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INVESTIGATING WORD CLASS EFFECTS IN FIRST AND SECOND LANGUAGES¹

MARCO R. FURTNER, JOHN F. RAUTHMANN, AND PIERRE SACHSE

Leopold-Franzens University of Innsbruck

Summary. – According to Zyzik in 2009, only a few recent studies have investigated similarities in use of words in comprehension of first languages (L1) and second languages (L2). Furtner, Rauthmann, and Sachse showed a rank order of word classes by frequency of eye-gaze regression when reading other difficult words: nouns, adjectives, closed-class words, verbs. The hypothesis was that a L1–L2 wordclass similarity effect between German (L1) and English (L2) would occur, and this was tested with jumbled word reading of English text (wherein letters within words have been jumbled) and eye-tracking by 141 participants. Analyses of regressive fixations from one word class to others showed that nouns were regressed most often and there was a rank order of importance among the word classes apparently used to enhance comprehension of other difficult words (nouns, adjectives, verbs, closed-class words). Thus, previous findings for L1 were largely replicated. Findings are discussed regarding language acquisition.

When words in a text are not understood, people try to deduce their meaning using the semantic context provided by other words. Furtner, Rauthmann, and Sachse (2009) developed a unique design to estimate which word classes are used to decipher the meaning of text. This method involved reading words with jumbled letters and measuring the number of eye-gaze regressive fixations (= regressions) on words previously read in the text, i.e., words that the readers looked back at as they sought to comprehend the text. Furtner, et al. observed a rank order of word classes that readers regressed on when encountering difficult words: nouns, adjectives, verbs, and finally closed-class words (e.g., prepositions, conjunctions, etc., in descending order of importance). Nouns, adjectives, and verbs are classified as content words as they represent semantically meaningful content. Closed-class words, on the other hand, mainly structure a language's grammar and convey less semantic information (e.g., Ferrer i Cancho & Solé, 2001; Schmauder, Morris, & Poynor, 2000). Eye gaze was preferentially regressed on nouns when a reader was confronted with a difficult word. In German, it seems, the noun serves as a semantic anchor from which other words can be better understood.

The goal was to assess the rank order of regressed word classes serving as "comprehension enhancers" for difficult words in a second language (English, L2) as acquired by German (L1) native speakers. It was

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¹Address correspondence to Marco R. Furtner, Ph.D., Department of Psychology, University of Innsbruck, Innrain 52, A-6020 Innsbruck, Austria or e-mail (Marco.Furtner@uibk.ac.at).

hypothesized that the rank order of comprehension-enhancing words should remain stable across languages, since reading skills in L1 would be similar to L2. This also means that a participant who regressed his gaze on nouns in German to understand other words in the sentence better would do exactly the same when reading English.

Theoretical Background

Linguists concerned with influences from L1 to L2 particularly focus on language acquisition (Zyzik & Azevedo, 2009). According to Zyzik (2009), research on second languages has included little investigation of content-word classes, although these are of key importance, especially when learning a new language (Gentner & Boroditsky, 2001; Imai, Li, Haryu, Hirsh-Pasek, Golinkoff, & Shigematsu, 2008). For example, Wade-Woolley (1999) showed that when reading words, L1 has an influence on the understanding of L2, which is referred to as a transfer effect (cf. Sparks, Patton, Ganschow, & Humbach, 2009). Results of a priming study by Wang and Abe (2008), who examined visual word recognition in L2, found evidence that the processing of an L1 word automatically and simultaneously activates correspondent word recognition in L2 (cf. Jared & Kroll, 2001; Sunderman & Kroll, 2006). According to Zyzik (2009), native speakers possess a highly developed implicit system concerning word class use in L1 independent of correct and explicit meta-linguistic knowledge (cf. Alderson, Clapham, & Steel, 1997). In early phases of L2 acquisition, a new word-class system has to be established, and particularly the noun is preferred (Gentner, 2006). In support of, people learning a second language tend to make more mistakes in verbs than nouns (Lennon, 1996) and nouns connect in a more transparent way (Furtner, et al., 2009). Furthermore, verb acquisition lags behind noun acquisition in early childhood (Gentner, 2006), and this early noun preference can have trajectories into adulthood (when the noun is still preferred for core semantic processing of sentences). However, these processes are poorly understood as yet (cf. Zyzik, 2009).

One of the implications of such a process would be that word classes (explicitly or implicitly) used to enhance the understanding of other (difficult) words in L1 would be similarly used in L2, meaning that there should be a similarity effect of comprehension-enhancing word classes between L1 and L2.

Current Study

There have been few empirical studies on similarities of importance of word classes in L1 and L2. In this study, a combination of eye-tracking methodology and jumbled-word reading (letters were jumbled *within* each word) was used to examine whether there were similar effects in the use of word classes to improve comprehension of a difficult word. Furtner, *et al.* (2009) used the same methodology to identify a rank order of importance of word classes in reading jumbled text: nouns, adjectives, verbs, closed-class words, descending in relative importance. If the rank orders of the word classes' importance in reading L1 and L2 are the same, one should be able to replicate findings of Furtner, *et al.* (2009) in L2. It was hypothesized that due to the noun's relative predominance, there should be a similar rank order in L2 (English). The same rank order (nouns–adjectives–closed-class words–verbs) as in Furtner, *et al.* (2009) for L2 texts was hypothesized.

Method

Combining eve-tracking and jumbled-word reading is a novel approach in research on visual perception. Jumbled-word reading was used by Grainger and Whitney (2004) for the first time, and since, it has often been shown that research participants are able to read and understand jumbled texts easily (e.g., Perea & Lupker, 2004). Rayner, White, Johnson, and Liversedge (2006) reported that readers fixated difficult and unfamiliar words longer. Jumbled-word reading creates an environment in which almost every word is difficult or unfamiliar, so the entire reading process requires deeper information processing and conscious control. The extreme speed of human reading, which has become automatic, is slowed down when reading a jumbled text (see Rayner, 1998) as people have to put effort into un-jumbling and understanding of each word. For instance, in the jumbled phrase "stenecne empalxe" ("sentence example"), in trying to read the difficult word *empalxe*, the reader might gaze back at the already-understood noun *stenecne* for context; this process can be tracked by eye-movement analysis. Gaze-fixation points will show that a reader has looked back at previously read words, and how many times he does so. The method of jumbled-word reading allows identification and control of words' difficulty (see Rayner, et al., 2006) as people will fixate their gaze more frequently and for longer periods when reading jumbled words. Jumbled-word reading thus served to (a) control contextual effects, (b) increase difficulty in reading without using unknown or bizarre words, and (c) account for individual differences in linguistic abilities and adeptness, both of which effects would be very strong in a "normal" text. This method has also been used by Furtner, et al. (2009).

Participants

In the present study, students (N=141; 91 women, 50 men) participated. Their mean age was 24.6 yr. (SD=5, range=13–49). All were native speakers of German (L1), but possessed long-term (i.e., more than 10 yr. of experience starting at an age of 11–12 years) and sufficient knowledge of

English (L2). They understood English text, which was ensured by asking them about the content of the text after reading it (comprehension) and whether they had any difficulties understanding it. All participants were from the university, and most of them were majoring in psychology. Participants had normal or corrected-to-normal eye vision. All participants were blind to the study's aims and hypotheses and were the same participants as those in Furtner, *et al.* (2009) for intra-individual comparisons between L1 and L2 in a within-subjects design.

Material

As stimulus material² for text reading, an excerpt of a tourism brochure was selected. The text was selected according to two predefined criteria. First, the L2 jumbled-word text should not be too complex. Second, it should be relatively short, considering the complexity of the analyses to follow. The text had 68 words which were presented with jumbled letters (Fig. 1). Each word in the text was jumbled with a special software program, "Der Wortverdreher" ("The word jumbler"), by Hahn (2009)³ according to two rules. First, the first and last letters remained in their positions. Second, words with only two or three letters remain unjumbled (e.g., "the" remains as it is). The jumbled-word text version was presented left-adjusted with a font size of 34 in Times New Roman and a line-spacing of 1.5.

Apparatus

A Pentium IV computer with a graphics card NVIDIA GeForce 4 MX 4000 was used. The German text was displayed on a 17-inch computer monitor (View Sonic VG700b) with a display refresh rate of 75 Hz. Eye movements were recorded with a frequency of 2×60 Hz with two binocular cameras which were positioned beneath the computer display. The NYAN software (Eyegaze Analysis System, LC Technologies, Inc.) allowed registering, recording, and analysis of eye gaze saccades and fixations (the point between two saccades at which eyes are relatively stationary and information input occurs; range from 100–1,000 msec.). Two observation monitors allowed watching the right and left eyes (through input from the left and right binocular camera beneath the computer display) while in the process of eye-tracking to correct for the sitting posture of participants if necessary.

Procedure

First, the eye-gaze tracker was calibrated for each participant individually, and after successful calibration, the jumbled-word text in L2 was

²This material is neither identical with nor a translation of Furtner, et al.'s (2009) L1 text.

³The program can be found at http://www.derdickehase.de/dgleichd/wrot.php. Retrieved October 1, 2010).

Tourism town Innsbruck (normal text version)

Discover the amazing variety of the Tyrolean capital Innsbruck. Let your eyes see the "Nordkette" mountains of this unique country. Take your time to enjoy this moment in the "heart of the Alps". Time seems to stand still above the roofs of the Old Town of Innsbruck. The Old Town reflects the political and cultural significance of Innsbruck in the heart of Europe. Innsbruck is an Olympic city with charm. Linking traditional with modern.

Tourism town Innsbruck (text with jumbled letters)

Decvosir the aiaznmg vetraiy of the Tlyeoarn Ctpiaal Innsrubck. Let yuor eeys see the "Nordtekte" mounantis of tihs unuiqe cntuory. Tkae yuor tmie to enojy tihs mmonet in the "haret of the Apls". Tmie smees to snatd siltl aobve the rofos of the Old Twon of Innsbucrk. The Old Twon reltcefs the policiatl and cuutlral sgfniinciace of Innsrcubk in the hreat of Eruope. Innscubrk is an Oplyimc ctiy with cahrm. Lkninig tirdanotial with medron.

FIG. 1. English text "Tourism Town of Innsbruck" in two different versions (normal and jumbled letters)

presented on the computer screen. Participants were instructed before the experiment to focus on understanding the text. Before presenting the English (L2) text, the German (L1) jumbled-word text had been presented in the same sitting and all above procedures also applied to L1 reading as reported in Furtner, *et al.* (2009). After reading the L2 text (about 2 to 3 min.), participants were asked about words with which they had difficulty understanding or were unfamiliar. These words were then highlighted by a lab assistant on an MS PowerPoint sheet. Then, participants were asked what they had actually understood from the text and to reproduce the jumbled-word text in L2 from memory. To check whether participants really read and understood the L2 text, a lab assistant had a text-oriented checklist with content blocks from the text (see Table 1), and points were assigned for each correct reproduction of the 10 content block items from the text (Table 1).

Data Preparation and Analyses

First, a word-class analysis of the jumbled-word L2 text was conducted, identifying (1) nouns, (2) adjectives, (3) verbs, and (4) closed-class words (e.g., pronouns, prepositions, conjunctions, etc.). A frequency analysis of word classes showed that the English text contained 31% nouns (n=21), 15% adjectives (n=10), and 15% verbs (n=10), which gives a proportion of 61% content words and 39% closed-class words (n=27). Detection of a similarity effect between L1 and L2 for the relative importance of word classes in enhancing the comprehension of difficult words required that the rank order of noun, adjective, verb, and closed-class words (decreasing in importance) found for L1 (German; cf. Furtner, *et al.*, 2009)

Content Block	Item 1	Item 2	Item 3	Item 4
1	Tyrolean capital Innsbruck	"Nordkette" moun tains	- "heart of the alps"	
2	Old Town	political	cultural	"heart of Europe"
3	Olympic city	traditional	modern	

 TABLE 1

 Content Block Checklist For Oral Reproduction of Text

Note.—Participants were to reproduce orally the jumbled-word text, and their answers were marked on a checklist of 10 items (with three major content blocks) derived from meaning-ful units of text.

should also be apparent in English (L2). Thus, regressive eye-gaze fixations were investigated. For instance, to help the comprehension of the phrase "*Tihs is an esay empalxe stenecne wihch has been jubmeld up*," the difficult jumbled word *jubmeld* would be compared with the previous jumbled noun *stenecne* (an eye-gaze regression); eye-gaze fixations would recur from the comprehension-helping noun to the difficult word (see Furtner, *et al.*, 2009).

In the L2 text, there were four types of words difficult to understand (noun, verb, adjective, closed-class words) and four types of words the reader could use to enhance comprehension of the difficult word (noun, verb, adjective, closed-class words), for a design with 16 different types of possible regressive fixations (e.g., when trying to understand an adjective better, regressing to a noun, and so on).

Three criteria were used to evaluate the difficulty of an L2 jumbled word: (1) an interview of each participant (Subjective criterion), (2) general fixation per word in the jumbled text (Objective criterion) (Question: How many participants fixated the word more than three times? Result: Absolute number of participants with more than three fixations per word), and (3) number of fixations on each word (Objective criterion) (Question: How often was the word fixated by all participants? Result: Mean number of fixations per word). An increase in the number of fixations is an indicator of a word's difficulty (Goldberg & Wichansky, 2003). In this process, 16 most difficult jumbled L2 words (7 nouns, 5 verbs, and 4 adjectives) could be identified (Table 2).

Results

Noun Similarity Effect Between L1 and L2

According to the first hypothesis, L2 nouns should be used most often to improve understanding of a difficult word as they are also used in L1. The "use" of a word to understand the word currently being read is defined as a change in eye-gaze fixation back to a previous word. As can be seen in Table 3, for 42% (n = 135) of the difficult words, a previously read

Difficult Jumbled	1. Interview	w, Subjective	2. Gener	al Fixation	3. Nun	nber of Fi	xations
Words (>3 fixations)	п	Rank	п	Rank	М	SD	Rank
medron	104	1	72	2	10.4	4.7	12
Decvosir	90	2	71	3	15.0	8.2	1
vetraiy	72	3	54	9	12.6	6.7	4
snatd	62	4	76	1	12.1	5.2	6
siltl	38	5	28	14	10.4	5.7	12
reltcefs	33	6	54	9	12.2	4.8	5
tirdanotial	25	7	58	7	11.5	5.9	8
cntuory	24	8	64	6	13.7	6.0	3
Lkninig	19	9	31	13	14.4	7.8	2
aiaznmg	18	10	33	12	9.6	5.4	14
Tlyeoarn	17	11	44	11	11.4	6.4	9
cahrm	16	12	71	3	10.8	4.4	11
sgfniinciace	12	13	16	16	11.4	3.6	9
rofos	10	14	18	15	9.5	3.5	16
smees	10	14	55	8	9.8	3.5	15
haret	10	14	65	5	11.7	6.8	7

TABLE 2 Criteria for Difficulty of Words: Subjective, Eye-gaze Fixations, and Number of Eye-gaze Fixations

Note.—Lower ranks denote more difficult words.

noun was regressed most often, followed by adjectives (21%, n = 68), verbs (20%, n = 63), and closed-class words (17%, n = 55). Differences in frequency between word class regression were statistically significant ($F_{3,317} = 2.75$, p < .05; $\eta^2 = 0.17$). A Games-Howell multiple comparisons *post hoc* test, used

Comparison post hoc Test For Word-class Differences							

TABLE 3

Descriptive Statistics of Regressions				Post hoc Comparisons					
Word-class	п	%	М	SD	Regressed Word-class		Comparison by Word- class		
					i	j	ΔM_{i-j}	SE	Cohen's d
Noun	135	42	1.21	0.52	Noun	Verb	0.10	0.06	0.23
Adjective	68	21	1.13	0.42		Adjective	0.08	0.07	0.17
Verb	63	20	1.11	0.36		CC-words	0.19*	0.05	0.50
CC-words	55	17	1.02	0.14	Adjective	Verb	0.02	0.07	0.05
Total	321	100	1.22	0.43	2	CC-words	0.11	0.05	0.35
					Verb	CC-words	0.09	0.05	0.33

Note. — CC-words = closed-class words; Groups *i*, *j* = word-classes regressed to enhance comprehension of other difficult words; ΔM_{i-j} = mean difference between Groups *i* and *j*;*SE* = standard error. **p* < .01.

because it is more robust against violations of normal distribution in data, yielded only one statistically significant difference in regression frequency by word class—between nouns and closed-class words (see Table 3).

Rank Order Effect: L1 and L2

According to the second hypothesis, the relative importance of word classes in enhancing words difficult to understand should be the same in L1 and L2. Thus, one would expect the order of nouns, adjectives, closed-class words, and verbs (decreasing in importance) as this was previously reported for L1 in Germans (Furtner, *et al.*, 2009). The order of word-class regressions for understanding was compared between the jumbled-word German text used in Furtner, *et al.* (2009) and the jumbled-word English text in the current experiment (same participants). The order of use frequency in the jumbled-word German text was as follows: (1) nouns (49%), (2) adjectives (25%), (3) closed-class words (16%), and (4) verbs (10%).

When German native speakers (L1) confronted a jumbled English text (L2), the following distribution of eye-gaze regressions was observed: (1) nouns (42%), (2) adjectives (21%), (3) verbs (20%), and (4) closed-class words (17%). When the frequency distributions of the word classes within the English text were take into account, there were 31% nouns, 15% adjectives, 15% verbs, and 41% closed-class words. Therefore the word-class frequency did not distort the expected rank order, which was the same as found with L1 text: nouns>adjectives>verbs>closed-class words.

Discussion

The question was whether there is a language use similarity between L1 (German) and L2 (English) for word classes that apparently enhances comprehension of other words during reading. The method used eyetracking and jumbled-word reading. In L2, nouns were the most frequently regressed if the next words read were difficult. The rank order of regression by word class in this measure of word-comprehension enhancement largely replicated the order found for L1 (cf. Furtner, *et al.*, 2009), as expected.

Present findings may indicate some similarities of reading skills between L1 and L2. First, in both L1 and L2 texts the noun was used in almost 50% of cases to help understand another difficult word, as indicated by more regressions on the helping noun (cf. Furtner, *et al.*, 2009). Second, a similar L2 order of word classes regressed for comprehension enhancement was found when compared to L1, but the relative importance of verbs and closed-class words had reversed. A verb was more often regressed to help understand another word in L2 than in L1. Compared to the noun and adjective, the verb apparently conveyed less semantic meaning in German, but in English the verb and adjective produced almost similar regression rates which indicates more semantic weight for the verb in English compared to German. However, this higher importance of the verb need not be an inherent quality of the English language *per se*, but rather of an acquired language, as verbs might be of more semantic importance in L2 than in L1, in which implicit semantic schemata are much more salient and readily applicable.

Moreover, further evidence was provided for the significance of the noun, and its universal predominance has been shown in a multitude of studies (e.g., Gentner, 2006; Imai, Haryu, Okada, Li, & Shigematsu, 2006). Generally, researchers have focused on nouns and verbs, but barely or not at all on adjectives and closed-class words (Dürr & Schoblinski, 2006). As present findings indicate, closed-class words are of little importance in conveying information beneficial to text comprehension, when compared to other word classes (cf. Schmauder, *et al.*, 2000).

According to Zyzik (2009), few empirical investigations have been focused on transfer effects between L1 and L2 of word classes (here referred to as similarity effect), but "the existing research that addresses the problem of word class in the L2 context are a handful of vocabulary acquisition studies" (p. 148). People possess a highly developed implicit L1 system in the access to word classes which they also use in their L2 (cf. Wade-Woolley, 1999; Zyzik, 2009). Supporting this view is the present one that nouns are regressed most in L1 *and* L2 when a word is difficult. Furthermore, present findings support McClelland and Rumelhart's Bilingual Interactive Activation Model (1981) in which they postulated representation of L1 and L2 words in an integrated lexicon which were concatenated on a higher level. Current findings indicate, however, that not only single words are directly linked to each other in L1 and L2, but also entire word classes – at least within two Indo-European languages.

Merits, Limitations, and Lines For Research

This initial examination has been empirically focused on a potential L1–L2 similarity effect with all word classes (nouns, adjectives, verbs, closed-class words), using a methodological combination of eye-tracking and jumbled word reading. Furthermore, two key findings from Furtner, *et al.* (2009) were replicated in L2, the predominance of the noun and the word-class rank order of relative importance in enhancing comprehension of other words difficult to understand. Thus, an L1–L2 similarity effect was shown (cf. Sunderman & Kroll, 2006; Sparks, *et al.*, 2009).

One limitation of the present study is that the stimulus material was not the same text as in Furtner, *et al.* (2009), which may make comparisons more tentative. However, findings were replicated despite differences in stimulus material which stands in favor of generalizability of these findings. Moreover, the same participants as in Furtner, *et al.* (2009) were tested, this made it possible to provide stronger evidence for intra-individual word-class similarity effects between L1 and L2. Although this bears the risk of inflated relations between L1 and L2 and thus also in word-class rank orders, this design is the best possible if one wants to study how L1 will affect L2 of the same group's semantic processing.

Further limitation is that jumbled word reading may evoke metalinguistic strategies due to an unecological reading situation. Future studies should thus also incorporate ecological texts without any jumbling to rule out spurious or artificial effects from supervisory cognitively controlled reading skills.

Further studies could (a) include intra- and interindividual designs to study possible L1–L2 similarity effects (i.e., same and different samples), (b) delve into the question of grammatical and syntactic differences in the languages compared (here focus was on semantics), (c) compare languages other than Indo-European ones (e.g., Hamito-Semitic), (d) control for individual differences in verbal intelligence and language knowledge, and (e) examine similarity effects not only for monolinguals but also polylinguals.

Conclusion

In the present study, for German speakers' L2 (English) the noun was regressed most when there was another word which was difficult to understand and a rank order, similar to that of the group's L1 (German), of importance of a word class in enhancing other words' comprehension, namely, noun>adjective>verb>closed-class words. Thus, empirical evidence is provided via eye-tracking and jumbled word reading for a similarity effect in word classes between L1 and L2. Present findings may also be of interest to researchers studying language acquisition.

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