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Verb and Verb-Derived Noun Production: Hemifield Similarities and Differences

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Abstract

The present study explores hemispheric differences in verb and verb-derived noun production in terms of the impact of various picture and word characteristics on visual field reaction time variance. The unique contribution of predictors has been interpreted as activation of a corresponding property, as indication of a stage of picture processing and as activation of a corresponding mechanism/system in a certain hemisphere. The results of a regression analysis suggested that action-associated images were activated in the right hemisphere independently of the type of word produced. However, activation patterns in the left hemisphere appeared to be sensitive to the difference in word types. Whereas verb production activated the conceptual system in the left hemisphere, verb-derived noun production activated the lexical system in the same hemisphere. This differential pattern was interpreted in terms of the different weights of motor information carried by verbs and verb-derived nouns.

Keywords: action naming; lateralized picture presentation; reaction time.

Introduction

Recently, many studies have reported evidence for processing differences between parts of speech such as nouns and verbs. This evidence comes from neurological studies suggesting that nouns and verbs are processed by distinct neural systems (Damasio & Tranel, 1993; Daniele, Giustolisi, Silveri, Colosimo, & Gainotti, 1994; Gainotti, Silveri, Daniele, & Giustolisip 1995; Shapiro, Pascual-Leone, Mottaghy, Gangitano, & Caramazza, 2001; Shapiro & Caramazza, 2003) as well as from electrophysiological studies which point to distinct neural generators for nouns and verbs in the intact brain (Koenig & Lehmann, 1996; Pulvermüller, Preissl, Lutzenberger, & Birbaumer, 1996; Pulvermüller, Lutzenberger, & Preissl, 1999). Behavioral studies using word recognition and a visual field (VF) experimental paradigm have supported the idea that nouns and verbs are processed differently and by widely distributed brain structures (Sereno, 1999; Nieto, Santakruz, Hernandez, Camacho-Rosales, & Barosso, 1999). Seemingly consistent in suggesting processing differences, neurological and electrophysiological studies vary in associating different brain areas with processing of each word class. Usually, results of lesion studies associate the left frontal lobe with verb processing and the left temporal cortex with noun processing (e.g., Damasio & Tranel, 1993; Gainotti et al., 1995; Shapiro et al., 2001; Hillis, Tuffiash, Wityk, & Barker, 2002). However, a recent neuropsychological meta-analysis of impaired and spared naming for various categories suggested that semantic representations of such categories as actions, artifacts, living things, etc. are bilaterally distributed and anatomically closely connected with those areas that contributed to the development of these categories (Gainotti, 2004). That is, the study supports the sensory-motor model of semantic knowledge which assumes that conceptual and semantic representations are built on the basis of brain structures that subserve sensory-motor mechanisms involved in the development of these categories. A similar view is supported by electrophysiological data that showed the activation of motor areas in verb processing and the activation of occipital areas in concrete noun processing (Pulvermüller et al., 1996; Pulvermüller et al., 1999). These authors suggest that verbs highly associated with action may form functional units, distributed over areas, including those related to movement/motor activity, and nouns, highly associated with a visual sense, would form functional units that include visual/occipital areas.

Behavioral VF studies on word recognition are less specific suggesting no lateralization in noun processing and a left hemisphere advantage for verb processing (Sereno, 1999). In addition, Nieto et al. (1999), manipulating the imageability of nouns and verbs, observed no hemispheric differences in the processing of high and medium imagery nouns and of high imagery verbs and a left hemisphere advantage in the processing of low imagery nouns and medium and low imagery verbs. Thus, the study suggested that more lateralization exists for verbs than for nouns and that lateralization depended on word imageability.

The present study aimed to contribute to the existing evidence on word class processing differences by exploring lateralized processing in a production task for verbs and verb-derived nouns (VDNs). VDNs in Bulgarian are close to the English gerund and are formed by adding a derivational morpheme to the root of a verb. Mainly, verbs and VDNs differ in their syntactic role in the sentence, in their lexical form and in movement-based information (motor-action semantics) with verbs carrying stronger action semantics than VDNs do.

The present study uses a large number of potential predictors conventionally believed to influence lexical access and to reflect different types of information (e.g., conceptual, semantic, and lexical) that is usually measured and analyzed in traditional picture naming experiments. To the best of our knowledge, it is the first attempt in exploring differences in lateralized action naming with two word forms based on the same root and produced in response to identical action pictures.

Picture naming is a complex production-like process influenced by many, usually interconnected, factors (for a review, see Johnson, Paivio & Clark, 1996). Models of picture naming postulate at least three distinct stages – object (or action, in our case) identification, name activation, and response production (Johnson et al., 1996), while some go so far as five stages, e.g., Levelt's model (Levelt, 2001) which distinguishes the following: recognition of visual object (or action), concept activation, lemma (grammatical information) activation, lexeme (phonological level) activation, and articulation. In picture naming in a central presentation mode, the most powerful predictors of performance are name agreement and/or number of alternative names to a picture (measures of uncertainty), image agreement and age of response word acquisition (AoA). Name agreement usually refers to the degree to which participants agree on the name of the picture measured by the percentage of people who produced a given name. The number of alternative names refers to the number of valid names given to a picture. Image agreement reflects the degree (subjectively rated) to which a mental image generated by participants in response to the name of the picture matches the picture. AoA, measures of uncertainty and image agreement have been shown to be strong predictors of picture naming reaction time (RT) in a number of studies (e.g., Kremin, Hamerel, Dordain, De Wilde & Perrier, 2000; Bonin, Chalard, Méot & Fayol, 2002). Most recent studies on picture naming in a central presentation mode use multivariate regression analysis to determine and discuss predictors of picture naming processing recognizing that picture naming is influenced by many factors that are sometimes difficult to control. The present study uses several predictor variables that reflect various levels of picture and picture-related word structures such as picture visual complexity, uncertainty measures, image agreement, frequency and AoA of the response word, phonological length, etc. Research on picture naming suggests that visual complexity presumably affects an early stage of object recognition (Johnson et al., 1996; Bonin et al., 2002). Image agreement and object/action familiarity have an impact on the level of object/action identification/concept activation that is, the better the match between a pictured object/action and its representation in the brain and the more familiar the object/action is, the faster it would be processed (Cuetos, Ellis & Alvarez, 1999; Bonin et al., 2002). Uncertainty affects picture naming at or around the object/action postidentification stage of name activation (Johnson et al., 1996; Barry, Morrison, & Ellis, 1997; Bonin et al., 2002), i.e., the effect is presumably lexico-semantic. Frequency and AoA may affect name activation at the phonological stage or between the semantic and phonological stages (Johnson et al., 1996; Cuetos et al., 1999; Bonin et al., 2002; Bonin, Barry, Méot & Chalard, 2004). Word length affects name activation and/or response generation (Johnson et al., 1996). Thus, the significant contribution of a predictor to VF RT variance may indicate not only activation of, or access to, the property in the corresponding hemisphere but also approximately the processing stage(s) of picture naming. Finally, activation of a property and/or of a corresponding processing level can be seen as indication of activation of the corresponding system(s) or mechanism(s) in the hemisphere such as conceptual, semantic, lexical, and phonological.

As noted, current data suggest that the action and object conceptual and semantic systems are bilaterally distributed (Pulvermüller et al., 1999; Gainotti, 2004) thus, it could be expected that action naming, which necessarily involves strong conceptual and semantic processing, may produce bilateral conceptual and/or semantic activation. However, VDN processing patterns and (possible) differences between verb and VDN production in lateralized picture naming are not clear.

Method

Participants 60 participants (28 males and 32 females) took part in the action naming task and another 60 (30 males and 30 females) in the VDN production experiment. They were university students with an average age of 22.0 years (age range 18 to 35), right-handed Bulgarian monolinguals with normal or corrected to normal vision. Participants received course credit or were paid for their participation.

Stimuli and Predictor Variables 136 stimuli were selected from the pictures in an on-line action naming task with 275 pictorial stimuli in Bulgarian, which was part of a cross-linguistic study, 50 participants per language (Szekely et al., 2004). For more details on participants, procedures, and pictorial stimuli in the picture naming norming study, see Szekely et al. (2004) and/or visit an on-line data base at http://www.crl.ucsd.edu/~aszekely/ipnp/.

All target names were subjected to five different tests aimed at obtaining separate subjective ratings for word (verb and VDN) frequency, action and VDN familiarity, action image agreement, action and VDN imageability (procedure adopted from Paivio, Yuille & Madigan, 1968), action and VDN concreteness, all rated on a 1 to 7 scale, from lowest to highest. Six different groups of 40 university students each participated in the verb and VDN frequency, action and VDN concreteness and imageability ratings. Familiarity ratings (rated on a 1 to 7 scale, from lowest to highest) were obtained from 20 students for action familiarity and from 16 students - for VDN familiarity. In addition, 35 students participated in the action image agreement procedure. Two different groups of 30 students participated in action and VDN AoA rating tasks on a 1 to 7 scale where 7 referred to the earliest acquired items (under 2 years of age) and 1 to the most recently acquired items (over 13 years old). None of the participants in the rating tests participated in the on-line picture naming experiment. Target names were coded for word length measured in number of phonemes. Finally, subjective ratings of picture visual complexity (7-point scale, 7 – the most visually complex) were obtained from 30 Hungarian university students (Székely, unpublished).

The number of valid alternative names to a picture and name agreement for each VF and word class were derived empirically after experimental data collection and included as predictor variables. All target names were grammatically unambiguous: either verbs in their citation form or verb-derived nouns with an identical root for each picture across word class and VF.

Procedure Procedures in both experiments (verb and VDN production) were identical apart from instructions concerning the forms of words to be produced.

Stimuli (black and white line drawings, 4.5 x 4.5 cm) were presented unilaterally, to the right or to the left of a fixation point (a cross; "+") in the center of the screen. The distance to the center of the stimuli subtended a horizontal visual angle of 4 degrees in relation to the participant. The visual angle from the fixation point to the nearest edge was 1.9 degrees. The distance between the participant's head and the screen was kept at 60 cm.

Participants were tested in a sound-proof booth. Six pseudo-randomized orders were constructed such that stimuli appeared in the same VF no more than three consecutive times. The experimental session started with 8 practice trials, none of the practice pictures appeared in the experimental part. The appearance of the stimuli in each visual field was counterbalanced across participants, i.e., half of the participants saw a stimulus in one VF, and the other half saw the same stimulus in the other VF. Each stimulus was presented only once to each participant – either in the left or in the right visual field. Each stimulus was displayed for 200 msec. Immediately after stimulus disappearance a mask (one out of ten variants of randomly distributed black lines and curves on a white background was arbitrarily chosen for each trial) was displayed at the same place as the stimulus for 200 msec. Participants were instructed to name pictures with verbs (actions) in the first person, singular, present tense in the action naming experiment, and to name pictures with verb-derived nouns (examples of VDN form were provided) in the VDN production experiment. In addition, participants were asked to name pictures as fast and as accurately as possible without moving their gaze away from the fixation point. The importance of maintaining one's gaze on the fixation point was repeatedly stressed. The intertrial interval varied randomly between 1 and 2 sec. If a participant produced no response, the next trial started in 5 sec. Responses were recorded by the experimenter. Reaction times were measured from the offset of each stimulus. A Carnegie Mellon button box recorded voice onset RT and controlled stimuli presentation timing. A Power Macintosh 6400/200 equipped with the PsyScope software (Cohen, MacWhinney, Flatt, & Provost, 1993) controlled the order of presentation and the size of the stimuli. Each experimental session lasted 15-20 min.

Results and Discussion

Trials on which no response was registered (7.3% in verb and 8.5% in VDN production) and trials with technical errors (0.6% in verb and 0.9% in VDN production) were excluded from the analyses. Response times lying more than 2 standard deviations away from the mean were removed which resulted in the removal of 3.7% (verb) and 4.3% (VDN) of overall responses. The data were averaged for each word class by items and VFs over participants and a mean RT for each valid response was obtained. The number of alternative names to a picture (including target), name agreement and target names for each picture in each VF were derived from these data. After that items that produced different target names in each VF and each word class, were excluded from further analyses. Thus, the analyses were based on mean RTs for 119 target verb responses identical in each VF and 119 VDNs with an identical verb root for each picture in each VF. For example, in response to a picture depicting swimming, the obtained target verbform in both VFs was *pluvam (swim)* and the obtained target VDN in both VFs was *pluvane (swimming)*. Table 1 presents descriptive statistics for the predictor characteristics of each word class averaged over 119 items.

Table 1: Pictorial and target word characteristics for each word class.

	Verb		VDN	
Predictor	Mean (SD)	Range	Mean (SD)	Range
NA, LVF	40.9 (25.2)	3.3-96.7	41.9 (24.6)	3.3-100
AN, LVF	8.6 (3.7)	2-18	8.2 (3.5)	1-17
NA, RVF	39.9 (24.1)	3.3-96.7	40.5 (24.6)	3.3-96.7
AN, RVF	8.6 (3.7)	2-17	8.2 (3.7)	2-17
VC	3.0 (0.5)	1.7-4.4	3.0 (0.5)	1.7-4.4
ImAgr	5.4 (1.1)	2.5-6.8	5.4 (1.1)	2.5-6.8
No Ph	5.9 (2.0)	2-10	7.1 (1.5)	5-11
Freq	4.5 (1.2)	1.3-6.7	4.9 (1.0)	2.5-6.7
Image	5.3 (0.7)	2.8-6.7	5.6 (0.8)	3-6.9
Fam	5.6 (1.0)	3.2-6.9	5.6 (0.7)	3.4-6.8
Concr	4.6 (0.6)	3.0-5.9	4.5 (0.5)	3.3-5.6
AoA	5.3 (0.6)	3.1-6.5	5.5 (0.7)	3.4-6.6

Note. LVF – left VF, RVF – right VF, NA – name agreement, AN – number of alternative names, VC – visual complexity, ImAgr – image agreement, No Ph – number of phonemes, Freq – word frequency, Image – word imageability, Fam – familiarity, Concr – concreteness.

Comparing Mean RTs across Word Class and VF

A two-way analysis of variance obtained no significant main effect or interaction (all ps>.1). Thus, no VF and word class differences were found in lateralized picture naming task in terms of overall naming speed, that is, the overall cognitive demands on naming actions with the two different word forms did not differ. Table 2 summarizes the descriptive statistics for naming latencies in each VF and word class.

Table 2: Descriptive statistics for each VF and word class (ms).

	LVF		RVF	
	Mean (SD)	Range	Mean (SD)	Range
Verb	1366 (264)	850-2118	1392 (312)	918-2447
VDN	1413 (303)	903-2500	1406 (317)	951-2675

Regression with Predictor Variables

Simultaneous regression analyses were performed separately for each VF and word class examining the contribution of the

10 predictor variables. Results of the analyses are presented in Table 3.

The predictors together accounted for 47.4% of LVF and 49.0% of RVF variance in verb production and for 42.7% of LVF and 34.1% of RVF variance in VDN production. The results showed (Table 3) that the most powerful predictor of picture naming, i.e., percent of name agreement, made its independent contribution to RT variance in both VFs and for both parts of speech. Name agreement influences picture naming at an early stage of name competition, the target pre-selection stage, and activates a lexico-semantic mechanism. However, another powerful predictor, action image agreement, emerged as a significant predictor in both VFs with verb responses only and in the left but not right VF with VDN responses (Table 3). Image agreement influences picture naming at the early stages of recognition (Barry, Morrison & Ellis, 1997), in our case, action recognition, that is, the impact is on the conceptual level. RT to the right VF in VDN production was influenced by length in phonemes and AoA of response words (Table 3). As noted earlier, AoA influences name activation somewhere in between the semantic and phonological levels or only the phonological one. The significant contribution of the word's length measured in numbers of phonemes suggests that the loci of influence of these two variables do not coincide completely. It may be suggested that AoA influences the target post-selection stage or, in other words, it activates a lexico-phonological mechanism. This suggestion is in accordance with the results of a study of repetition priming of picture naming (Barry, Hirsh, Johnston, & Williams, 2001) which showed that AoA functions at the level of lexico-phonological retrieval (the lexeme level).

Table 3: Simultaneous multiple regression analysis on RT separately for each grammatical class and VF.

	Verb				VDN			
	LVF		RVF		LVF		RVF	
	β	*t*	β	*t*	β	*t*	β	*t*
NA	**-.43**	**-4.4**	**-.30**	**-3.1**	**-.58**	**-5.7**	**-.34**	**-2.8**
AN	.04	.38	**.30**	**3.0**	-.03	-.30	-.03	-.26
VC	-.07	-1.0	.00	.04	-.12	-1.5	.03	.38
ImAgr	**-.29**	**-3.5**	**-.32**	**-4.0**	**-.21**	**-2.4**	-.15	-1.7
No Ph	-.11	-1.2	-.04	-.39	-.01	-.14	**-.19**	**-2.2**
Freq	-.25	-1.6	-.19	-1.3	-.08	-.75	.04	.36
Image	.11	1.1	-.04	-.40	.04	.41	-.16	-1.7
Fam	.17	1.0	.09	.55	-.15	-1.2	-.14	-1.1
Concr	**-.22**	**-2.5**	.13	1.5	.06	.63	-.05	-.51
AoA	-.21	-2.0	-.05	-.47	.02	.24	**-.24**	**-2.2**

Note. For each measure, the beta weight (β) and *t* statistic value (*t*) are reported; bold values are significant at $p<.05$. LVF – left VF, RVF – right VF, NA – name agreement, AN – number of alternative names, VC – visual complexity, ImAgr – image agreement, No Ph – number of phonemes, Freq – word frequency, Image – word imageability, Fam – familiarity, Concr – concreteness.

Finally, and in addition, ratings for target action concreteness made an independent contribution to the left VF RT variance while the number of alternative names to a picture affected right VF RT variance in verb production. Note that name agreement also contributed to the RVF RT variance in verb production (Table 3). In spite of the high intercorrelation of name agreement and number of alternative names (r=-.67), each of these variables made unique independent contributions to RT variance, which confirms the suggestion that even though highly correlated and generally related to the relationship between a pictured object/action and its name, these characteristics represent theoretically distinct measures (Johnson et al., 1996). While name agreement may be regarded as the degree of connection strength between an object/action and a single dominant lexical item, number of alternative names to a picture may be viewed as the number of connections between an object/action and (potential) lexical items or different names to a picture (Johnson et al., 1996) that is, a measure that reflects certain lexico-semantic characteristics such as semantic neighborhood density or synonymy.

No effects of picture visual complexity, word frequency, action familiarity or imageability were observed in any condition. Overall, the results suggest that verb production activated conceptual, semantic and lexico-semantic features of action representation in both hemispheres while VDN production affected hemispheric processing differentially by inducing lexico-semantic and action-image activation in the right hemisphere and activation of lexico-semantic, lexico-phonological and purely phonological representations in the left hemisphere.

Conclusion

The primary purpose of the study was to examine hemifield processing of verb and VDN production and of hemispheric activation of various language systems such as semantic, lexical, and phonological. For this purpose, a multiple regression analysis was used with lateralized picture naming. The initial assumption and logic of applying this methodology was based on the relationship between linguistic systems/mechanisms, processing stages in picture naming and the loci of impact of various factors that represent different levels of picture and response word characteristics.

Independently of the type of response word and VF, picture presentation prompted the activation of the lexico-semantic system in both hemispheres at an early name identification stage where several picture-name candidates compete with each other. Support for this finding comes from an fMRI study of three semantic tasks (including verb and noun generation) which suggests that the left inferior frontal gyrus is involved in the selection of available responses among competitive alternatives (Thompson-Schill, D'Esposito, Aguirre & Farah, 1997). In addition, a MEG study of centrally presented picture naming (Levelt, Praamstra, Meyer, Helinius & Salmelin, 1998) found that right parietal activation is associated with the processing of lexical selection. Finally, Neininger & Pulvermüller (2003) have shown that the right hemisphere is necessary for word processing and that the right frontal lobe is related to the processing of semantics and lexical form of a verb.

The activated language systems appeared to be sensitive to both type of response word and VF. The verb production task induced action-image activation in both hemispheres and activation of action semantics in the right hemisphere. These results support a suggestion (Oliveri, Finocchiaro, Shapiro, Gangitano, Caramazza & Pascual-Leone, 2004) that verb production may lead to the generation of motor/action mental images and, consecutively, to bilateral activation of the corresponding motor cortical regions. These authors suggested that the mental images generated are related to conceptual rather than semantic characteristics of verbs. In addition, a neuropsychological meta-analysis of naming data of various categories (Gainotti, 2004) strongly suggested that frontal lobes play a critical role in the semantic representation of actions and that these cortical areas overlap with areas that subserve motor mechanisms which, in their turn, are related to the action concept and to the process of development of these representations.

VDN production elicited differential patterns of activation in the two hemispheres. Similarly to the verb production result, picture presentation to the LVF induced action-image activation in the right hemisphere. However, picture presentation to the RVF prompted activation of purely lexical features, namely, lexico-phonological and phonological characteristics of response words. One possibility for the interpretation of this result may lie in the morphological differences between the two word types. Tyler, Bright, Fletcher & Stamatakis (2004) in a semantic categorization task contrasted fMRI activation of regularly inflected nouns (*dogs*) and verbs (*cutting*) and found that the left inferior frontal gyrus is involved in the morpho-phonological processing of verbs. However, verbs used in the present study were also regularly inflected (first person, singular, present tense). That is, most probably, the difference in activation patterns of the two word classes in the left hemisphere was not due to their difference in morphological structure. Another possible interpretation of differences in activation lies in the different weights of the motor semantic component that is carried by both word classes. As noted, verbs contain stronger action/movement based information than VDNs. That is, superficial word-form processing occurred in the left language-dominant hemisphere with a weak motor semantic component of the VDNs produced, while action-image representations were activated in the same hemisphere with a stronger motor semantic component of verbs. The right hemisphere appeared to be sensitive to the motor semantic component independently of its strength; thus, it may be more actively involved in the processing of action semantics than the left language-dominant one.

Further investigation is needed to understand the brain mechanisms that are activated in response to the visual field of presentation and various characteristics of the stimuli.

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References

Barry, C. & Hirsh, K.W., Johnston, R.A. & Williams, C.L. (2001). Age of acquisition, word frequency, and the locus of repetition priming of picture naming. *Journal of Memory and Language*, *44*, 350-375.

Barry, C., Morrison, C.M. & Ellis, A.W. (1997). Naming the Snodgrass and Vanderwart pictures: Effects of age of acquisition, frequency, and name agreement. *The Quarterly Journal of Experimental Psychology*, *50A(3)*, 560-585.

Bonin, P, Chalard, M., Méot, A., & Fayol, M. (2002). The determinants of spoken and written picture naming latencies. *British Journal of Psychology, 93,* 89-114.

Bonin, P., Barry, C., Méot, A., & Chalard, M. (2004). The influence of age of acquisition in word reading and other tasks: A never ending story? *Journal of Memory and Language, 50,* 456-476.

Cohen, J.D., MacWhinney, B., Flatt, M., & Provost, J. (1993). PsyScope: a new graphic interactive environment for designing psychology experiments. *Behavioral Research Methods, Instruments and Computers, 25(2),* 257-271.

Cuetos, F., Ellis, A.W., & Alvarez, B. (1999). Naming times for the Snodgrass and Vanderwart pictures in Spanish. *Behavior Research Methods, Instruments, & Computers, 31(4)*, 650-658.

Damasio, A. & Tranel, D. (1993). Nouns and verbs are retrieved with differently distributed neural systems. *Neurobiology*, *90*, 4957-4960.

Daniele, A., Giustolisi, L., Silveri, C. M., Colosimo, C., & Gainotti, G. (1994). Evidence for a possible neuroanatomical basis for lexical processing of nouns and verbs. *Neuropsychologia*, *32(11),* 1325-1341.

Gainotti, G., Silveri, C. M., Daniele, A., & Giustolisi, L. (1995). Neuroanatomical correlates of category-specific semantic disorders: A critical survey. *Memory*, *3(3/4),* 247-264.

Gainotti, G. (2004). A metaanalysis of impaired and spared naming for different categories of knowledge in patients with a visuo-verbal disconnection. *Neuropsychologia, 42,* 299-319.

Hillis, A.E., Tuffiash, E., Wityk, R.J., & Barker, P.B. (2002). Regions of neural dysfunction associated with impaired naming of actions and objects in acute stroke. *Cognitive Neuropsychology, 19(6),* 523-534.

Johnson, C.J., Paivio, A., & Clark, J.M. (1996). Cognitive components of picture naming. *Psychological Bulletin*, *120(1)*, 113-139.

Koenig, T. & Lehmann, D. (1996). Microstates in language-related brain potential maps show noun-verb differences. *Brain and Language, 53,* 169-182.

Kremin, H., Hamerel, M., Dordain, M., De Wilde, M., & Perrier, D. (2000). Age of acquisition and name agreement as predictors of mean response latencies in picture naming of French adults. *Brain and Cognition*, *43 (1/2/3)*, 286-291.

Levelt, W.J.M. (2001). Spoken word production: A theory of lexical access. *Proceeding of the National Academy of Sciences of the USA*, *98(23),* 13464-13471.

Levelt, W.J.M., Praamstra, P., Meyer, A.S., Helenius, P., & Salmelin, R. (1998). An MEG study of picture naming. *Journal of Cognitive Neuroscience, 10(5),* 553-567.

Neininger, B., & Pulvermüller, F. (2003). Word-category specific deficits after lesions in the right hemisphere. *Neuropsychologia, 41,* 53-70.

Nieto, A., Santakruz, R., Hernandez, S., Camacho-Rosales, J., & Barosso, J. (1999). Hemispheric asymmetries in lexical decisions: The effects of grammatical class and imageability. *Brain and Language*, *70*, 421-436.

Oliveri, M., Finocchiaro, C., Shapiro, K., Gangitano, M, Caramazza, A., & Pascual-Leone, A. (2004). All talk and no action: A transcranial magnetic stimulation study of motor cortex activation during action word production. *Journal of Cognitive Neuroscience, 16(3),* 374-381.

Paivio, A., Yuille, J.C., & Madigan, S. (1968). Concreteness, imagery, and meaningfulness value for 925 nouns. *Journal of Experimental Psychology Monograph Supplement*, *76(1),* Part 2, 1-25.

Pulvermüller, F., Lutzenberger, W. & Preissl, H. (1999). Nouns and verbs in the intact brain: Evidence from event-related potentials and high-frequency cortical responses. *Cerebral Cortex, 9*, 497-506.

Pulvermüller, F., Preissl, H., Lutzenberger, W. & Birbaumer, N. (1996). Brain rhythms of language: Nouns versus verbs. *European Journal of Neuroscience, 8,* 937-941.

Sereno, J. A. (1999). Hemispheric differences in grammatical class. *Brain and Language*, *70*, 13-28.

Shapiro, K., & Caramazza, A. (2003). Grammatical processing of nouns and verbs in left frontal cortex? *Neuropsychologia, 41,* 1189-1198.

Shapiro, K.A., Pascual-Leone, A., Mottaghy, F.M., Gangitano, M., & Caramazza, A. (2001). Grammatical distinction in the left frontal cortex. *Journal of Cognitive Neuroscience, 13(6),* 713-720.

Székely, A. (unpublished). Unpublished normative data in Hungarian language.

Szekely, A., Jacobsen, T., D'Amico, S., Devescovi, A., Andonova, E., Herron, D., Lu, C-C., Pechmann, T., Pléh, C., Wicha, N., Federmeier, K., Gerdjikova, G., Gutierrez, G., Hung, D., Hsu, J., Iyer, G., Kohnert, K., Mehotcheva, T., Orozco-Figueroa, A., Tzeng, A., Tzeng, O., Arévalo, A., Vargha, A., Butler, A.C., Buffington, R., & Bates, E., (2004). A new on-line resource for psycholinguistic studies. *Journal of Memory and Language, 51,* 274-250.

Thompson-Schill, S.L., D'Esposito, M., Aguirre, G.K., & Farah, M.J. (1997). Role of left inferior prefrontal cortex in retrieval of semantic knowledge: A reevaluation. *Proceedings of the National Academy of Sciences of the United States of America, 94,* 14792-14797.

Tyler, L.K., Bright, P., Fletcher, P., & Stamatakis, E.A. (2004). Neural processing of nouns and verbs: The role of inflectional morphology. *Neuropsychologia, 42,* 512-523.