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On Processing BEASTS and BIRDS: An Event-Related Potential Study on the Representation of Taxonomic Structure

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In two event-related potential (ERP) studies it was investigated whether concrete nouns of different taxonomic level (basic level terms, e.g., BIRD, and superordinate terms, e.g., BEAST) are processed differentially under conditions where no processing of taxonomic relations is required. The first experiment, a lexical decision task with taxonomic terms serving as no-go trials, revealed no differences in ERP waveforms to basic level as compared to superordinate terms. The second experiment, a modified oddball paradigm, revealed a consistent pattern of ERP differences: Superordinate deviants elicited a prolonged early positivity as compared to standard items, possibly a P3a component, while basic level deviants elicited an enlarged N400 compared to standard items. Additionally, taxonomic items presented only once in a recognition test elicited different ERPs depending on their respective taxonomic level. Moreover, study- as well as recognition-ERP patterns differed depending on whether Subjects were confronted with basic level terms or with superordinates as standards. It was concluded that representations of basic level terms form a distinct conceptual class, while representations of superordinate terms probably do not.

INTRODUCTION

Since the influential paper of Rosch and her colleagues (Rosch, Mervis, Gray, Johnson, & Boys-Braehm, 1976), numerous studies have confirmed that there exists a certain subset of taxonomically organized concrete nouns which seems to possess a privileged status in categorization tasks. The words that form this subset—the so-called basic level terms—label objects at an

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intermediate level of categorization. That is, they are neither ''abstract'' terms like BUILDING or ANIMAL or PLANT, which form highly heterogenous classes of objects, nor ''specific'' terms like BUNGALOW or CHOW-CHOW or ACACIA, which form classes of virtually identical objects, but rather refer to categories of perceptually and functionally *similar* objects, like HOUSE, DOG, or TREE.

Especially if compared to superordinate terms, basic level terms are privileged in a number of ways. They are the first to be learned and used by children during language acquisition (Mervis, 1984; Mervis & Crisafi, 1982; Mervis & Rosch, 1981), they are most often used in spontaneous object naming (Cruse, 1977; Rosch *et al.*, 1976), and they give rise to the shortest reaction time (RT) latencies in word–picture categorization tasks (Hoffmann & Ziessler, 1981; Murphy & Brownell, 1985; Murphy & Smith, 1982; Rosch *et al.*, 1976) as well as in picture–word categorization tasks (Murphy & Wisniewski, 1989; Rosch *et al.*, 1976). Superordinate terms, on the other hand, are particular in that they show exactly the opposite properties: it takes many years until children learn to use superordinates the same way as adults do (Blewitt & Krakow, 1992; Callanan & Markman, 1982; MacNamara, 1982; Markman & Callanan, 1986; Markman, Horton, & McLanahan, 1980), they are almost never used spontaneously in object naming (Hoffmann, 1986), and in all categorization studies cited above superordinate terms elicited the longest RT latencies. Thus one is led to assume that basic level terms and superordinate terms form two functionally distinct classes of concepts[1]: while basic level terms can be characterized as ''object identification devices,'' superordinates obviously play a completely different role in categorization. It has been argued that they may be especially involved in the organization of and information transfer between subordinated concepts (cf. Hoffmann, 1983, 1986).

There is some empirical evidence that these functional differences correspond to systematic representational differences between basic level concepts and superordinate concepts. For example, if lists of words associated by subjects (Ss) in response to a given stimulus item are analyzed semantically, one typically finds that basic level terms are those stimuli to which *perceptual features* are predominantly listed (e.g., the stimulus item BIRD evokes associations like ''feathers,'' ''wings,'' ''beak,'' etc.; Hoffmann & Ziessler, 1982; Rosch *et al.*, 1976; Tversky & Hemenway, 1984), while with superordinates mostly *subordinate terms* are associated (Hoffmann & Ziessler, 1982). Additionally, Murphy and Wisniewski (1989) found a differential influence of picture complexity and picture consistency on word–picture

[1] The term ''concept'' is used as referring to ''the mental representation of a word and its meaning.'' Whether this includes two distinct representational systems—a ''lexical'' one and a ''conceptual'' one—or one unitary system is not relevant for the present purpose.

categorization times.[2] However, in all studies cited above participants were required to perform some sort of categorization task. The present study was designed to test whether evidence for representational differences between basic level terms and superordinates can be obtained even under conditions, where no such ''taxonomic processing'' is required. To this purpose, event-related brain potentials were recorded while participants performed a lexical decision task (Experiment 1) or a reading task (Experiment 2).

EVENT-RELATED POTENTIALS AND LANGUAGE PROCESSING

A comparatively simple way to measure certain brain activities is to compute event-related potentials (ERPs) from the electroencephalogram (EEG). To this purpose, the EEG is recorded from electrodes located at various scalp positions, while the subject is performing the experimental task. Each time a certain event occurs (for example, each time a word appears on the screen), a specific event signal is added to the EEG. After finishing the recording, EEG waveforms obtained by numerous trials are grouped together according to their respective event signals. Then the waveforms of each group are averaged. As a result of the averaging procedure, random fluctuations of the spontaneous EEG cancel each other out, and only those modulations of the EEG waveforms remain that are time-locked to the occurrence of the respective event. These so-called *ERP waveforms* are generally assumed to reflect specific patterns of neural activity related to the event in question (cf. Kutas & Van Petten, 1994). They typically consist of a sequence of positive- and negative-going deflections, some of which are event specific with respect to their scalp distribution, latency, and amplitude and are modulated by certain experimental manipulations. These deflections are identified as *components* of the ERP waveform. In comparing ERP waveforms obtained from different types of events one thus can investigate whether these events elicit systematically different patterns of neural activity. If differences between ERP waveforms occur, this usually is interpreted as indicating that specific processes are involved in processing the respective types of events.

There is some evidence that basic level terms and superordinates give rise to such ERP differences. Kouninous and Holcomb (1992) were able to show that in a sentence verification task, terminal basic level terms (e.g., ''Some animals are DOGS'') produced an enlarged N400 component compared with terminal superordinate terms (e.g., ''Some dogs are ANIMALS''). The N400—a negative going deflection with a peak latency of approximately 400 ms after stimulus onset—usually is interpreted as indicating the difficulty of

[2] There even seems to be a neuropsychological dissociation in that some aphasic patients have difficulties in using superordinate terms but can use basic level terms normally, while other patients show the opposite pattern of deficits (D. Y. von Cramon, pers. commun.).

semantic integration processes: the greater the difficulty of integrating a new meaningful item into a given context, the larger the amplitude of the N400 elicited by this item (Brown & Hagoort, 1993; Holcomb & Neville, 1990; Kutas & Hillyard, 1980a,b, 1984, 1989; Kutas & Van Petten, 1990). However, in the Kounious and Holcomb study, basic level terms elicited a larger N400 than superordinates regardless of the degree of semantic relatedness between subject term and predicate term (e.g., ''Some *animals* are DOGS'' vs. ''Some *vehicles* are DOGS''), thus indicating that there may be other factors contributing to the observed effect. To test whether the difference in N400 amplitude was due to specific representational formats or resulted merely from task-related interactions of subject and predicate term, a second experiment was conducted in which subjects had to perform a concrete/abstract jugdment for successively presented single words. All taxonomic items had to be classified as ''concrete,'' while terms like GUILT or JOY were used for the ''abstract'' category. Under this condition, too, basic level terms elicited an enlarged N400 compared with that seen with superordinates. The authors concluded that systematic representational differences exist between basic level terms and superordinates, resulting in systematically different activation patterns. However, in both experiments participants had to perform specific categorization tasks. In the first experiment, they had to evaluate the semantic relation between two terms, and in the second experiment, they had to decide whether a given word was the name of an object or not. Do basic level terms and superordinates still give rise to different ERP waveforms if no such *active* categorization is required? The aim of the present study was to investigate this issue more closely.

Two experiments were conducted, one using a word repetition paradigm, the other one using an oddball paradigm. In each experiment, Ss silently had to read basic level terms and superordinate terms, presented one word at a time, without performing any specific category-related tasks. To ensure sufficiently ''deep'' processing, Ss had to perform a lexical decision task on a number of nontaxonomic items in the first experiment and had to memorize each item for a variable amount of time in the second. Both tasks were designed to minimize the probability of semantic-relational processing (i.e., the active evaluation of the relations between two concepts as in sentence verification or picture–word categorization).

CRITERIA OF STIMULUS SELECTION

To ensure that any ERP-differences obtained throughout the experiments are due only to different taxonomic levels, the words serving as stimuli had to be selected with great caution. However, since words are a very heterogenous, overlearned, and meaningful material, it seems virtually impossible to control for *all* factors possibly influencing the processing in one or the other way. In particular, it seems impossible to consider subjective factors, such as positive or negative emotions associated with a given word, and objective factors, such as word length, simultaneously. Nevertheless, within certain limits one can try to control at least some of the most influential objective factors. In the present study, the criteria for selecting a word as stimulus were as follows:

(a) The material should be as *semantically heterogenous* as possible in order to avoid effects based upon semantic-relational processing: for example, if almost all of the stimuli were names for artifacts, while only one or two were names of plants, one would assume that these latter items were regarded as being ''deviant'' with respect to the more often presented artifact terms, thus undesirably giving rise to semantically based ''oddball'' effects (see below). Therefore, words were selected from 18 (Experiment 1) and 21 (Experiment 2) different semantic categories, and for each superordinate term representing a category there was one basic level term representing an exemplar of this category.

(b) On the other hand, the material should be as *morpho-syntactically simple and homogenous* as possible, since differences in morpho-syntactic complexity are known to influence word processing (e.g., O'Regan & Lévy-Schoen, 1984). Consequently, no compound nouns were included (unfortunately, affixoid forms could not be avoided completely).

(c) Additionally, the words had to be *semantically unambiguous;* that is, polysemous words (words with more than one meaning, e.g., GLASS: object and material) were not allowed, because there is some evidence that both meanings are activated during reading (Oden & Spira, 1983; Tanenhaus & Leiman, 1979; Van Petten & Kutas, 1987).

(d) No word consisted of more than 13 or less than 4 letters, and in order to avoid effects due to sensoric differences in the stimulus material, the mean *word length* (ca. 6.6 letters) as well as the distribution of different word lengths was about the same for basic level terms and superordinates.

(e) Similarly, the *frequency of occurrence* in normal discourse (measured as frequency per 1 million words according to the Mannheimer Korpus in CELEX) as well as the distribution of frequencies was about the same for basic level terms and superordinates, because differences in the preexperimental familiarity of words—for which word frequency can be used as a measure—give rise to specific ERP differences (e.g., Rugg & Doyle, 1992; Smith & Halgren, 1987). Since it was not possible to construct a sufficiently large corpus of high-frequency words that also follow the criteria mentioned above, only relatively low-frequency words (occurrence less than 100/million) were selected as stimuli.

(f) Of course the most important feature of the selected words was whether they could be identified as basic level terms or superordinate terms, respectively. Since there exists no clear-cut boundary between these two types of nouns, but rather a continuum from ''more basic level-like exemplares'' to ''more superordinate level-like exemplares'' (Hoffmann, 1986), a rather pragmatic way of distinguishing between them was adopted: Basic level terms were defined as those terms which are at the relatively most abstract level of a given hierarchy where the object denoted can still be imagined visually (Hoffmann, 1983, 1986; Lakoff, 1987; Rosch *et al.*, 1976)—that is, the most abstract words which still denote an object that can be represented by a simple picture. Consequently, superordinate terms were defined as those words for which the request to draw a picture of the respective object would lead to the question of *what kind of* object one should draw (e.g., while the request to draw a DOG would be regarded as being rather unproblematic, the request to draw an ANIMAL inevitably would lead to the question of what kind of animal one should draw). Each word selected according to the criteria mentioned above was checked against this criterion by various members of the institute staff. Those words for which there was no complete agreement about whether they should be regarded as basic level or superordinate terms were removed from the corpus and replaced by new items, for which the procedure was repeated. A list of all stimuli is provided in the Appendix. For a detailed description of the stimulus material see Schlaghecken and Bölte (1998).

EXPERIMENT 1

In this experiment, a word-repetition paradigm was used together with a lexical decision task. Ss had to identify nonwords and first names (catch trials) against a background of nouns. Half of the nouns were basic level terms and superordinates (taxonomic items), the other half were nouns that do not readily fit into a taxonomic hierarchy (distractor items; e.g., relational terms like UNCLE). It was assumed that in order to identify the response relevant items, Ss had to read each item thoroughly, thus activating the mental representations of taxonomic and distractor items in order to classify them as nogo trials. If systematically different types of representations exist for basic level terms and superordinates, this should give rise to different activation patterns of the respective items. More specifically, if the results obtained in the Kounious and Holcomb (1992) study described above are due to task-independent representational differences, a similar pattern of basic level terms eliciting an enlarged N400 component as compared with superordinate terms should be observed. While the catch trials were used to keep the Ss attended to the stimuli, the distractor items were interspersed to prevent Ss from becoming aware of the relevance of taxonomic items. Thus any conscious or active processing of taxonomic relations should be minimized in this design.

Each item was presented three times per block and six times throughout the experiment, because it was assumed that presenting the items repeatedly would possibly influence the ERP waveforms to basic level terms and superordinate terms differentially. In comparing ERP waveforms for repeated items with ERP waveforms elicited by the first presentation of the same item, one usually finds a positive-going shift with an onset of approximately 300 ms, the so-called ‘‘word repetition effect’’ (Rugg, 1985; Nagy & Rugg, 1989). Numerous studies have shown this repetition effect to be sensitive to various aspects of word processing: First, the repetition effect is smaller in amplitude for words occurring with high frequency in normal discourse than for words occurring with low frequency, but shows the same latency and scalp distribution for both types of stimuli (Rugg, 1990; Young & Rugg, 1992). Second, it is smaller in amplitude and shows an enlarged latency for nonwords (Rugg, 1987), this effect being even more prominent for orthographically illegal nonwords (Rugg & Nagy, 1987). Third, in testing children with visually presented words no repetition effect occurred for those words the children were not able to read (Berman & Friedman, 1993). Fourth, while there are substantial differences in amplitude and scalp distribution of the repetition effects for pictures vs. words (Berman, Friedman, & Cramer, 1991), no differences occurred in the repetition effects of visual vs. auditory presented words (Domalski, Smith, & Halgren, 1991), indicating that the repetition effect is sensitive to *conceptual* rather than to perceptual aspects of stimuli.

For the present experiment, these last two findings are of major interest, as they give rise to the assumption that differential repetition effects may also be obtained for conceptual distinct classes of words. Thus if basic level concepts and superordinate concepts differ sufficiently with respect to their representational structure, one may expect to find specific repetition effects for each taxonomic level. On the other hand, the finding of differential repetition effects for high-frequency and low-frequency words is of some relevance for the present experiment, too. Since, as mentioned above, almost all RT studies on object identification and categorization reveal a strong RT advantage for basic level terms, one could assume that during lexical access basic level terms are activated more easily than superordinate terms simply because Ss are more *familiar* with terms like HOUSE than with terms like BUILDING. If this assumption holds, comparing the repetition effect for basic level terms with the repetition effect for superordinates should reveal the same pattern of results as comparing repetition effects for high-frequency and low-frequency words; that is, superordinates should elicit a larger repetition effect than basic level terms do, while the latency and scalp distribution of both repetition effects should be the same. If, on the other hand, the representations of basic level terms and superordinates are in some *other* (i.e., conceptual) respect sufficiently different to give rise to different repetition effects, these differences should not resemble the influence of frequency on the word repetition effect.

Method

Subjects. Twenty-eight paid volunteers (10 male), ages 19–43 years (mean age 25 years) participated in the experiment. All Ss were native speakers of German and had normal or corrected-to-normal vision. All Ss reported to be right-handed.

Stimuli. As stimuli, 270 character strings were used. Of these, 120 were nouns, 60 were first names, 60 were orthographically legal nonwords, and 30 were letter–digit combinations. Half of the nouns were distractor items (nontaxonomical items, as described above), 30 were superordinate terms, and 30 were corresponding basic level terms. The items consisted of 6.53 characters on average. Word frequency was controlled only for taxonomic items and was about 19.4/mio (per million) according to CELEX. Each item was presented in capital letters in the middle of a computer screen, one at a time. Letters were 1 cm in height and items were 6.5 cm long on average (corresponding to a visual angle of $0.6° \times 3.7°$ at a distance of 1 m). In order to keep the Ss as much attended to each stimulus as possible, the SOA varied slightly: SOA was either 1450, 1500, or 1550 ms, each SOA occurring with equal probability, while stimulus duration was held constant at 400 ms.

Design. To avoid any influence of semantic relations on the processing of the stimuli as much as possible, 12 different experimental blocks (‘‘regular blocks’’) were constructed such that each block contained either five different basic level terms or five different superordinate terms. Additionally, each block contained five different distractor items, five different first names, and five different nonwords. Taxonomic items occurring together in one block were selected from the taxonomic list according to the principle of minimal semantic overlap (e.g., a block could contain VEGETABLE and VEHICLE, but not VEGETABLE and FRUIT). Within each block, each item was presented three times, leading to a total sum of 60 trials per block. Only for taxonomic items there was a regular sequence of presentations: each one was repeated two times before the next taxonomic item occurred, and each presentation (first presentation, first and second repetition) was preceded by two to three distractor items and/or catch trials. The occurrence of these items was controlled only to the extent that no item was immediately repeated, and no sequence of two items was ever repeated.

Four different sequences of these 12 regular blocks were constructed, and Ss were assigned randomly to one of these. The regular blocks were presented two times in order to test whether repetition effects for basic level terms and superordinates differ between short-term repetition and delayed repetition. After the first presentation, Ss had to perform a distractor task with a length of six blocks; after this, the sequence of regular blocks was repeated. In the six distractor blocks, stimulus material was changed in that taxonomic items were replaced by letter-digit-combinations, and Ss had to respond to these items and ignore first names and nonwords. Distractor words served as response-irrelevant items in the regular as well as in the distractor blocks.

Procedure. Ss were seated in a comfortable chair in a dimly lit, electrically shielded, sound attenuated chamber, 1 m in front of a 17″ computer screen, with response buttons under their left and right index fingers. During each block, stimuli were presented in the middle of the screen, one word at a time. Ss were instructed to carefully read each item and react as quickly and accurately as possible if the item was a nonword or a first name. For half of the Ss, nonwords required a left button press and first names a right one; for the other half, this relation was reversed. Ss were instructed to maintain central eye fixation during each trial and to avoid eyeblinks. Each block had a duration of approximately 1.5 mins followed by a short break of approximately 15 s. After every three blocks Ss were informed about their average RT and error rate. At the beginning of the experiment, Ss were informed about the item repetition and were told that this had no relevance for their responses.

In the first part of the experiment, the 12 normal blocks were presented. After a short rest period, in which Ss received a new instruction, the 6 distractor blocks were presented. In these blocks, Ss had to respond only to letter–digit combinations and had to ignore nonwords and first names. The task then was to press the right response button if a letter–digit combination contained a ‘‘Z’’ and to press the left button otherwise. After a second rest period, the first part of the experiment was repeated.

Recording. EEG was recorded with Ag–AgCl electrodes from FPZ, FZ, CZ, and PZ (midline electrode sites), F7 and F8 (left and right fronto-lateral sites), T3′ and T4′ (left and right temporolateral sites, each shifted 1 cm in parietal direction), and TP3 and TP4 (halfway between T3 and P3, and between T4 and P4, respectively). All electrodes were referenced to the right earlobe, and impedance was kept below 5 kOhm. Continuous EEG was recorded for each block separately, with a sample frequency of 256 Hz and an amplifier bandwith of 0.1–70 Hz. Reaction times were recorded for each block.

Data analysis. ERPs were averaged off-line, the interval ranging from 100 ms before stimulus onset to 900 ms after stimulus onset. Baseline correction was performed for the 100-ms prestimulus interval. Events containing eyeblinks (EEG amplitude at FPZ larger than +/− 50 μV), false responses, or responses faster than 100 ms were excluded from further analysis. In addition, three Ss were excluded from further analysis because of massive alpha wave activity. Events were grouped according to the criteria type (basic level term, superordinate term, distractor, nonword, first name, and letter-digit-combination) and presentation (first, second, third presentation in the first regular part, and fourth, fifth, and sixth presentation in the second regular part).

After visual inspection of the Grand Mean Average-ERP the same time windows of 200–300 ms, 300–500 ms, and 500–800 ms were selected for statistical analysis that were used in other studies on word repetition, too (e.g., Rugg, 1990). In each of these time windows, mean amplitudes of ERP waveforms were analyzed. Repeated measures ANOVAs were computed for each pair of successive presentations with the within-subject factors TYPE (basic level, superordinate), PRESENTATION (see above), and POSITION (FPZ, FZ, CZ, PZ, F7, T3′, TP3, F8, T4′, and TP4). Where appropriate, a Greenhouse–Geisser correction of degrees of freedom was computed (under Results, Greenhouse–Geisser epsilon is indicated by ‘‘GG’’). Since in this study only the effects of taxonomic level are of interest, only ERP data from basic level term items and superordinate term items will be reported under Results. Mean RTs were computed for the two regular parts only, according to the criteria Type (nonword, first name) and Experimental Part (first and second regular part). No statistical analysis of RTs was performed.

Results

Behavioral data. Mean RT for nonwords was 676 ms in the first regular part and 625 ms in the second regular part. Mean RT for first names was 591 ms in the first part and 557 ms in the second. Mean error rate was about 3.9% in the first and 3.1% in the second regular part.

EEG data. As an overview, grand mean average waveforms of basic level and superordinate terms, collapsed across all presentations, are given in Fig. 1, while in Fig. 2 difference waveforms, showing the effects of each repetition, are provided.

200–300 ms. The slightly enlarged positivity elicited by repeated items in this latency range failed to reach statistical significance for all pairs of successive presentations within each regular part. Only for the comparison of the last presentation in the first regular part with the first presentation in the second regular part (third/fourth-presentation pair; see Fig. 2, middle panel) was there a significant main effect of PRESENTATION ($F(1, 27) = 7.72$, $p < .01$) due to the fact that the fourth presentation elicited less positive going ERPs. Additionally, only for this pair was there a significant POSITION × PRESENTATION interaction ($F(9, 243) = 4.45$, $p < .004$, GG = .39), since the (reversed) repetition effect was largest at centro-parietal electrodes. Although the enlarged positivity seems to be most prominent in the first repetition for basic level terms and in the second repetition for superordinates, no main effect of TYPE or interaction of TYPE × PRESENTATION was observed in this time window.

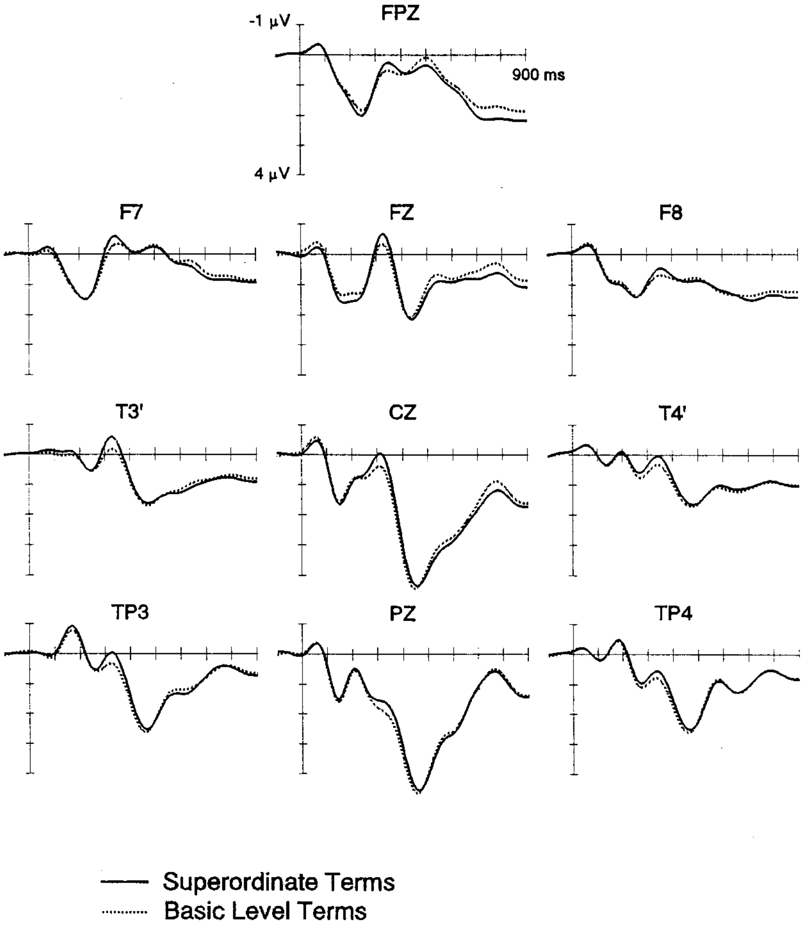
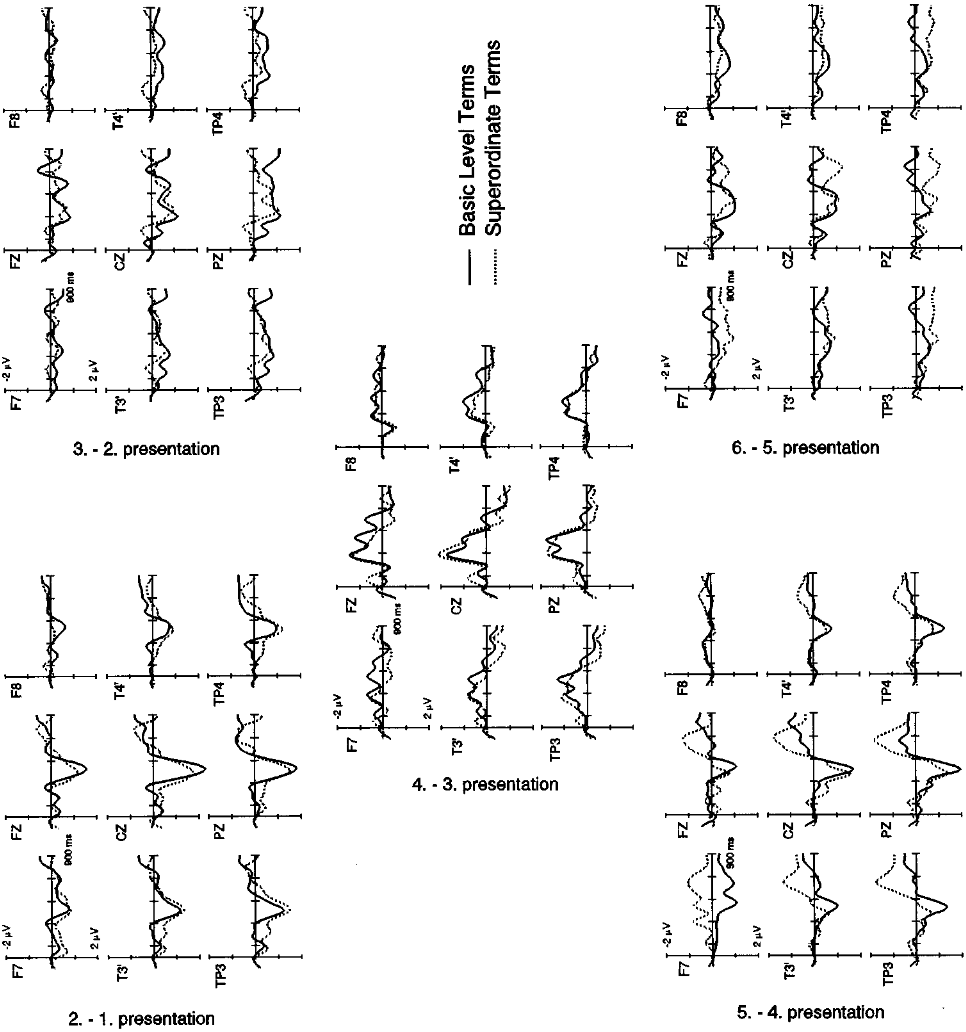


FIG. 1. Experiment 1. ERP waveforms elicited by basic level terms (solid line) and superordinate terms (dotted line) for each subsequent presentation.

FIG. 2. Experiment 1, difference waveforms. ERP waveforms from successive presentations were subtracted from one another, such that negative (upward)-going difference waveforms indicate that the ERP elicited by the following presentation was more negative than the ERP elicited by the preceding presentation, while positive (downward)-going difference waveforms indicate that the ERP elicited by the following presentation was more positive going. Difference waveforms for basic level terms are indicated by solid lines; difference waveforms for superordinates by dotted lines. The top part of the figure represents repetitions within the first regular part of the experiment, and the bottom part represents repetitions within the second regular part. The middle part (4.–3. presentation) represents the ERP differences between the last presentation of the first and the first presentation of the second experimental part.


Basic Level Terms
Superordinate Terms
3. - 2. presentation
2. - 1. presentation
4. - 3. presentation
6. - 5. presentation
5. - 4. presentation
F7
FZ
F8
T3'
CZ
T4'
TP3
PZ
TP4
-2 µV
2 µV
900 ms

300–500 ms. There was a significant effect of stimulus repetition for each pair of successive presentations, in that following items elicited more positive going ERPs than did their preceding items. This effect was most prominent for the first presentation/second presentation pair ($F(1, 27) = 21.3$, $p = .000$), but also occurred in all other pairs (second/third-presentation, $F(1, 27) = 5.21$, $p < .031$; fourth/fifth-presentation, $F(1, 27) = 6.76$, $p < .015$; fifth/sixth-presentation, $F(1, 27) = 12.89$, $p < .001$) with the exception of the third/fourth pair: as in the previous time window, for this pair the effect was reversed in that the fourth presentation elicited a more negative going ERP than the preceding presentation. This effect, too, was significant ($F(1, 27) = 10.35$, $p < .003$). Additionally, there was a significant POSITION × PRESENTATION interaction for all pairs except the last one (first/second, $F(9, 243) = 6.49$, $p = .000$, GG = .44; second/third, $F(9, 243) = 2.83$, $p \leq .038$, GG = .37; third/fourth, $F(9, 243) = 3.6$, $p < .014$, GG = .37; fourth/fifth, $F(9, 243) = 7.02$, $p = .000$, GG = .38). As can be seen from Fig. 2, this is probably due to the fact that the effect was always largest at centro-parietal electrode sites. Again, no main effect of TYPE or interaction of TYPE and PRESENTATION could be found.

500–800 ms. In this time window, repeated items elicited a slightly more negative going ERP than did their respective preceding items, but this effect was not significant. Only for the fourth presentation/fifth presentation pair, where the fifth presentation elicited more positive going ERPs, there was a significant effect of repetition ($F(1, 27) = 7.31$, $p < .012$). Additionally, there was a significant TYPE × PRESENTATION interaction for the fourth/fifth pair ($F(1, 27) = 5.88$, $p < .022$), but because of its isolated existence and since separate analyses of the fourth and fifth presentation revealed no effect of TYPE, this effect probably should be regarded as a random result.

Discussion

The effects of word repetition in the early as well as in the mid-latency time window closely resemble the effects described by Young and Rugg (1992): Repeated items elicited a slightly enlarged positivity in the 200- to 300-ms latency range, which did not reach statistical significance, as well as a highly significant enlarged positivity in the 300- to 500-ms latency range, which had its maximum at centro-parietal electrode sites. In the 500- to 800-ms time window, however, the results of these two studies differ. Not only is a significant main effect of REPETITION missing in this latency range, but the tendency of repeated items to elicit slightly more *negative* going ERPs than their preceding items stands in marked contrast to the enhanced *positivity* reported by Young and Rugg (1992) for the first repetition. This difference will be considered in more detail below.

No evidence for different representations of basic level terms vs. superordinate terms was found in the present experiment. Neither ERP waveforms for single presentations nor the word repetition effect turned out to distinguish between different taxonomic levels. However, as mentioned above, numerous studies on object identification and categorization revealed a strong RT advantage for basic level terms as compared to superordinate terms. Why do the ERP waveforms fail to reflect any difference in processing these terms? There seem to be three possible interpretations of the present finding: First, ERPs, while doing well on rather coarse-grained manipulations of word frequency or stimulus expectancy, are simply not sensitive enough to reflect more subtle differences in representational structures. Alternatively, while there is no problem with ERP measurement, the present finding may indicate that the representations of basic level terms and superordinates do not differ. According to this assumption, the RT effects reported in the introduction section are not due to fundamental representational differences, but only to task-specific preferences—perhaps Ss are just more accustomed to naming objects with basic level terms than with superordinates.

If neither of these two interpretations is correct, the failure to find any representation-related effect may be due to the heterogeneity of the stimulus material used in the present experiment and/or the processing strategies required in this task. In normal categorization tasks, Ss are usually confronted with taxonomic terms only (names for objects or classes of objects). Throughout the experiment, each stimulus presentation thus reinforces processing strategies which involve the activation of specific representations, resulting in a rather stable RT effect. If, on the other hand, the stimulus material is more heterogenous (for example, partly consists of pictures representing complex scenes), the RT advantage for basic level terms almost vanishes (Murphy & Wisniewski, 1989). Additionally, categorization tasks require semantic processing of the words presented, while the lexical decision task used in the present experiment just required relatively simple matching procedures. Thus it seems possible that the design used in this experiment, in contrast to its intended effect, prohibited potentially existing representation-related differences from becoming manifest in the ERP waveforms. This interpretation is also supported by Young and Rugg (1992), who cite a previous study of Young (1989), in which there was—like in the present experiment—no late positivity elicited by repeated items. The authors attribute this difference to different task demands: while in the 1992 study Ss had to perform a semantic analysis of the items in order to find the targets (in this case, animal names), in the 1989 study a passive exposure paradigm was used, in which Ss were not encouraged to perform semantic processing. According to this line of reasoning, the presence or absence of the late positivity can be regarded as indicating whether or not systematic semantic processing of the stimulus material took place during the task. Thus the present pattern of results supports the idea that in this experiment Ss used some sort of matching procedure rather than semantic analysis to fulfill the task requirements. It seems quite possible, though, that representational differences between different taxonomic levels become manifest only under conditions in which concentrating on taxonomic relations is the appropriate strategy, but are easily overridden by other demands if more flexible or totally different processing strategies are required. To further investigate this issue, a second ERP experiment was conducted, using a word reading and memorizing task instead of a lexical decision task and homogenous material (taxonomic terms only) instead of heterogenous stimuli.

EXPERIMENT 2

The main purpose of this experiment was to encourage Ss to concentrate on the processing of taxonomic terms. More specifically, the taxonomic level of each item should be of more relevance in this experiment than in the previous one—again without instructing Ss to perform active categorization or other tasks related to taxonomic structure. A commonly used tool for testing whether Ss discriminate between two stimuli automatically (i.e., without specifically attending to the stimuli) is the so-called oddball design: while one stimulus is presented frequently (standard stimulus), the other one occurs infrequently (deviant stimulus). Under standard oddball conditions, one usually finds the rare (deviant) stimuli to elicit an enhanced early negativity (N2 component) as compared to standard stimuli (Breton, Ritter, Simson, & Vaughan, 1988; McCarthy & Donchin, 1976), which is often followed by a positive going deflection (P3a component) if Ss have to attend to the stimulus material (Snyder & Hillyard, 1976; Squires, Squires, & Hillyard, 1975). In addition, rare stimuli also elicit an enhanced P3b component, this effect being modified by different factors such as task relevance (Squires, Donchin, Herning, & McCarthy, 1977), stimulus discriminability (Magliero, Bashore, Coles, & Donchin, 1984; Polich, Howard, & Starr, 1985), and sequential structure (Squires, Petuchowski, Wickens, & Donchin, 1977; Squires, Wickens, Squires, & Donchin, 1976).

In the present study, however, the question was not whether Ss discriminate automatically between two single stimuli, but between two *sets* of stimuli. To this purpose, a modified oddball paradigm was used: 21 semantically different nouns of a given taxonomic level (e.g., 21 basic level terms) were presented frequently throughout the experiment (standard stimuli), while 21 nouns of a different taxonomic level (in this case, 21 superordinate terms) were interspersed comparatively seldom (deviant stimuli). Ss were instructed to carefully read each word and to speak out aloud the last word they had read in case a special ‘‘warning’’ signal occurred shortly after the respective word (to enhance Ss’ attention, SOAs between successive words as well as between a word and the warning signal was varied). The basic assumption underlying this design was as follows: If the taxonomic level of a given word is a special feature of this word, one could expect that Ss gradually extract this feature from the frequently presented standard items and use it as a ''template,'' against which each new item is matched. That is, the frequent presentation of numerous semantically different but taxonomically equivalent words could lead Ss to develop a certain expectancy regarding the taxonomic level of the next word, although there is no need to direct attention to the taxonomic level of each word. There is some electrophysiological evidence that the possibility to establish a template and to match each item against it does not depend upon using the standard oddball design. As recent ERP studies have shown, effects of deviant items can be obtained even under conditions where standard and deviant items can be identified only if Ss have extracted rather complex knowledge about the sequential structure of the to-be-presented items (Eimer, Goschke, Schlaghecken, & Stürmer, 1996), thus supporting the assumption that despite the complex nature of the stimulus material used in the present experiment, oddball-like effects of deviant items would occur if Ss were able to extract the underlying regularity.

To better distiguish between effects of deviance and effects of taxonomic level, half of the Ss (further referred to as group BLT) received basic level terms as standard items and superordinate terms as deviants, while for the other half (group SOT) this relation was reversed. Additionally, Ss had to perform a recognition task after completing the oddball experiment. In this test block, new basic level terms as well as new superordinates were presented together with the old items. If processing basic level terms is systematically different from processing superordinate terms, these manipulations should lead to the following consequences: First, if repeated presentation of taxonomically equivalent words leads to the development of a template against which each new stimulus is matched, there should be oddball effects of deviant items in that ERP waveforms elicited by standard items should differ from ERP waveforms elicited by deviant items in the N2/P3a- and/or the P3b-latency range as described above. Second, if effects of deviance are influenced by taxonomic relations, these effects should differ between experimental groups, thus resulting in a Group $\times$ Item Type interaction. Third, if integrating unexpected basic level terms is different from integrating unexpected superordinates (as indicated by the Kounios and Holcomb (1992) study cited above), there should be a differential deviance effect in the N400 latency range. Fourth, if specific processing strategies related to taxonomic structures are sufficiently reinforced by the experimental design, differences between ERPs elicited by new basic level terms and ERPs elicited by new superordinate terms should be obtained throughout the recognition test.

Method

Subjects

Thirty-four paid volunteers (14 male), ages 18–41 years (mean age 26.5 years), participated in the experiment. All Ss were native speakers of German and had normal or corrected-to-normal vision. All Ss reported to be right-handed. Half of the Ss (7 male) were assigned to experimental group BLT, the other half to group SOT.

Stimuli

Forty-two basic level terms and 42 corresponding superordinate terms served as stimulus material, the mean number of characters being 6.75 per item, the mean word frequency being about 19/mio, according to the Mannheimer Korpus. Again, only relatively low-frequency words (occurrence less than 100/mio) served as stimuli. Each item was presented in capital letters in the middle of a computer screen, one at a time. Letters were 1 cm in height and items were 6.5 cm long on average (corresponding to a visual angle of $0.6° \times 3.7°$ at a distance of 1 m). Stimulus duration was 400 ms, the SOA was 1500, 1600, or 1700 ms in the study blocks and 1700, 1900, or 2100 ms in the recognition test (each SOA occurring with equal probability). In addition to these stimuli, a visual warning signal was presented occasionally, consisting of an asterisk with a size of approximately 1 cm^2. Warning signal duration was 400 ms; SOA was 900, 1100, or 1300 ms (with equal probability).

Design

From the 84 stimulus words, four lists of 21 items each were constructed such that word frequency and word length were about the same for each list. The first list contained 21 superordinate terms; the second one their corresponding basic level terms. These lists were used as study lists. The third list contained the remaining superordinate terms, the fourth list the remaining basic level terms, these two serving as test lists.

From the study lists, three times seven study blocks were constructed, forming three experimental parts of seven individual blocks each. One of the lists was selected as containing standard items (items presented frequently), the other one as containing deviant items (items presented infrequently). For half of the Ss, the study list of basic level terms served as standard list and the study list of superordinates as deviant list (group BLT); for the other half, this relation was reversed (group SOT).

Within each study block, the complete list of standard items was presented together with three new items from the deviant list. Deviants were selected in a pseudorandom order such that each item occurred in only one block of each experimental part. Consequently, it took seven blocks (one experimental part) to present the complete list of deviant items, while the complete list of standard items was presented in each block. Study blocks were constructed in the following way: First, three deviant items were selected that had as yet not been presented in the respective experimental part. Second, three different random sequences of standard and deviant items were constructed. Third, three warning signals were added to each sequence, occurring at randomly chosen positions. Fourth, the three sequences were appended to form one study block. Thus, each item was presented three times per block (consequently, each block contained 72 trials), resulting in a total number of 21 presentations of each standard item and 3 presentations of each deviant item in each experimental part. All three parts were constructed similarly, but with a new sequence of deviant items for each part. Especially, deviant items were regrouped for each part to the extent that a given triplet of deviants could occur in a block only once throughout the experiment. In addition to these study blocks, a recognition block was constructed containing all items from the two study lists together with all items from the two test lists in a random sequence. To further minimize effects of serial position and semantic relations, study blocks and recognition block were constructed for each S individually.

Procedure

Ss were seated in a comfortable chair in a dimly lit, electrically shielded, sound attenuated chamber, 1 m in front of a 17″ computer screen, with response buttons under their left and right index fingers. During each block, stimuli were presented in the middle of the screen, one word at a time. Ss were instructed to carefully and silently read each item and to speak out loud the last item they had read in case the warning signal occurred. Accuracy of performance was controlled via microphone installed inside the cabin. Ss were instructed to maintain central eye fixation during each trial and to avoid eyeblinks. They were not informed about the recognition test at the end of the experiment, and if Ss asked whether they would have to perform any memory test this was explicitly denied.

Each block had a duration of approximately 2 min and was followed by a short break of approximately 15 s. After each study part (7 blocks, see above), Ss were given a rest period of several minutes. After completing the 21 study blocks, Ss were informed about the recognition test. They were told that they would now see words they had read throughout the experiment together with new words and were instructed to respond with a left button press in case they thought an item was new and with a right button press otherwise. The recognition block had a duration of approximately 2.5 min.

Recording

EEG recording was identical to that in Experiment 1. RT was recorded in the recognition test only; for verbal responses in the study phase no RT was recorded.

Data Analysis

Averaging procedures and rejection criteria were identical to Experiment 1, except that one further rejection criterion was added: Because of probable muscle artifacts resulting from speaking, events immediately following the warning signal were excluded from analysis. Events were grouped for the study phase according to the criteria GROUP (group BLT, group SOT), TYPE (standard items, deviant items), PRESENTATION within a block (first presentation, first and second repetition), and EXPERIMENTAL PART (first, second, and third study part). In order to observe more global effects, these time-related averages were regrouped together, thus resulting in one ERP waveform for standard items and one for deviant items for each subject. Since the time course of effects is not of major interest for the present study, only effects observed in these global ERP waveforms will be reported in the result section. For the recognition test, events were grouped according to the criteria GROUP (group BLT, group SOT), LEVEL (basic level term, superordinate term) and OCCURRENCE (old, new). Mean amplitude of ERPs was analyzed in three partly overlapping time windows: 280–340, 300–500, and 550–650 ms, selected according to the criterion of maximal ERP differences as visible in the Grand Mean Average ERP-waveforms. For each time window, repeated measures ANOVAs were computed with the between-factor GROUP (BLT, SOT), and the within-factors TYPE (standard, deviant for the study phase) or LEVEL (basic level terms, superordinate terms for the recognition test), and POSITION (FPZ, FZ, CZ, PZ, F7, T3′, TP3, F8, T4′, and TP4). For recognition test ERPs, the additional factor OCCURRENCE (old, new) was included. Where appropriate, a Greenhouse–Geisser correction of degrees of freedom was computed (epsilon indicated by ‘‘GG’’). Recognition test RTs was analyzed according to the criteria GROUP (group BLT, group SOT), TYPE (basic level term, superordinate term), OCCURRENCE (old, new), and ACCURACY (correct response, incorrect response).

Results

Behavioral Data

RTs to old basic level terms were 641 ms for group BLT (standard = basic level terms) and 725 ms for group SOT (standard = superordinate terms). RTs to old superordinate terms were 695 ms for group BLT and 730 ms for group SOT. RTs to new basic level terms were 703 and 742 ms, respectively, and RTs to new superordinate terms were 699 and 755 ms, respectively. A repeated measures ANOVA revealed a significant main effect of OCCURRENCE ($F(1, 32) = 6.52$, $p < .05$), since ‘‘old’’ responses were faster than ‘‘new’’ responses, as well as a highly significant main effect of TYPE ($F(1, 32) = 10.11$, $p < .01$), since responses to basic level terms were faster than responses to superordinate level terms.

Additionally, both the two-way interaction OCCURRENCE × TYPE as well as the three-way interaction GROUP × OCCURRENCE × TYPE were significant ($F(1, 32) = 5.28$, $p < .05$, and $F(1, 32) = 9.28$, $p < .01$, respectively). To identify these interactions, additional repeated measures ANOVAs (all between Ss) were computed, two comparing old (or new, respectively) basic level terms with old (new) superordinate terms and two comparing old basic level terms (superordinates) with new basic level terms (superordinates). As can be expected from Fig. 3, there was a main effect of TYPE only for old items ($F(1, 32) = 12.99$, $p < .01$), together with a GROUP × TYPE interaction for these items ($F(1, 32) = 8.77$, $p < .01$), and a main effect of OCCURRENCE only for basic level terms ($F(1, 32) = 14.52$, $p < .01$), together with a main effect of GROUP ($F(1, 32) = 4.22$, $p < .05$) and a GROUP × OCCURRENCE interaction ($F(1, 32) = 4.66$, $p < .05$). As is also visible from Fig. 3 (right), error rate differed markedly between old items in that items presented frequently during the study phase (standard items) were recognized correctly at a rate of about 93%, while almost 25% of the former deviants were not recognized ($F(1, 32) = 8.28$, $p < .01$).

EEG Data

Study phase. In the 280- to 340-ms latency range, there was a highly significant TYPE × POSITION interaction ($F(9, 288) = 12.07$, $p = .000$, GG $= .47$) as well as a significant interaction of GROUP × TYPE ($F(1, 32) = 6.25$, $p < .018$) (Fig. 4). This interaction was further analyzed by computing repeated measures ANOVAs for each group separately: For group BLT deviant items (i.e., superordinate terms) elicited a prolonged positive deflection compared to standard items, leading to a marginally significant main effect of TYPE ($F(1, 16) = 4.41$, $p < .052$) together with a significant interaction of TYPE × POSITION ($F(9, 144) = 3.11$, $p < .027$, GG $= .39$). When only those fronto-centrally located electrodes relevant for P3a-analysis (FPZ, FZ, CZ, F7, and F8) were taken into account, there was a significant main effect of TYPE ($F(1, 16) = 7.5$, $p < .015$) but no interaction of TYPE and POSITION anymore. For group SOT, on the other hand, no effect of deviant items (basic level terms) was found.

In the 300- to 500-ms latency range there was a highly significant main effect of TYPE ($F(1, 32) = 17.08$, $p < .001$), as deviant items elicited an

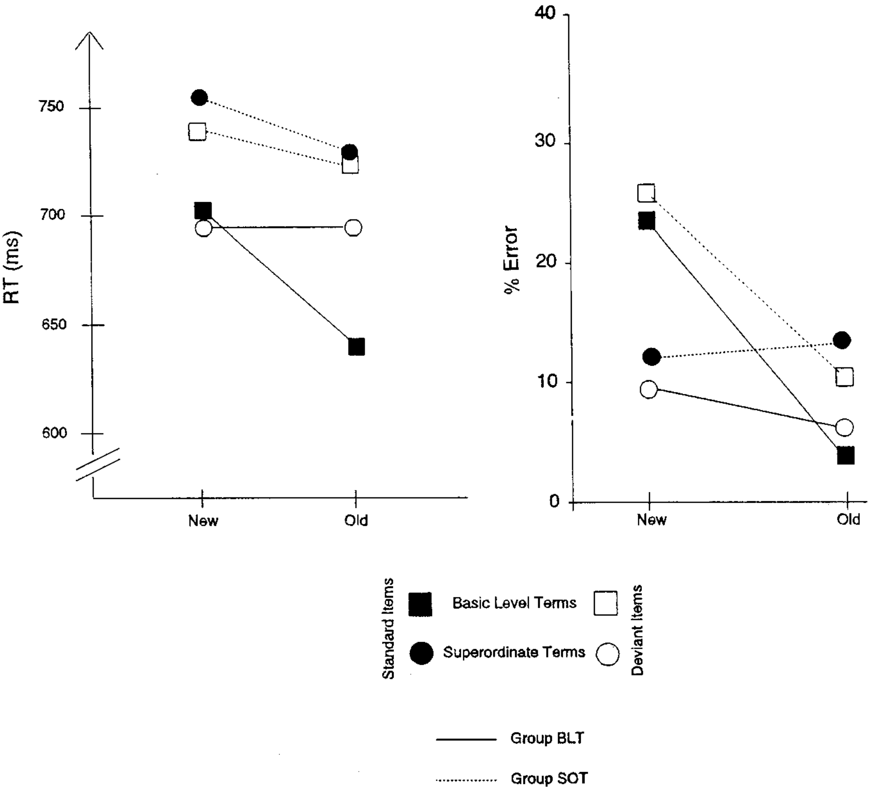


FIG. 3. Experiment 2. Mean RT (left) to new and old basic level terms (squares) and to new and old superordinate terms (circles), respectively, plotted separately for group BLT (solid line) and group SOT (dotted line). Solid end marks indicate former standard items; open end marks indicate former deviants.

enhanced negativity as compared to standard items in this time window (Fig. 4). This effect was maximal at temporo-parietal electrode sites and missing at frontal sites, resulting in a highly significant interaction of TYPE $\times$ POSITION ($F(9, 288) = 17.76$, $p < .001$, GG = .49). Additionally, there was a highly significant interaction of GROUP $\times$ TYPE $\times$ POSITION ($F(9, 288) = 4.84$, $p < .001$, GG = .49). Additional repeated measures ANOVAs, conducted for each group separately, revealed that the main effect of TYPE was highly significant for group SOT ($F(1, 16) = 13.68$, $p < .002$), but only reached significance for group BLT ($F(1, 16) = 3.98$, $p < .063$).

Within the 550- to 650-ms window there was no main effect of TYPE, but a significant effect of GROUP ($F(1, 32) = 4.49$, $p > .042$), as ERP waveforms were more positive going for Group BLT than for Group SOT (Fig. 5). Additional repeated measures ANOVAs, conducted for each group

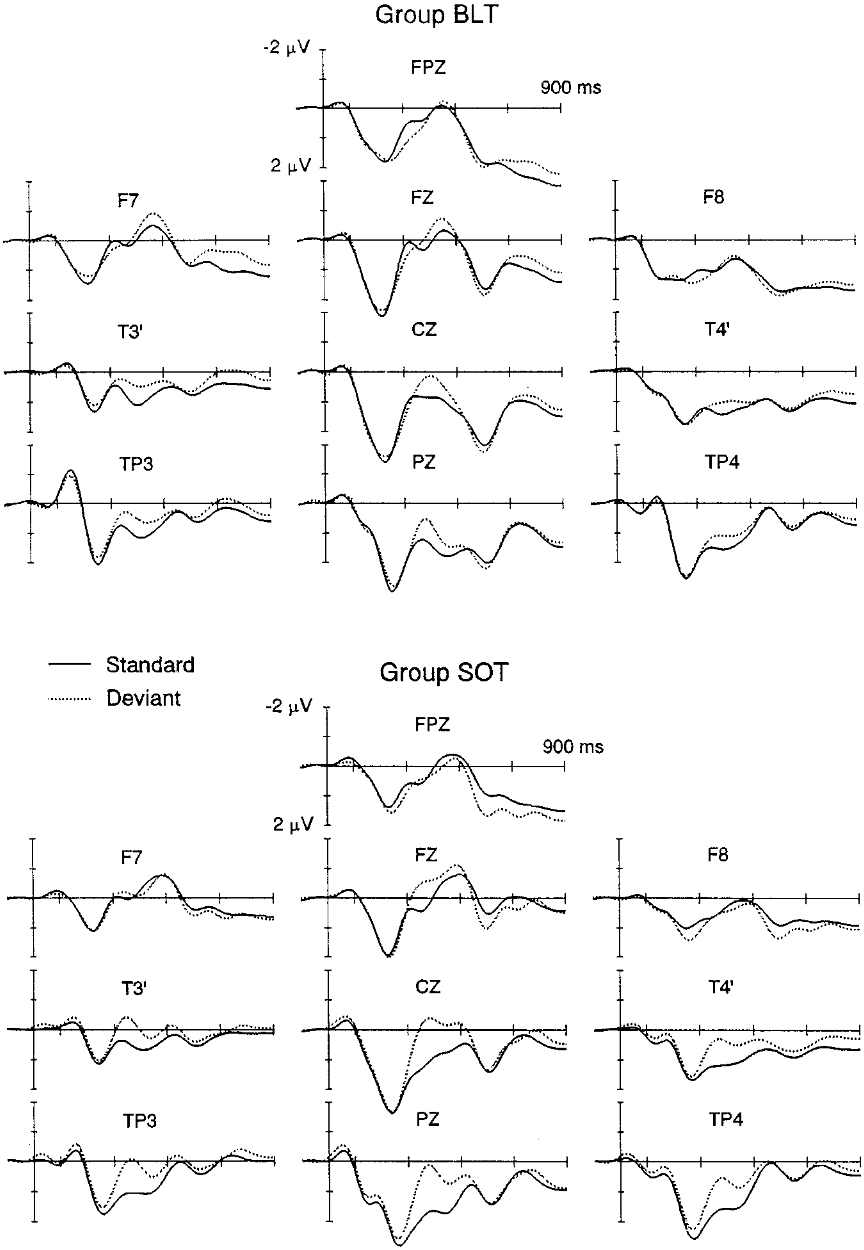


FIG. 4. Experiment 2. ERP waveforms elicited by standard items (solid line) as compared to ERP waveforms elicited by deviant items (dotted line) during study phase, plotted separately for each experimental group. Each ERP waveform represents an average over all presentations throughout the study blocks.

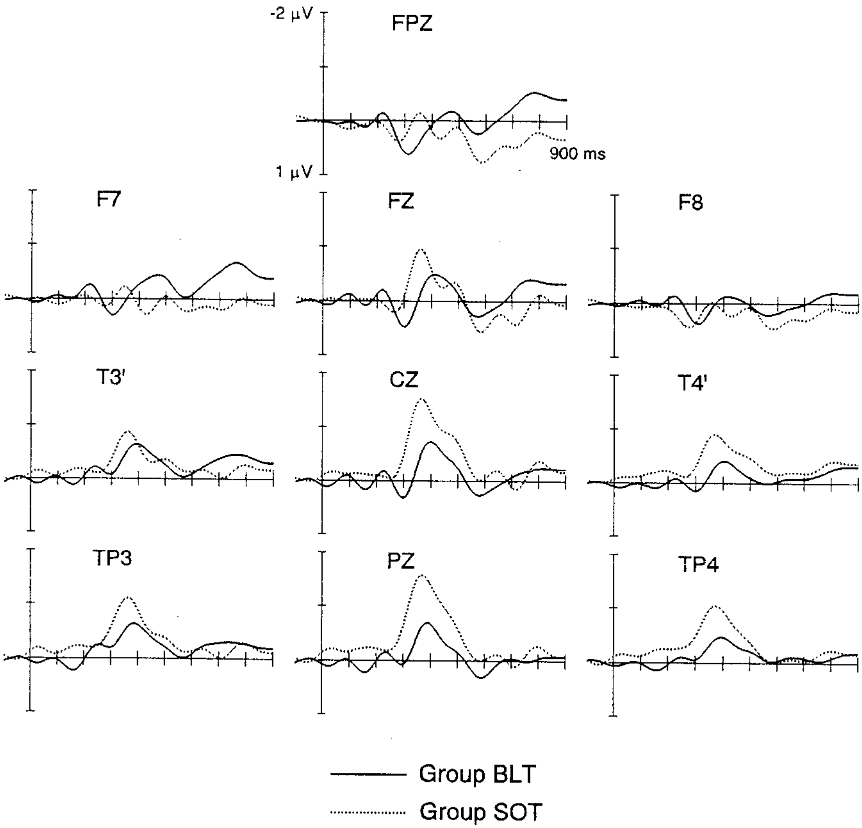
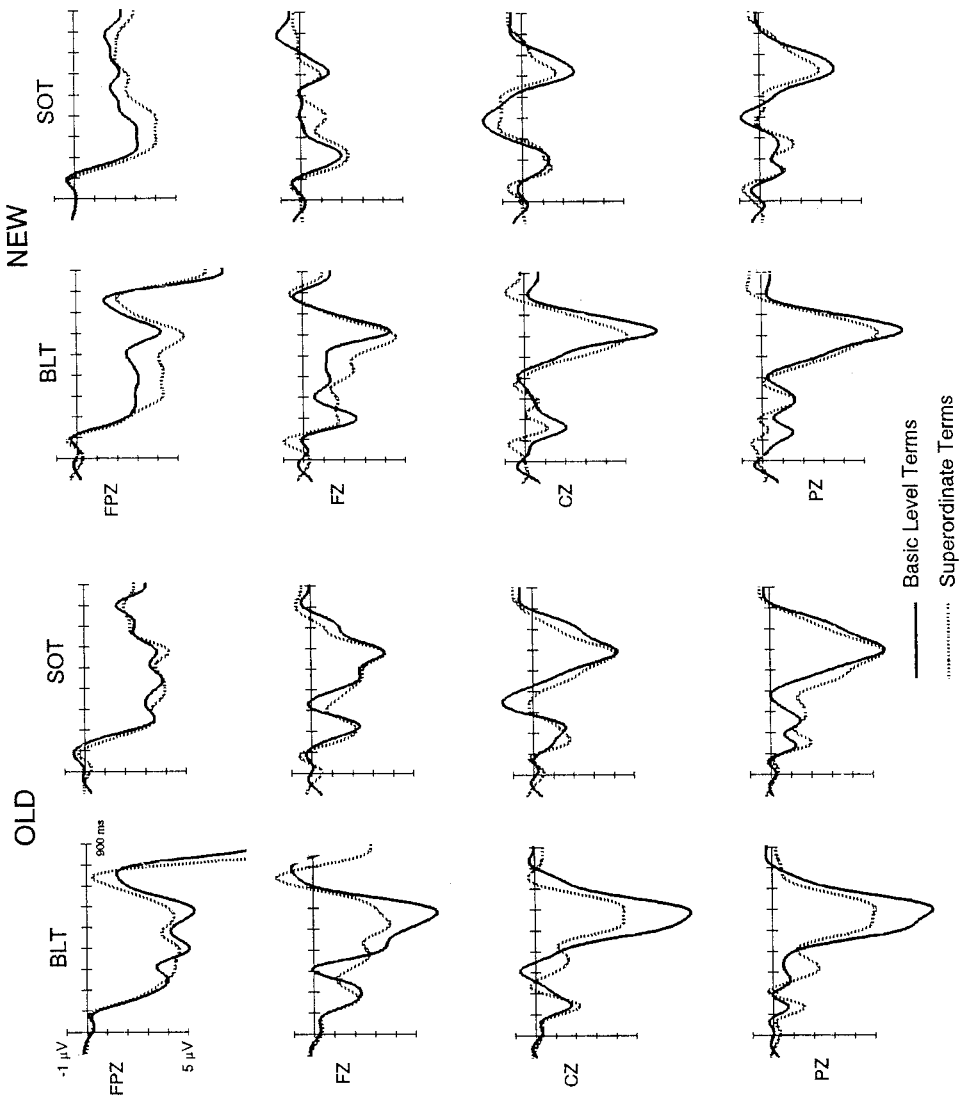


FIG. 5. Experiment 2. Difference waveforms, computed as deviant-ERP minus standard-ERP, i.e., negative (upward)-going deflections indicate that ERPs to deviant items were more negative, positive (downward)-going deflections indicate that ERPs to deviant items were more positive, plotted separately for group BLT (solid line) and group SOT (dotted line).

separately, revealed no main effect of TYPE for any group, but a highly significant TYPE × POSITION interaction for group SOT ($F(9, 144) = 6.64$, $p = .000$, GG = .49), probably because at fronto-central sites deviant-related ERPs were more positive going than standard-related ERPs, while at more parietal sites no such difference occurred.

Recognition test. Within the 280- to 340-ms window there was a highly significant main effect of LEVEL ($F(1, 32) = 17.16$, $p < .001$), as superordinate terms elicited more positive-going ERPs than basic level terms (Fig. 6). Additionally, there was a significant GROUP × LEVEL × POSITION interaction ($F(9, 288) = 2.98$, $p < .021$, GG = .45). Further analyses revealed that for Group BLT, there was a highly significant main effect of LEVEL ($F(1, 16) = 11.86$, $p < .003$) as well as a significant LEVEL ×


OLD
NEW
BLT
SOT
BLT
SOT
FPZ
FZ
CZ
PZ
FPZ
FZ
CZ
PZ
-1 µV
5 µV
900 ms
Basic Level Terms
Superordinate Terms

POSITION interaction ($F(9, 144) = 3.23$, $p < .019$, GG = .43), while for Group SOT there was a main effect of LEVEL ($F(1, 16) = 5.70$, $p < .03$), but no interaction with POSITION.

In the 300- to 450-ms latency range basic level terms tended to elicit more negative-going ERPs than superordinate terms, resulting in a highly significant main effect of LEVEL ($F(1, 32) = 9.26$, $p < .005$), and new items elicited more negative-going ERPs than old items, resulting in a highly significant main effect of OCCURRENCE ($F(1, 32) = 8.61$, $p < .006$). No difference between groups was obtained during this latency window.

In the 550- to 650-ms latency range, there was a highly significant main effect of LEVEL ($F(1, 32) = 8.18$, $p < .007$), as basic level terms tended to elicit more positive-going ERPs than superordinate terms. This was particularly true for Group BLT, resulting in a significant GROUP × LEVEL interaction ($F(1, 32) = 6.42$, $p < .016$). Furthermore, there was a highly significant main effect of occurrence ($F(1, 32) = 12.41$, $p < .001$), as new items elicited a less enlarged positivity than old items. In Group SOT this pattern was more pronounced than in Group BLT, as indicated by a significant GROUP × OCCURRENCE interaction ($F(1, 32) = 6.69$, $p < .014$). By far the largest positivity was elicited by old basic level terms in Group BLT, thus resulting in a significant GROUP × LEVEL × OCCURRENCE interaction ($F(1, 32) = 5.92$, $p < .021$). Neither in the 280- to 340-ms time window nor in the 300- to 450-ms time window did a main effect of GROUP occur. Within the 550- to 650-ms time window, however, there was a highly significant main effect of GROUP ($F(1, 32) = 8.33$, $p < .007$), as ERPs for Group BLT showed a much larger positivity than ERPs for Group SOT.

Discussion

The results of Experiment 2 indicate that it is possible to observe processing differences between superordinate terms and basic level terms even under experimental conditions where no active categorization is required. Using a modified oddball paradigm, basic level terms and superordinates turned out to produce different types of deviance effects on ERP waveforms. In each of the three time windows effects differed between experimental groups: First, in the early time window there was a slightly prolonged positivity and reduced negativity elicited by superordinates in a context of basic level terms (group BLT) at fronto-central electrode sites, this effect was missing for basic level terms in a context of superordinate terms (group SOT).

FIG. 6. Experiment 2. ERP waveforms elicited by basic level terms (solid line) as compared to ERP waveforms elicited by superordiante terms (dotted line) presented in the recognition block, plotted separately for old items (left) and new items (right) and for each experimental group.

Because of its early onset and its frontal distribution the prolonged positivity resembles a P3a component (see above), thus indicating that some sort of ‘‘mismatch’’ detection occurs when a rare superordinate term has to be processed under conditions where normally basic level concepts are activated. The finding that this effect is missing for rare basic level terms in a context of superordinates possibly points at a more fundamental difference between the underlying representations: One could speculate that only basic level concepts are structurally similar enough to form a homogenous context or ‘‘template,’’ against which nonbasic level items are automatically detected as being deviant. Second, both groups showed a centro-parietally distributed enlarged negativity related to deviant items in the 300- to 500-ms range, which resembles the N400 component observed in studies of semantic processing (Brown & Hagoort, 1993; Holcomb & Neville, 1990; Kounios & Holcomb, 1992; Kutas & Hillyard, 1984, 1989). This component is usually regarded as reflecting how difficult it is to integrate a new item into a given context (see above). According to this interpretation, the finding that the N400 effect was significantly more pronounced for basic level deviants (group SOT) than for superordinate deviants (group BLT) is not only in line with the results of the Kounios and Holcomb (1992) study, but furthermore indicates that superordinate terms are more easily integrated into a semantically heterogenous context than basic level terms. Third, groups differed in that in the 550- to 650-ms latency range group BLT showed significantly more positive-going ERPs than group SOT. It remains unclear, however, how this effect is to be interpreted.

In the recognition phase, too, basic level terms and superordinates gave rise to different ERP waveforms. Again superordinate terms elicited more positive going ERPs in the P3a latency range, while basic level terms elicited an enhanced N400 component. Although new items elicited a larger N400 than old items, there was no significant interaction of taxonomic level and item occurrence in any of the three time windows, thus revealing that after sufficient exposure to taxonomic items during the oddball blocks, even new and only once presented taxonomic items were processed differentially. Additionally, ERP waveforms elicited by new items differed significantly between experimental groups in the late time window, indicating a differential influence of prior basic level processing vs. prior superordinate level processing on the processing of new taxonomic terms. It has to be noted, however, that this transfer effect from study phase to recognition test seems to be rather incomplete: under *complete* transfer conditions one would expect that ERP waveforms elicited by those new items which are of the same taxonomic level as the former standard items resemble the ERPs to those standard items, and that ERP waveforms elicited by those new items which are of the same taxonomic level as the former deviants resemble the ERPs to those deviants. No such effect was obtained in the present experiment. However, since the recognition task of the test phase differed markedly from the word reading task of the study phase, the finding of incomplete transfer may be due to task-specific processes influencing the item-specific processing rather than to the principled impossibility of complete transfer.

CONCLUDING REMARKS

The findings of the present study support the hypothesis that there are systematic differences between the representations of words belonging to different taxonomic levels. Under conditions where no ''deep'' processing of the stimulus material is required (Experiment 1), no evidence for different activation patterns of superordinates and basic level terms could be obtained. Experiment 2 showed that under conditions where Ss are encouraged to process each single item intensively, ERP waveforms elicited by basic level terms differed significantly from ERP waveforms elicited by superordinate terms. Since there was no categorization task required (nor any other task involving the processing of semantic relations between items), these differences give additional and converging evidence for the assumption that there exist systematic representational differences between basic level and superordinate terms.

The ERP differences observed in Experiment 2 occurred in relatively early (about 280 ms) as well as in mid-latency (about 400 ms) and late (about 550 ms and later) ERP measurement windows. If one assumes the early component to reflect effects of *activating* certain representations (since in this latency range ERPs elicited by words begin to differ from ERPs elicited by nonwords, cf. Rugg, 1987), and the later components to reflect effects of *integrating* a new item into a given context, the present pattern of results could tentatively be interpreted in the following way: The frequent activation of basic level terms results in a certain expectation with regard to specific activation processes. Superordinate terms, if inserted infrequently, do not match this template and thus give rise to some sort of early orienting response (as reflected in the P3a effect), but since they are easily integrated semantically, they elicit an only marginally enlarged negativity in the N400 latency range. If, on the other hand, superordinate terms serve as standard items, no early effect occurs, thus indicating that frequent activation of superordinates does *not* result in the development of a certain template against which a mismatch could be detected. Consequently, one could assume that superordinate terms do not possess a specific representational structure. Nevertheless, basic level terms presented infrequently in a context of superordinate terms give rise to an enlarged N400 component and thus are to be regarded as being more difficult to integrate semantically. According to this interpretation, basic level terms and superordinates not only differ in that the former possess a certain representational structure while the latter do not, they also differ with respect to their semantic interactions with contextual items: Superordinate terms can be integrated more easily into a given context than basic level terms.

Of course, this interpretation is highly speculative and has to be tested further in numerous ways. For example, if two types of deviants were employed in the modified oddball paradigm, one consisting of words from the alternative taxonomic level, one consisting of words from the same level as the standard items, systematically different deviance effects should be obtained. More specifically, basic level deviants in a context of basic level standards should elicit an enlarged N400 component, but no other effect of same-level-deviants (especially no P3a-effect) should occur. Furthermore, it should be investigated whether basic level/superordinate differences are restricted to the oddball design or could also be obtained in other paradigms designed to investigate automatic discrimination processes.

APPENDIX

Stimulus Material Used in Experiment 1

Superordinate	Basic level
VIEH (cattle)	RIND (cow)
INSEKT (insect)	HORNISSE (hornet)
PFLANZE (plant)	BAUM (tree)
OBST (fruit)	APRIKOSE (apricot)
GEMÜSE (vegetable)	KARTOFFEL (potato)
GEBÄCK (pastry)	KUCHEN (cake)
BESTECK (cutlery)	MESSER (knife)
GESCHIRR (table-ware)	TELLER (plate)
INSTRUMENT (instrument)	KLARINETTE (clarinet)
WERKZEUG (tool)	HAMMER (hammer)
WAFFE (weapon)	PISTOLE (pistol)
FAHRZEUG (vehicle)	SCHIFF (ship)
GEFÄSS (vessel)	KANNE (can)
BEHÄLTER (container)	TASCHE (bag)
KLEIDUNG (clothing)	STIEFEL (boot)
SCHMUCK (jewels)	BROSCHE (brooch)
GEBÄUDE (building)	PALAST (palace)
MOBILIAR (furniture)	SPIEGEL (mirror)
m. WL. = 6.8	m. WL. = 6.6
m. WF. = 20.7/mio	M. WF. = 20.4/mio

Note. m. WL., mean word length; m. WF., mean word frequency.

Stimulus Material Used in Experiment 2, Study Phase and Recognition Test

Superordinate	Basic level
OBST (fruit)	PFLAUME (plum)
WAFFE (weapon)	PISTOLE (pistol)
GEBÄCK (pastry)	SEMMEL (roll)
GEFÄSS (vessel)	FLASCHE (bottle)

GEMÜSE (vegetable)	ZWIEBEL (onion)
GEPÄCK (luggage)	KOFFER (suitcase)
INSEKT (insect)	SCHMETTERLING (butterfly)
REPTIL (reptile)	SCHLANGE (snake)
BESTECK (cutlery)	LÖFFEL (spoon)
GEBÄUDE (building)	PALAST (palace)
GETRÄNK (beverage)	BIER (beer)
PFLANZE (plant)	BLUME (flower)
SCHMUCK (jewelry)	BROSCHE (brooch)
FAHRZEUG (vehicle)	SCHIFF (ship)
GESCHIRR (table-ware)	TELLER (plate)
KLEIDUNG (clothing)	STRUMPF (stocking)
MOBILIAR (furniture)	TEPPICH (carpet)
WERKZEUG (tool)	SPATEN (shovel)
SÄUGETIER (animal)	SCHWEIN (pig)
SPIELZEUG (toy)	PUPPE (doll)
INSTRUMENT (instrument)	KLARINETTE (clarinet)
m. WL. = 7.0	m. WL. = 6.8
m. WF. = 18.4/mio	m. WF. = 18.7/mio

Note. m. WL., mean word length; m. WF., mean word frequency.

Stimulus Material Used in Experiment 2, Recognition Test Only

Superordinate	Basic level
FRUCHT (fruit)	KIRSCHE (cherry)
MUNITION (ammunition)	GEWEHR (gun)
BACKWERK (baker's ware)	BROT (bread)
BEHÄLTNIS (vessel)	KANNE (can)
GETREIDE (corn)	KARTOFFEL (potato)
BEHÄLTER (container)	TASCHE (bag)
TIER (animal)	HORNISSE (hornet)
LEBEWESEN (creature)	FROSCH (frog)
HAUSRAT (household effects)	MESSER (knife)
BAUWERK (building)	HÜTTE (hut)
FLÜSSIGKEIT (liquid)	WEIN (wine)
GEWÄCHS (plant)	BAUM (tree)
ZIERAT (ornament)	PERLE (pearl)
MASCHINE (machine)	AUTO (car)
NAHRUNG (food)	TASSE (cup)
WÄSCHE (underwear)	STIEFEL (boot)
MÖBELSTÜCK (piece of furniture)	LAMPE (lamp)
GERÄT (utensil)	HAMMER (hammer)
VIEH (cattle)	SCHAF (sheep)
AUTOMAT (automaton)	BALL (ball)
KUNSTWERK (work of art)	OBOE (oboe)
m. WL. = 7.3	m. WL = 5.5
m. WF. = 16.0/mio	m. WF. = 21.6/mio

Note. m. WL., mean word length; m. WF., mean word frequency.

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