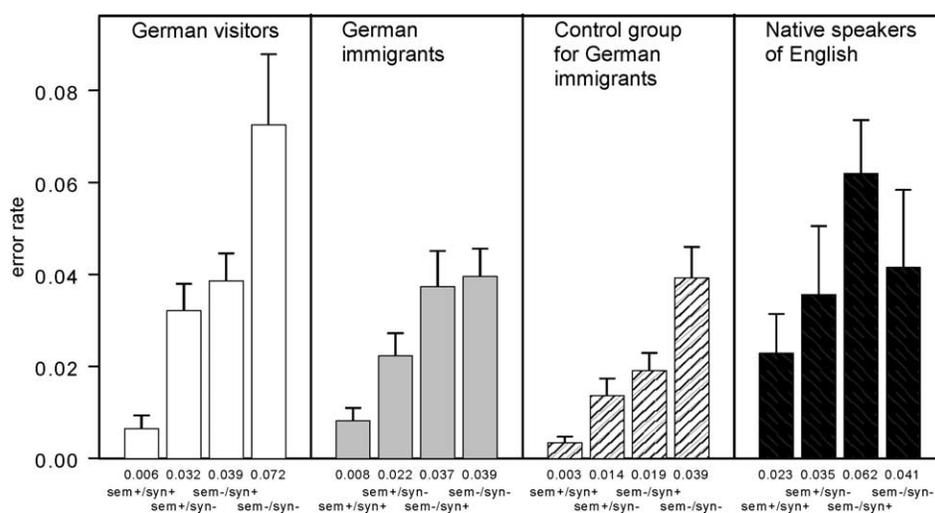


Fig. 1. Mean error rates with standard error of the mean for each word condition and group.

While for all native German speakers the lowest error rates were observed for *sem + /syn +* and the highest error rates in *sem - /syn -*, the *Native speakers of English* committed most errors in the condition *sem - /syn +*, the only condition that differed significantly from *sem + /syn +*.

### 3.1.2. Pseudo-words

There was a marginally significant effect of GROUP for the error rates ( $F(3,47) = 2.47$ ,  $P = 0.073$ ) (see Fig. 3) due to a trend towards higher error rates for the *Native speakers of English* compared to the native German speakers (all pairwise comparisons:  $P \approx 0.1$ ).

## 3.2. Decision times

### 3.2.1. Words

The effect of GROUP ( $F(3,47) = 10.45$ ,  $P < 0.0001$ ) indicates that the overall decision times of the *Native speakers of English* were longer than those of all other groups (all pairwise comparisons:  $P < 0.001$ ) while the three remaining groups did not differ significantly ( $P > 0.5$ ) (see Fig. 2). The effect of CONDITION was significant ( $F(3,141) = 236.38$ ,  $P < 0.0001$ ,  $\epsilon(H-F) = 0.664$ ). Since the GROUP by CONDITION interaction was significant in the overall ANOVA ( $F(9,141) = 3.26$ ,  $P = 0.006$ ,  $\epsilon(H-F) = 0.664$ ), the four conditions were compared separately for the four groups (see lower corner of Table 3). Decision times varied similarly as a function of CONDITION in all three groups of native German speakers (effect CONDITION in *German visitors*:  $F(3,33) = 143.76$ ,  $P < 0.0001$ ,  $\epsilon(H-F) = 0.866$ ; *German immigrants*:  $F(3,42) = 96.46$ ,  $P < 0.0001$ ,  $\epsilon(H-F) = 1$ ; *Control group for German immigrants*:  $F(3,39) = 43.68$ ,  $P < 0.0001$ ,  $\epsilon(H-F) = 0.419$ ). For these groups the shortest decision times were obtained for condition *sem + /syn +* and the longest for

Table 3  
Specific within-group comparisons for each priming condition

L1 = German, L2 = English								L1 = English, L2 = German							
German visitors				German immigrants				Control group for German immigrants				Native speakers of English			
sem + /syn +	sem + /syn -	sem - /syn +	sem - /syn -	sem + /syn +	sem + /syn -	sem - /syn +	sem - /syn -	sem + /syn +	sem + /syn -	sem - /syn +	sem - /syn -	sem + /syn +	sem + /syn -	sem - /syn +	sem - /syn -
sem + /syn +	<b>0.0005</b>	<b>&lt; 0.0001</b>	<b>0.0009</b>		<b>0.0112</b>	<b>0.0026</b>	<b>0.0003</b>		<b>0.0306</b>	<b>0.0008</b>	<b>0.0002</b>		0.1337	<b>0.0040</b>	0.0942
sem + /syn -	<b>&lt; 0.0001</b>		0.2276	<b>0.0118</b>	<b>&lt; 0.0001</b>	0.1251	<b>0.0251</b>	<b>&lt; 0.0001</b>		0.3256	<b>0.0010</b>	<b>0.0038</b>		0.1402	0.6841
sem - /syn +	<b>&lt; 0.0001</b>	<i>0.2621</i>		<b>0.0176</b>	<b>&lt; 0.0001</b>	<i>0.7694</i>	0.7115	<b>&lt; 0.0001</b>	<i>0.9967</i>		<b>0.0344</b>	<b>&lt; 0.0001</b>	<b>0.0003</b>		0.1168
sem - /syn -	<b>&lt; 0.0001</b>	<b>&lt; 0.0001</b>	<b>&lt; 0.0001</b>	<b>&lt; 0.0001</b>	<b>0.0004</b>	<b>&lt; 0.0001</b>		<b>&lt; 0.0001</b>	<b>0.0050</b>	<b>&lt; 0.0001</b>		<b>&lt; .0001</b>	<b>&lt; .0001</b>	<i>0.6863</i>	

Comparisons of error rates (upper right corner) and decision times (lower left corner, in *italic print*) for words, *P*-values are reported.

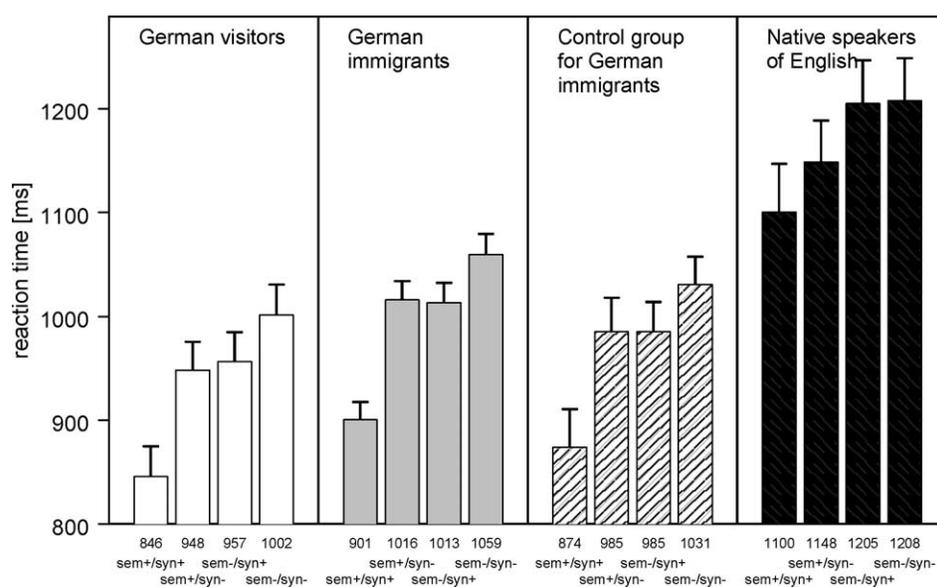


Fig. 2. Mean decision times (ms) with standard error of the mean for each word condition and group.

condition *sem - /syn -* (all comparisons:  $P < 0.01$ ). A different decision time pattern emerged for the *Native speakers of English* (effect CONDITION:  $F(3, 27) = 45.61$ ,  $P < 0.0001$ ,  $\epsilon(H-F) = 1$ ). As in the remaining groups, the shortest decision times were observed for the condition *sem + /syn +*. However, *sem + /syn -* resulted in larger priming effects than *sem - /syn +*. Indeed, the latter condition did not differ from condition *sem - /syn -* indicating no processing gain of the *Native speakers of English* by morpho-syntactic priming only.

### 3.2.2. Pseudo-words

Fig. 3 displays a significant effect of GROUP ( $F(3, 47) = 8.45$ ,  $P = 0.0001$ ) for the pseudo-word decision times. The decision times for pseudo-words were longer for the *Native speakers of English* compared with the other groups (all pairwise comparisons:  $P < 0.02$ ). No significant difference was found between the remaining groups.

## 4. Discussion

The present study used a semantic and morpho-syntactic priming paradigm with auditory stimuli and a lexical decision task to test both effects of non-use and effects of late acquisition upon semantic and morpho-syntactic language aspects.

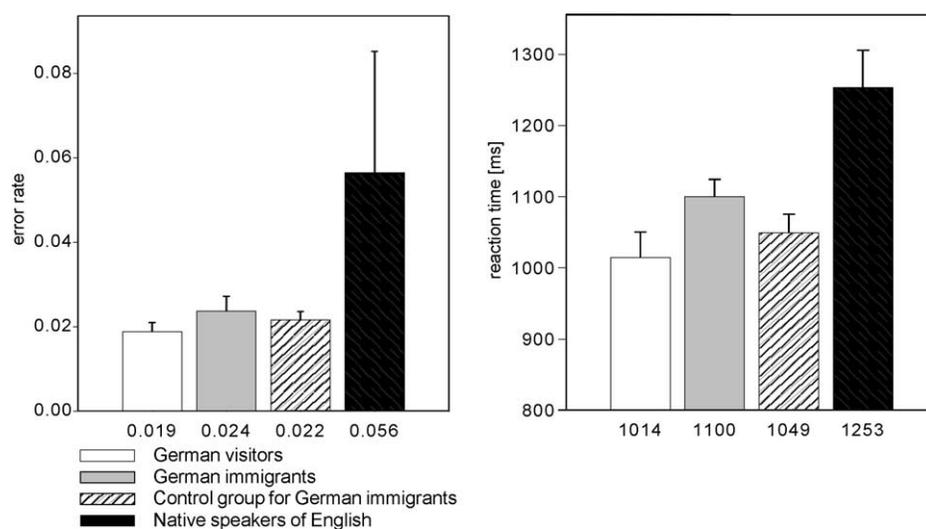


Fig. 3. Error rates (left figure) and mean decision times (ms) (right figure) to pseudo-words with standard error of the mean for the four groups.

#### 4.1. Effects of late acquisition of L2

Late acquisition of German as L2 resulted not only in longer overall processing times but also in a very specific lack of morpho-syntactic priming effects when the semantic context did not facilitate lexical access. The results are consistent with previous work (Hahne, 2001; Neville, Mills, & Lawson, 1992; Weber-Fox & Neville, 1996) and suggest that the development of syntactic functions might be more tightly linked to restricted times during development than the elaboration of semantic sub-functions. Neville and Bavelier (2001) have suggested that the latter are based on associative learning mechanisms that permit learning throughout life. In contrast, they proposed that syntax is based on a computational mechanism that can be set up only during limited periods in life. Interestingly, the *Native speakers of English* showed some gain from morpho-syntactic priming when the noun was semantically primed as well. This result pattern is the reverse of what has been found earlier; Schriefers, Friederici, and Rose (1998) observed that gender disagreement can eliminate semantic priming effects. It could be speculated that semantic aspects of language dominate and/or are faster accessed than syntactic aspects during language comprehension in bilinguals. If these are misleading, language understanding cannot be facilitated by congruent syntactic information. This hypothesis is supported by the relative high error rates of the *Native speakers of English* in the *sem - /syn +* condition.

In sum, the morpho-syntactical processing disadvantage of the bilinguals who had learned German as L2 late in life seems to be very specific and is unlikely due to more general problems in comprehending German. Although the lexical decision times were longer than for the native speakers of German, the group of *Native speakers of English* performed very well, indeed close to the accuracy of L1 German speakers.

Since only grammatical gender agreement was tested, it remains to be shown how general this morpho-syntactic disadvantage is across syntactical functions.

#### 4.2. *Effects of language attrition (L1)*

Similar processing gains from a congruent semantic and/or morpho-syntactic context were obtained for all three groups of native German speakers. Therefore, no evidence for language attrition could be obtained in the present study. Other language aspects need to be investigated in order to test how general the present findings are.

It could be argued that the present paradigm was not sufficiently sensitive to uncover effects of attrition. However, the specific disadvantages observed for the *Native speakers of English* renders this hypothesis unlikely. Moreover, the same material and paradigm successfully demonstrated compensatory performance in blind adults who rely much more on auditory language processing than sighted people (Röder et al., 2003). Fleisch et al. (unpublished) had found some evidence of disadvantages for German long-term immigrants in the processing of non-preferred word-orders although this study did not control for age effects. It has been suggested that the processing of word-to-word relations depends on the activity of the “parser” proper (Grodzinsky, 2002), whereas the analysis of grammatical gender has been associated with postlexical processes (Friederici & Jacobsen, 1999). Therefore, morpho-syntactical functions, as grammatical gender, once acquired might not be affected if not used for an extended period of time while other syntactic functions might “suffer” more from non-use or possible interference by L2. Finally, in the present study semantic-associative processing was unaffected by non-use too. It might be speculated that the later rely on abstract conceptual representations that, at least partly, are not linked to a particular language or language at all. Pertinently, unaffected semantic priming effects are not only observed after long periods of non-use of an L1 but also after late acquisition of both L2 and L1 (Neville et al., 1992).

Although longer visits in Germany were rare in the group of *German immigrants*, they were not as isolated from their native language as, e.g. the Korean adoptees in France (Pallier et al., 2003). On the other hand, the Korean adoptees came to France much earlier (at a mean age 5.6 years) than the *German immigrants* to the US (at a mean age: 22.3 years). L1 is learned up to a native speaker’s level by about 10 years (Oerter & Montada, 2002). Future research needs to tear apart if a more total insulation or an earlier exposure to L2 results in more extended language attrition than observed in the present study.

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