FROM THEORY TO PRACTICE OF SECOND LANGUAGE ACQUISITION

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Abstract:

The paper offers an introduction to current achievements in the fields of neurolinguistics and psycholinguistics and suggests a link to (a) cognitive linguistic as a language description model and (b) the theory and practice of second language acquisition in classroom settings. After a brief overview of history and research methods, some models, relevant to both first and second language processing are discussed, followed by a closer inspection of specific fields, typically related to SLA. These involve pronunciation on all levels, semantic priming and the critical period hypothesis. An unbiased presentation of contradictory views, ideas and research results has constantly been attempted.

History of Neurolinguistics

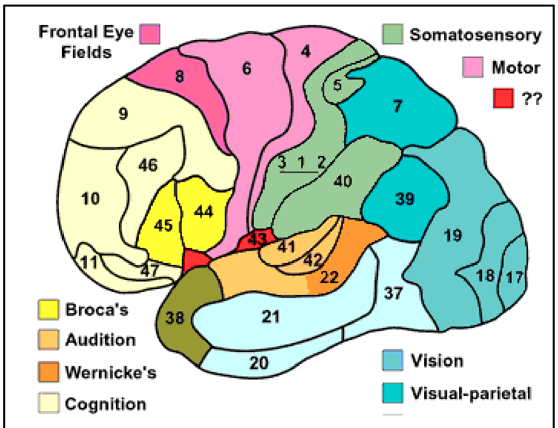

Fig. 1 Left Hemisphere. Broca's and Wernicke's Areas. Adapted from: Wikipedia.org

Even the briefest of overviews of the history of neurolinguistics (much older a scientific field than the modern name would suggest, dating back to antique) must include the names of Pierre Paul Broca (1824-1880) and his famous patient monsieur Leborgne, more commonly known as monsieur Tan. Due to severe epileptic attacks, monsieur Leborgne was unable to produce any language, except for the syllable 'tan' (hence the nickname), but seemed to have otherwise perfectly normal cognitive abilities and his non-verbal responses were both coherent and appropriate. Postmortem examination of monsieur Tan's brain revealed a lesion in the posterior part of the frontal left-hemisphere lobe, later called Broca's area (Fig. 1). Broca concluded that this brain area is responsible for language processing. The type of aphasia – inability to produce language, with retained comprehension abilities, is still referred to as Broca's aphasia.

Some decades later Carl Wernicke (1848-1905) researched for his doctoral thesis patients suffering aphasia different from Broca's – while able to speak rapidly and fluently (though incomprehensibly) these patients seemed unable to comprehend language, with the inability varying in degree and specificity. Postmortems revealed lesions is the temporal area of the left hemisphere. Based on this discovery, Wernicke posited that the two areas are involved in different aspects of language processing, with Broca's area being mostly responsible for language production and Wernicke's area (Fig. 1) - the center of language comprehension.[1]

[1] With some adjustments and modifications this view is still considered largely correct.

Neurolinguistics and Psycholinguistics today.

While observation of patients with language impediment and postmortem brain research were the main brain research possibilities until some decades ago, new technologies allow a wider range of experiments and, most importantly, non-invasive research of healthy participants. The list of methods below is not comprehensive, but includes the most popular and yielding methods:

Event-related Potentials (ERP). Electroencephalograms (EEG) measure changes of electrical activities in the brain, based on the central assumption that increased activity in certain a brain area results in increased electrical potential. These changes can be related to a certain stimulus (onset event) which enables insight in the temporal dimensions of language processing. The resulting ERP (fig.2) are small and must be filtered out from the general brain activity electrical background after a number of measurements. Major drawback of the method is the poor spatial resolution. ERP can tell with impressive precision when something happens in the brain but not – where it happens. The potential changes can be positive or negative, related to the background level. No explanation of the positive or negative polarity of certain ERP has been found yet.

Functional Magnetic Resonance Imaging (fMRI). This method is based on the so called 'blood oxygenation level dependent' (BOLD). Since the human brain cannot store energy, increased brain activity necessarily results in increased blood flow. Oxygenated and deoxygenated blood have different magnetic properties (diametric and parametric respectively), most important of which is the higher degree of inhomogeniety of the background magnetic field caused by deoxygenated blood. These inhomogenieties can be measured, offering an image of brain processes with high spatial resolution. A major drawback of this method is the poor temporal resolution, as changes of the magnetic potentials are only visible after some minutes (compare this with ERP, operating on the level of milliseconds).

Because of their seemingly complementary character, ERP and fMRI are often used parallel to each other. As they measure different things, however, mapping them to each-other is not unproblematic. Nevertheless, some of the most important discoveries in neurolinguistics have been achieved using these two methods. (For details see Bornkessel-Schlesewsky, I. & Schlesewsky, M., 2009: 20-24)

Transcranial Magnetic Stimulations (TMS). ERP, fMRI and other methods, not discussed here can reveal, with different levels of precision, which brain areas are involved in certain cognitive process. They cannot reveal, however, to what extent the involvement of one particular area is indispensible for that process and exactly which aspect of a complex cognitive process may be related to a certain neural network. TMS use magnetic induction to currently 'deactivate' a brain area. The participants are then asked to perform different tasks. The degree of success or failure can be directly related to the degree of involvement of that brain area in the respective cognitive processes.

Behavioural Methods. These involve observations and measurements of human behaviour in different experimental settings, with no direct brain research.

Judgments: In experiment settings of this type participants are asked to judge acceptability and / or suitability of certain language elements. These judgments are often related to a certain critical condition (e.g. expression more/less acceptable than modal). Judgments of native speakers and L2 speakers are often compared, researching differences in L1 and L2 processing and levels of proficiency.

Judgment conditions can be varied in terms of input (visual, auditory), complexity (phonemes, words, supra-segmental elements), time frame, etc. Increasing time pressure for the judgements, in particular, results in the so-called time-accuracy trade-off (SAT) and measuring the minimal time needed for processing a certain language element (resulting in the minimal time needed for a correct judgment).

Eye Movement Measures (EMM) or eye-tracking. This measurement method is based on the fact that reading is characterized by alteration of rapid eye movements (saccades) and periods of fixation. It is assumed that little or no information intake is possible during saccades. Saccades can be progressive or regressive (precise direction depends on the script. For text in Latin script progressive saccades would be from left to right, regressive – from right to left). Different measurements can be used to concentrate on different cognitive processes involved in reading: early measurements (duration of first fixation on a text segment) can be compared to late measurements revealing information on time course of language processing; regressive saccades may indicate increased comprehension difficulties and need for reanalysis, etc.

Experiments based on behavioural methods, being easier to set up, less time demanding, and requiring simpler (and less expensive) equipment, are far more common and often precede and complement neuroscientific methods.

Research Results related to Language Processing

Since Hans Berger first suggested correlation of EEG measures with cognitive processes (Berger, 1929) ERP based experiments have been used increasingly in neurolinguistics research. Different experiments, seemingly focusing on the same phenomenon often have different, even contradictory results and reexamining settings and stimuli may occasionally be more revealing than a single experiment. Where results can be replicated, more certainty is allowed, although never absolute certainty. One of the few results commonly accepted throughout neurolinguistics is the N400 ERP, first discovered by Marta Kutas and Steven Hillyard (Kutas, M. and Hillyard, S., 1980). The name N400 characterizes a peak of negative negative polarity about 400 ms after a stimulus onset, related to lexical-semantic processing. While all lexical units trigger ERP, the N400 amplitude is notably higher in case of rarer words in single word experiments or semantic violations in phrase or sentence processing (compare Fig. 2 and Fig. 3)

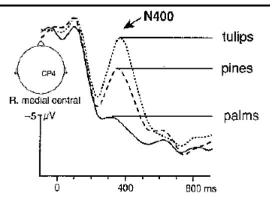

Fig. 2 N400. Single word processing. Adapted from Kutas and Federmeier, 2000 as quoted is Bornkessel-Schlesewsky and Schlesewsky 2009: 9)

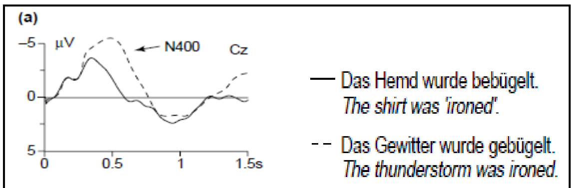

Fig. 3. N400 of semantic violation. Adapted from Friederici, 2002

Some years later, another important ERP – Early Left Anterior Negativity (ELAN) was discovered and replicated in different experiment settings. ELAN is related to syntactic processing, it peaks at about 200 ms after stimulus onset with notably higher amplitude in cases of semantic violation. (Fig. 4)

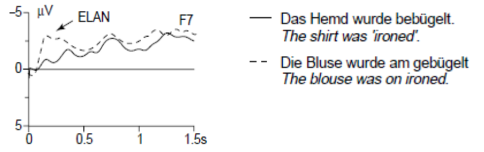

Fig. 4 ELAN. Adapted from Friederici, 2002

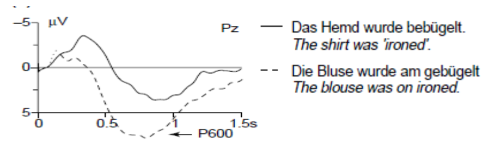

Fig. 5 P600. Adapted from Friederici, 2002

A third ERP – P600, seems to be the point of interaction between syntax and semantic, where defective sentences are 'repaired' and complex sentences (the so called 'garden path sentences) are 'rerun' and reanalyzed to correct misinterpretations[2].(Fig. 5)

N 400 and ELAN have been largely used as an argument for the independent processing of syntactical and lexical-semantic information with syntax 'coming first' and meanings 'filling the slots' by structuralists in serial, syntax-first models (e.g. Frazier & Clifford, 1997). Interactive models, on the other hand, assume simultaneous processing of syntax and semantics and interaction of the two from the very beginning (e.g. Marlsen-Wilson and Tyler, 1980)

In 2002 Friederici suggested a third, neurocognitive model, integrating the first two (fig. 6) In this model she distinguishes between early (successive) and late (interactive) processing. Prosodic influences processing from the very beginning.

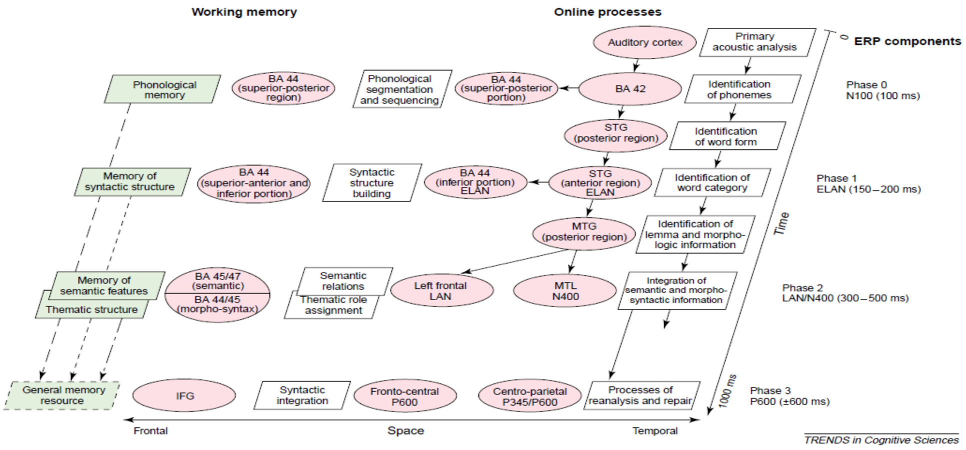

Fig. 6 Neurocognitive model of auditory sentence processing. Source: Friederici, 2002).

The model is based on empirical evidence from neurophysiological research and is largely accepted. Some years later a team around Bornkessel-Schlesewsky reexamined experimental

[2] The beginning of the sentence ,John said Mary is a very good …' may be ambiguous, the 'short path' (and most probable first interpretation) being relating the predicate 'said' to 'John as subject'. The disambiguing last element (e.g. 'boy') will cause a mental rerun and realignment of elements, relating the predicate 'said' to the subject 'Mary'. The extra processing effort is visible in a higher P600 amplitude. (Friederici, A.D., 1995) Notably, the P600 is not present in cases of oral input with matching syntax and prosody indicating that prosody influences language processing from the very beginning. (Steinhauer, Alter & Friederici, 1999)

data to find out that the 'boundary' between syntax-processing and lexical-semantic processing is even less solid and that comparable violations may cause N400 effect in some languages and ELAN + P600 in others. (Bornkessel-Schlesewsky et.al. 2011)

Implications for SLA

Contacts between neurolinguistics and SLA, if present at all, may be at best described as tentative and full of mutual distrust. Not too long ago I discussed the N400 effect with a highly gifted, competent and dedicated English language teacher and she asked, quite to the point 'so what'. In order to answer this questions (and I believed it does deserve an answer or answers) language teachers should know more about neurolinguistics and neurolinguists about the practice of language teaching. [3] Some questions that arise immediately may be:

1. Can the way we process language (whichever model proves right in the end) be used as an indicator about the structure of language as a universal category? (E.g. would an interactive or partially interactive model mean, that no (or no substantial) distinguishing between grammar and lexis should be made in language description?
2. Do differences in processing particular languages (as indicated by different ERP effects) indicate inherent differences in structures and possible impossibility of describing universals?
3. To what extent does language **processing** actually influence language **acquisition** and should this effect be present, to what extent can it be made use of in a classroom setting?

I would be grateful for any ideas and insight language teachers may have on the subject.

Research Results related to SLA. CPH

A basic question, largely discussed both in neurolinguistics and SLT/SLA is our ability to acquire a second language and any possible correlation between age of arrival in the second language country (AoA) and highest possible level of proficiency. The Critical Period Hypothesis (CPH) I am referring to has been a topic of heated debates for more than half a century now, with no hope of immediate reconciliation. A good definition of critical period most scientists agree on is the one by Singleton and Ryan (1989) stating that it:

1. Limits the acquisition of a skill to the effect that beyond the CP it can no longer be acquired.
2. Relates to very specific activities or behavioural patterns.
3. Is of limited duration

It should be noted that the CPH initially referred to L1 acquisition. Very limited empirical research is possible here, but evidence from the so called 'wolf children' and children with late-discovered hearing impediment indicates that a critical period for L1 acquisition does indeed exist.

[3] And effort should be made on both sides. Experiments, based on memorizing lists may be reveal information about our abilities to memorize lists but not about our ability to acquire a language. The fact that numerous experiment settings distinguish between native speaker and L2 speaker, seemingly oblivious of different levels of L2 proficiency may be a powerful indicator of the lack of proper communication between the fields.

Relating research on a CP to SLA may be seen as an 'emergency exit' in a situation where sufficient L1 research is impossible. Defenders of the CPH in its extreme form do, indeed follow this path, assuming that (a) there is no difference between L1 acquisition and L2 acquisition (b) language acquisition is a 'mono-block' – one homogeneous process and not a complex network of different cognitive processes.

The Critical Period Hypothesis was first postulated by Penfield and Roberts who considered 'loss of brain plasticity' at the age around 9 as responsible for it. They consider learning new language after this age to be 'unphysiological', though not impossible (Penfield and Roberts (1959:255).

In 1967 Lenneberg, who is considered the real father of CPH in SLA, proposed a different theory of CP, based on brain maturity and lateralization. According to him brain lateralization as completed at the age of about 13, making LA after this age more difficult and native-like proficiency – impossible. Although the age of lateralization, proposed by Lenneberg has been repeatedly refuted by other scientists[4], the idea has never been completely given up.

More recently Jonson and Newport (1989) after some large-scale empirical research, proposed the 'maturational hypothesis', according to which brain maturation, which enables complex cognitive processes has inhibitory effect on language acquisition abilities.

In the context of neurolinguistics research Kim et.al (1997) reported that a fMRI study revealed different cortical areas involved in SL processing as compared to L1. They compared distances between L1 and L2 cortical areas, relating those to AoA and discovered a consistent correlation: the later AoA – the further apart were the two areas. This was considered 'the final physiological proof' for the existence of CP in SLA.

Opponents of the CPH however criticized the study, pointing out that:

1. The level of L2 proficiency was not taken into consideration. The distance of the cortical areas reported by Kim's team may relate to that and not to AoA
2. Even if SL is indeed processed by different cortical areas, there is no indication that this makes native-like proficiency impossible.
3. The CPH regards LA as a single process while it is a complex network of processes. While certain empirical data may indeed be interpreted as indicating the existence of a CP for pronunciation, this is not the case with other aspects of SLA, in particular with lexis.[5] (See Clahsen & Felser, 2006 on the topic)
4. The CPH does not explain the considerable differences on levels of proficiency among late learners. If it existed and the boundaries were as impenetrable as it suggests, all later SL learners should be equally bad L2 speakers.

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[4] Krashen (1973) and Kimura (1967, 1974) for example, place completion of brain lateralization much earlier – at the age of 5-6, other scientists like Szaflarski et.al. (2006) – much later at the age of about 20

[5] Bialystock and Hakuta (1994), for example, reanalyzed Johnson and Newport'S data and discovered that AoA had statistically relevant effect only on some of the structures under study. Bongearts (1995), reanalyzing data pointed out that none of the participants received any special pronunciation training . He conducted some experiments his own, where late AoA speakers who have never been to an English speaking country received pronunciation rated by native speakers as native. Moyer (1999) was able to replicate the results with German L2 speakers.

5. Extra-linguistic factors that may influence level of proficiency are ignored. These include:
    a. Expensive language courses for adults versus free courses for school children in numerous countries.
    b. Little exposure to L2 for adults who may choose contact to move in an L1 environment versus extensive L2 exposure for school children.
    c. Adults may feel subconsciously reluctant to ‘lose’ some aspects of L1 transfer (most notably pronunciation’ as it is equaled to ‘loss of identity’. Children seem not to undergo such an identity crisis.[6]
6. Empiric research often “misemphasizes” low proficiency L2 speakers and ignores proficient speakers, thus offering a distorted picture of possible level of proficiency[7].

In a frequently quoted and highly accessible article Marinova-Todd et.al (2000) summarize all point of criticism and quote a number of studies, (a) relating level of proficiency to length of exposure to SL rather than AoA and (b) case studies reporting about achievement of native-like proficiency in spite of late (20+) AoA. (Loup, G., et al 1994)

Research on music processing seems to support this criticism. Numerous studies, independent of each other, indicate a strong relation between the ability to process music and language aptitude. Musacchia, G. et al (2007) et al performed a study with 29 participants, divided in two groups – musicians and a control group and established a positive correlation between musical training and language aptitude.

Besson et.al (2007) establish a positive correlation between musical training and language pitch processing. Moreover, musical training has a positive effect on pronunciation and pitch processing at any age. Other scientists before and after this study achieve the same results for children in experiments with similar settings (e.g. Moreno et.al. 2009)

Slevc and Miyake’s (2006) study established a stronger correlation between SL proficiency and length of exposure to SL than with AoA as well as strong correlation between musical training and both receptive and productive phonology (Fig. 7).

Variable	1	2	3	4	5	6	7	8	9	10	11
1. L2 receptive phonology	-										
2. L2 productive phonology	.77	-									
3. L2 syntax	.63	.62	-								
4. L2 lexical knowledge	.57	.49	.70	-							
5. Age of arrival	-.24	-.24	-.22	-.46	-						
6. Length of residence	.43	.51	.53	.46	-.09	-					
7. L2 use and exposure	.14	.20	.33	.40	.00	.25	-				
8. Motivation to use L2	.19	.09	.03	.14	-.08	-.02	.11	-			
9. Nonverbal Intelligence	.01	.09	.20	.20	-.29	.13	.11	-.16	-		
10. Phonological short-term memory	.37	.19	.48	.27	-.03	.26	-.09	-.01	.13	-	
11. Musical ability	.52	.45	.35	.26	-.19	.29	.04	.07	.12	.23	-

Fig. 7 Correlations between language proficiency and other factors. Note that length of residence is a stronger factor than age of arrival and musical ability – notably stronger than motivation to use L2. Adapted from: Slevc & Miyake, 2006: 678

[6] A fact supported by my own daughter who grew up spontaneously bilingual and happily described herself as a ’German who can speak Bulgarian like her mum’ at the age of 7.

[7] A researcher I spoke to admitted that the problem may partially be caused by the system of participants-recruitment for the studies. These are often students, who volunteer participation either for credit points or for money. Students who have arrived in the SL country to study, have not been exposed to the L2 long enough to achieve sufficient proficiency. The same students may be proficient speakers some years later, very successful both socially and financially, but inaccessible for recruitment.

Implications

As Marinova-Todd et.al. (2000) justly note, accepting the existence of a CP in SLA demands fundamental reforms in SL education regarding both beginning of education and evaluation system. After all demanding and evaluating language proficiency neurologically impossible to achieve by a +13 learner seems hardly justifiable. A more differentiated approach to CPH, however, can prove beneficial, as it outlines

- the need to offer accessible L2 courses for adult learners
- the need to consider and respect different kinds of motivation (including identity preservation)
- the need for better pronunciation training

The correlation between musical training and language proficiency, established on different level and at all ages may lead to a new role of music in a language classroom and possibly to new forms of co-work between the two subjects in the context of CLIL.

The Priming Effect

Most generally priming can be defined as ‘the phenomenon in which prior exposure to specific language forms or meanings either facilitates or interferes with a speaker’s subsequent language comprehension or production.’ (Trofimovich & McDonough2011)

Numerous EEG studies have confirmed its neurological basis: e.g. as a notably lower amplitude for a lexeme if preceded by such of the same category (dog-cat) or by one the second lexeme strongly collocates with (commit-a crime) (Fig. 8)

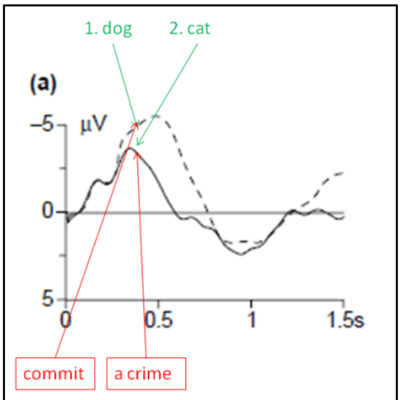

Fig. 8 ERP of Semantic priming

Similar priming effect has been discovered on all levels: from individual phonemes (compare, for example to studies of mismatch negativity, e.g. Näätanen et.al, 1997) to syntactic (a certain syntactic structure can prime faster recognition of later examples of the same structure (Mc Donough in Trofimovich & Mc Donough (ed.) 2011: 131-135)) up to discourse type recognition.

Notably, the semantic priming effect reminds strongly of some views in Cognitive Linguistics about the way language is stored in the brain. Eleanor Rosch (e.g. Rosch, 1978) suggests a categorization system based on semantic commonality (e.g. songbirds). Within this category, some elements are more typical and easier recognizable as pertaining to the category (e.g. nightingale), while other are more peripheral (e.g. crow).

Collocation priming, on the other hand, supports Langacker’s idea that repetition of a structure leads to its **entrenchment** and its eventual establishing as a unit. ‘Lexical items are expressions that have achieved the status of units for representative members of a speech community.’ (Langacker 2008: 17). Although these structures more often than not are also associated with a single semantic element, they may have a more complex semantic structure[8]. On the other hand, entrenchment does lead to diminishing individual salience and, where metaphorical expressions are concerned, diminishing or complete lack of transparency. Neurolinguistic studies further support this view. Pynte et.al (1996), for example found ERP-evidence of mechanisms of 'bypassing' word-by-word comprehension of metaphors. Although metaphors and collocations do not necessarily coincide (idiomatic expressions being a separate category), the existence of 'bypassing' mechanisms is highly suggestive. Some evidence of increased involvement of the right hemisphere in idiom comprehension may be seen as a further step on the long way to understanding the exact mechanisms of language processing.

Implications for the SL Classroom

Of all 'discoveries' of psycholinguistics and neurolinguistics, semantic priming was probably the fastest to reach the language classroom, partially in the context of the lexical approach (although Lewis does not explicitly refer to it) and occasionally in some more bizarre forms (e.g. the meanwhile discredited Keyword Method). The question should be asked, of course, is priming a reliable indicator of mechanisms of 'storing' language and even if this is so, to what extent does this influence language acquisition. Classroom evidence suggests, that teaching frequent collocations as units does indeed facilitate both frequency and accuracy, particularly in beginner stage. Interestingly L1 speakers often regard failing to use a collocation or the use of a 'banned collocation'[9] as a stronger indicator for 'non-nativeness' than pronunciation.

The English woman in Loup's study (Loup, et.al. 1994), who achieved native-like proficiency in Egyptian Arabic in spite of late AoA reports, that in the beginning stages of acquisition she often noted and memorized whole phrases with the exact context of use and only later began to break down' language in word categories (verbs, nouns adj.) and to reanalyze the expressions she had been successfully using for some time.

Conclusions

I am aware of the fact that the present paper completely lacks practical suggestions for the classroom. I hope, however, that it may make language teachers curious about the ways our brain learns languages and maybe find an unexpected explanation of a teaching strategy they have been using successfully in their own practice. I also strongly believe, that this type of knowledge may equip us with tools to analyse new approaches and 'Learn a language in 5 minutes miracles' more critically. Ideally, some of the thoughts and ideas presented here may lead to a 'new look' at teaching materials, some creative experiments and maybe the courage to occasionally try an utterly unorthodox teaching approach. And if the reaction of the experienced language teacher remains 'so what?' at least this will be a well-informed and well-founded question. Whichever the case, I would be grateful for reactions and reports from your classrooms.

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[8] ‚…unit status does not entail the absence or unimportance of components, merely the routinized nature of their expression' (Langacker 2008: 17)

[9] Obeying language laws and predictable for a SL speaker, but not used, e.g. 'commit an audition'

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