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A new journal of psychology

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III Dubrovnik Conference on Cognitive Science

DuCog III

## IMPLICIT PROCESSES ACROSS THE LIFE SPAN

Organized by the Central European Cognitive Science Association (CECOG)

Keynote speakers

**Miloš Judaš , James H. Howard, Jr. & Darlene V. Howard, Brian  
MacWhinney, Ranko Matasović**

Invited speakers

**Ágnes Lukács, Dezső Németh**

DUBROVNIK, 12-15, MAY, 2011

Centre for Advanced Academic Studies (CAAS) Dubrovnik  
University of Zagreb



SVEUČILIŠTE U  
ZAGREBU



Budapest University of Technology and Economics (BME)

## **PROGRAMME**

### **Thursday, May 12**

- 17:00-19:30 Registration and coffee  
19:30-20:00 Welcome words by Csaba Pléh, president of CECOG

### **Friday, May 13**

- 8:00-9:00 Coffee  
9:00-10:00 Poster session 1.  
10:00-10:30 Short talk: Ágnes Lukács  
10:30-11:00 Coffee  
11:00-12:00 Tutorial I: Ranko Matasovic  
12:00-15:00 Lunch time  
15:00-16:00 Poster session 2.  
16:00-17:00 Tutorial II: Milos Judas  
17:00-17:30 Coffee

### **Saturday, May 14**

- 8:00-9:00 Coffee  
9:00-10:00 Poster session 3.  
10:00-10:30 Short talk: Dezső Németh  
10:30-11:00 Coffee  
11:00-12:00 Tutorial III: Brian MacWhinney  
12:00-15:00 Lunch time  
15:00-16:00 Poster session 4.  
16:00-17:00 Tutorial IV: James and Darlene Howard  
17:00-17:30 Coffee  
17:30-18:00 CECOG Assembly  
18:00-18:15 Farewell words by Melita Kovacevic

### **Sunday, May 15**

- 8:30-9:00 Coffee  
9:00-12:00 Departure

**POSTER SESSIONS**

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Poster session 1: Friday, May 13, 9:00-10:00

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**Implicit sequence learning and working memory in dementia**

*Barbara Rea, Gréta Szatlóczki, Magdolna Pákáski, Karolina Janacsek, János Kálmán, Dezső Németh*

**Effect of consolidation on intermanual transfer in probabilistic and deterministic motor sequence learning**

*Dóra Győri-Dani, Judit Pekár, Karolina Janacsek, Emese Hallgató, Dezső Németh*

**Sequence specific interference on the Serial Reaction Time Task**

*Kornél Németh, Ferenc Kemény*

**Do sequential and concurrent processes of auditory stream segregation interact?**

*Zsuzsa Kocsis, Alexandra Bendixen, Orsolya Szalárdy, István Winkler*

**Learning a sequence with a memory load: Effects of age and learning conditions**

*Vinciane Gaillard, Axeé Cleeremans*

**Sequencing of two-digit numbers in dyslexic children**

*Maja Kelić, Antonija Maričić, Marijan Palmović*

**The role of number notation at children's numerical performance**

*Eszter Szabó, Attila Krajcsi*

**Pragmatic Preference for Round Numbers: A Modified Sternberg Paradigm**

*Sanja Budimir, Marijan Palmović*

**How do competent adults process multiplication facts?**

*Beth L. Losiewicz*

**Electrophysiological evidence for the implicit learning of the finite-state grammar**

*Ana Branka Šefer, Magdalena Krbot, Marijan Palmović*

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Poster session 2: Friday, May 13, 15:00-16:00

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**Interaction between serial but overlapping prospective tasks**

*Klára Várhelyi*

**The role of context in intentional forgetting**

*Barbara Batta, Brigitta Tóth, Márton Nagy, Zsófia Kardos, Anikó Kónya*

**Common mechanisms of test enhanced learning and retrieval induced forgetting**

*Attila Keresztes, Mihály Racsmány*

**Double dissociation in the rehabilitation of memory impairments**

*Mónika Albu*

**Spectral sleep EEG features of nightmare sufferers: evidence for a NREM disorder?**

*Klára Horváth, Péter Simor, Piroska Sándor, Réka Vida, Réka Lihi, Zita Sulyok, Róbert Bódizs*

**Objective and subjective components of the first night effect**

*Anna Kis, Péter Simor, Klára Horváth, Róbert Bódizs*

**Spectral sleep EEG features of nightmare sufferers: evidence for a NREM disorder?**

*Klára Horváth, Péter Simor, Piroska Sándor, Réka Vida, Réka Lihi, Zita Sulyok, Róbert Bódizs*

**The effect of hypnosis on prospective memory performance**

*Gyula Demeter, Mihály Racsmány, Marianna Juhász, Zoltán Ambrus Kovács, István Boncz, István Szendi*

**Executive functions in patients with obstructive sleep apnea syndrome**

*Bencze Neszmélyi, Mónika Albu, Mária Takács, Attila Terray-Horváth, Zoltán Szakács*

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Poster session 3: Saturday, May 14, 9:00-10:00

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**On the influence of causal beliefs on the feeling of agency**

*Andrea Desantis, Cédric Roussel, Florian Waszak*

**Predicting prejudice toward ethnic out-groups using explicit and implicit measures of attitudes**

*Lilla Varga*

**Category-specific aftereffects in the perception of bistable images**

*Péter Ujma Przemysław*

**Visual implicit learning and semantic categories**

*Krunoslav Matešić Jr., Eva Pavlinušić*

**The Opposite Effect of Trait and State Anxiety on Iowa Gambling Task**

*Péter Pajkossy, Linda Dezső, Zita Zoltay Paprika*

**Implicit learning and strategic adaptation in probabilistic environments**

*Imre Pentek*

**Deficits in automatic mental state attribution in Borderline Personality Disorder**

*Dora Fogd, Ágnes M. Kovács, Ernő Téglás, György Gergely, Zsolt Unoka*

**Intuition in patients with aphasia. The impact of speech comprehension on the semantic network activation.**

*Justyna Sarzyńska*

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Poster session 4: Saturday, May 14, 15:00-16:00

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**Processing pragmatic information in children with language impairment**

*Ana Rendulić, Morana Bilić, Marijan Palmović*

**Exploring the early stages of learning a foreign language**

*Tünde Éva Polonyi*

**Measurement of foreign language proficiency with psycholinguistic tasks**

*Péter Újma Przemysław*

**Electrophysiological evidence for the implicit learning of the finite-state grammar**

*Ana Branka Šefer, Magdalena Krbot, Marijan Palmović*

**Strategies and performance in Artificial Grammar Learning.**

*Marta Siedlecka, Dariusz Asanowicz, Michał Wierzchoń*

**Response strategies and performance in Artificial Grammar Learning Task**

*Dominika Czajak, Krzysztof Cipora, Dorota Żelechowska*

**Crossmodal transfer and unimodal interference in Artificial Grammar Learning**

*Ferenc Kemény, Ágnes Lukács*

**Implicit learning in different sense modalities: commonalities and constraints**

*Anna Anzulewicz, Maciej Taraday*

**Novelty recognition in artificial grammar learning**

*Michał Ziembowicz*

**Polarity Correspondence in Artificial Grammar Learning Task**

*Krzysztof Cipora, Dominika Czajak, Dorota Żelechowska*

**Influence of vowel harmony in implicit learning of structure phoneme sequences in Croatian and Hungarian**

*Tena Gnjatović, Maja Peretić, Marijan Palmović*

**Does syntax drive language? A meta-review of the recent experimental literature**

*Beth L. Losiewicz*

*Tutorial I***Challenges of Language Typology to theories of language learning and processing***Ranko Matasović*

University of Zagreb

Much of twentieth century linguistics was dominated by Chomsky's generative grammar, with its strong emphasis on innate and universal aspects of linguistic structure. This theory focused on in-depth studies of syntax and semantics of a few languages (mainly European), largely neglecting data from unfamiliar languages of Africa, Australia, and the Americas, the study of which was left to language typologists and less theoretically inclined linguists. Consequently, neurolinguistic studies of language processing and psycholinguistic theories of language learning often took for granted certain theoretical concepts developed by generative grammarians, or inherited from traditional grammar. Unsurprisingly, then, the work of linguists studying „exotic“ languages was largely ignored by neurolinguists and psycholinguists, and general claims about language learning and processing were made on the basis of study of just a handful of languages, most of which are genetically related and/or typologically similar (Ahlsén 2006, Ingram 2007, Schnelle 2010). Only quite recently have things began to change, chiefly with the publication of Bornkessel-Schlesewsky & Schlewsky 2009, which is the first handbook on neurolinguistics to take typological matters very seriously.

This talk will analyse some of the linguistic features, the learning and processing of which has been studied by neurolinguists and psycholinguists, and see whether general conclusions can be drawn from studies in which data were taken from only a handful of well-known languages such as English, German, and Dutch. We shall argue that many neurolinguistic and psycholinguistic studies have taken for granted the universality of certain concepts, which on closer inspection appear language-particular.

Let us mention a few examples:

1. Studies focussing on different patterns in learning and processing verbs and nouns (e.g. Tyler et al. 2004) tend to disregard that data from languages such as Nootka (Wakashan) and Kabardian (NW Caucasian) show that linguistic differences between these classes of words can be minimal, and that the opposition between nouns and verbs may be scalar rather than categorial.
2. Experiments involving the acquisition of complex syntactic patterns, such as subordination in English, were reported to show that language learning may help in bootstrapping the development of certain higher cognitive function, including the „theory of mind“ (De Villiers 2007). We will show that such claims are based on the assumption that the type of syntactic subordination found in languages such as Latin and English is universal, which is not the case.
3. Neurolinguistic experiments have tended to show “subject-first” preference, i.e. the tendency of the processing system to incrementally analyze an ambiguous initial argument as the subject of the clause. Although data on which this assumption is made are now becoming available from typologically different languages such as Hindi, Turkish, and Japanese (Bornkessel-Schlesewsky & Schlewsky 2009), researchers still assume that the concept of “subject” in such experiments is theory-independent and universal. However, we shall present data from languages such as Avar (NE Caucasian) and Cebuano (Austronesian) to show that this assumption is far from justified.

However, challenges that language typology presents to the study of language learning and processing should not discourage us from positing general hypotheses and accepting that some linguistic structures are indeed universal (Matasović 2005). We shall argue that radical typological relativism displayed by linguists like Evans & Levinson (2009) and Everett (2005) is not justified, and may be detrimental to the development of neurotypology.

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*Tutorial II***Cognitive and Neural Bases of Implicit Associative Learning in Healthy Aging***James H. Howard, Jr.<sup>1,2</sup> & Darlene V. Howard<sup>2</sup>*<sup>1</sup>The Catholic University of America and <sup>2</sup>Georgetown University

This presentation examines the cognitive and neural bases of implicit probabilistic associative learning and how these vary with adult age. Learning is said to be implicit when people acquire information about structural regularities in their environment without intending to learn or even becoming aware of what they have learned. Implicit learning is likely more important for adapting to the world than its explicit/declarative counterpart, particularly in later adulthood when little time is spent in formal schooling, a setting which emphasizes explicit learning. Nonetheless, the aging of implicit learning has been relatively neglected in the scientific literature, perhaps because it is often claimed that implicit processes in general are preserved during healthy aging. This apparent sparing creates a paradox since implicit associative learning calls on neural systems that show structural and functional declines in healthy aging, thereby raising the question of how it could be spared?

We will describe a series of behavioral studies with healthy older adults as well as with other populations (Howard, Howard et al. 2006; Negash, Petersen et al. 2007) that examine the conditions under which implicit associative learning reveals age differences. These findings lead to the conclusion that implicit associative learning is largely spared in healthy old age when relatively simple deterministic relationships are learned, but that persistent age-related deficits emerge when learning involves complex, probabilistic relationships (Howard and Howard 1989; 1992; Howard and Howard 1997; Howard, Howard et al. 2004; Howard, Howard et al. 2008).

Recent human and animal findings in cognitive neuroscience have provided evidence that implicit associative learning depends on a cortico-striatal network (Seger and Miller 2010). This network is particularly well suited for the gradual learning of stimulus-response associations based on the statistical relationship between the stimulus and response (Rieckmann and Bäckman 2009). Furthermore, there is substantial evidence that the striatal system declines with age revealing gross volume loss (Raz, Lindenberger et al. 2005) and reduced activation during performance (Backman, Karlsson et al. 2009), as well as changes in both pre- and post-synaptic neurochemistry (Rieckmann, Karlsson et al. 2011).

These findings lead to our hypothesis that implicit probabilistic associative learning is not spared in healthy aging, but rather it is characterized by persistent age-related learning deficits that can be detected as early as middle-age (Feeney, Howard et al. 2002) and worsen throughout the lifespan (Howard and Howard in press). These deficits are more pronounced with extended practice, and cannot be attributed solely to age-related deficits in general processing resources. Rather, they reflect a fundamental decline in the function of the striatal learning system. As training proceeds young adults come to rely increasingly on the striatal system, revealing growing age-related deficits with practice. We will present additional evidence that supports this hypothesis from functional (Simon, Barnes et al. 2008) and structural (Bennett, Madden et al. 2010; Bennett, Madden et al. 2010) neuroimaging as well as genetic studies (Simon, Stollstorff et al. 2011) using a recently developed triplets-learning-task. The significance of these results for successful aging will be discussed.

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*Tutorial III***Neuroanatomy and neurobiology of neural systems involved in learning and memory***Milos Judas*

University of Zagreb School of Medicine, Croatian Institute for Brain Research

The aim of this presentation is to provide a brief general overview of neuroanatomy and neurobiology of neural systems involved in learning and memory in the human and non-human primate brain. On the basis of how information is stored and recalled, the memory has been usually classified as implicit (procedural) or explicit (declarative). This distinction was first revealed with lesions of the limbic and association areas of the temporal lobe. Both clinical observations and experimental results in monkeys have demonstrated that the damage restricted to specific subregions of the hippocampal formation is sufficient to impair explicit learning and memory storage. However, the explicit memory is actually stored not in hippocampus, but in different regions of association cortex. For example, it seems that the semantic (factual) knowledge is stored in a distributed fashion in the entire neocortex, while episodic (autobiographical) knowledge concerning times and places seems to predominantly involve the prefrontal cortex. It was also shown that for both the encoding and recall of explicit knowledge a special form of a short-term memory (so-called working memory) is required. The prefrontal cortex seems to be especially engaged in processes of working memory. It is important to note that, in addition to neocortex, certain medial structures of the diencephalon (such as thalamic mediodorsal nucleus and the mammillary body) are also significantly implicated in memory and learning.

On the other hand, the implicit memory is stored in other (perceptual, motor, and emotional) neuronal circuits. The implicit memory can be nonassociative (habituation, sensitisation) or associative (classical and operant conditioning), and associative learning seem to be constrained by the biology of the organism. The cerebellum and the amygdala seem to be specifically involved in certain forms of implicit memory.

Finally, it should be noted that both explicit and implicit memory are stored in stages and the some learned behaviors involve both implicit and explicit forms of memory.

*Tutorial IV***The Tradeoff between Implicit and Explicit Learning in L2 Acquisition***Brian MacWhinney*

Department of Psychology, Carnegie Mellon University

Researchers typically view first language (L1) acquisition as based entirely on implicit processes. At the earliest stages, this must be the case, because the child has no representational system that could be used to support explicit processes. Eventually, the child develops metalinguistic understandings that support the detection of errors and the appreciation of metaphor and humor. However, these explicit mechanisms are not fully operative until age 4 and beyond, at a time when most of L1 has already been acquired.

In second language (L2) acquisition, the situation is nearly the opposite. Because their L1 provides adult learners with a fully established representational system, L2 learners are inclined to apply explicit processes wherever they may be useful. These processes include: translation, association formation, metalinguistic analysis, cue focusing, and rule formation. These processes can jumpstart rapid initial acquisition and retention over time. In a series of web-based and laboratory experiments, we show how the provision of simple explicit cues can lead to rapid learning for systems such as French nominal gender, Spanish conjugation, and Chinese pinyin orthography.

It is widely believed that continued reliance on these explicit mechanisms can lead to incomplete fluency and non-native levels of proficiency. Researchers such as Ullman and Clahsen have argued that second language learners fail to achieve native fluency because of critical period effects, involving inability to convert declarative representations to procedures. A variant of the Critical Period Hypothesis (CPH) is the Fundamental Differences Hypothesis (FDH) of Bley-Vroman, which holds that L1 and L2 acquisition are fundamentally different. In the context of the Unified Competition Model, I argue that the evidence presented by Ullman, Clahsen, and Bley-Vroman should be interpreted not as evidence for critical periods or fundamental differences, but as evidence that the conversion from explicit to implicit processing takes time and depends on consistent input.

To elaborate this analysis experimentally and observationally, we are conducting studies that vary level of learning, mode of instruction, consistency of cue structure, and spacing of trials and feedback. We refer to ERP data from Friederici and colleagues showing that native-like ELAN responses can be obtained in L2 learners, if the input is frequent and consistent. We also refer to ERP data from Osterhout showing that L2 learners shift from non-native N400 responses to native-like P600 responses for grammaticality violations. Finally, we present ERP data from Tokowicz and MacWhinney showing how both L1 and L2 compete during online processing.

The Unified Competition Model (UCM) is designed to address four major theoretical issues in parallel. These four issues are: explicit vs implicit learning, age-related factors in L2 acquisition, the fundamental differences between L1 and L2, and (indirectly) the role of Universal Grammar (UG). The UCM holds that one does not need to invoke the CPH, the FDH, or UG, if one views L2 learning as an ongoing transition from explicit to implicit representations.

The UCM approaches this issue by viewing L1 and L2 acquisition as relying on a core set of shared implicit processes, elaborated in L2 through additional explicit processes. For L2 learners, the four processes of entrenchment, parasitism, negative transfer, and social isolation constitute risk factors in the attainment of L2 fluency. However, the learner can compensate for these risk factors by relying on a set of four corresponding protective processes that maximize initial explicit learning. These processes involve resonance, internalization, positive transfer, and social participation.

The process of resonance involves a cluster of cognitive operations that foster increased proceduralization. A simple form of resonance involves associative linkages for smooth retrieval. A more extensive form of resonance involves the systematic mapping of representations in one neural

processing region to isomorphic representations in another. For L2 learners, the primary example of this type of resonance is the linkage of phonology and meaning to orthographic representations. If the L2 orthographic system does not match the L1 system, resonance is blocked across this dimension. Resonance depends heavily on reciprocal connections between hippocampus and the cortex that emphasize the consolidation of memories across time, as revealed through the action of methods such as graduated interval recall.

Resonance is also involved in the mapping or remapping between L1 and L2 grammatical categories. Here, proceduralization involves the rewiring of sequential processes, such as NP construction, to operate in new patterns with divergent categories in L2. This rewiring typically involves the formation of more direct input-output connections through rewiring processes supported by circuits between the anterior cingulate, the substantia nigra, and the basal ganglia.

The process of internalization has been highlighted in the application of Vygotskian theory to L2 learning by Lantolf and Pavlenko. Vygotsky holds that the internalization of social speech to inner speech serves to support cognitive development. A parallel effect can arise in L2 learning when learners come to think to themselves in their second language. This process may initially require explicit control, but can eventually become implicit and automatic, particularly during comprehension.

The process of positive transfer provides a general massive support for successful initial L2 learning. Because transfer focuses on similarities, it occurs with little explicit control. However, positive transfer may drag along with it elements of negative transfer that will have to be gradually eliminated through proceduralization.

All of these movements from explicit to implicit representations can be further promoted by learners' conscious decisions to engage fully in L2 social communities. Through maximal engagement, both explicit and implicit systems obtain the maximal amount of input data, thereby speeding overall acquisition.

**Abstracts – Short talks****Different forms of implicit learning in typical development and SLI***Ágnes Lukács*

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Focus on implicit learning in language impairment is motivated by the fact that the process of language acquisition is itself a form of implicit procedural learning, since it takes place incidentally, without conscious intent to learn, and without explicit knowledge of the acquired grammatical rules. One of the interesting questions is whether the implicit learning ability driving language acquisition is an instance of a general learning mechanism, or there are several mechanisms specialized for processing different types of inputs, which are organized by different principles, show different paths of development and can be selectively impaired. So far, there have been no systematic typical developmental and developmental neuropsychological studies on the background mechanisms of different forms of implicit learning.

The studies to be presented focus on testing different forms of implicit learning in typical development and in Specific Language Impairment (SLI) using 3 paradigms: 1) the Serial Reaction Time Task (SRT) testing the learning of motor sequences, 2) Artificial Grammar Learning (AGL) testing the extraction of regularities from auditory sequences 3) and Probabilistic Category Learning in the Weather prediction task (PCL-WP), a non-sequential categorization task. These three paradigms of implicit learning have been shown to be dissociable and to at least partly rely on different brain structures. Testing the same group of TD and LI children on all the three tasks provides an opportunity for within-group comparisons of performance on the three tasks, besides group comparisons.

We tested 16 children with SLI (mean age 11.3, SD: 1.3) and a control group of 16 age-matched typically developed children. All children with SLI have been selected to meet standard criteria for SLI: normal IQ, no hearing problems, no history of neurological impairment. They also scored at least 1.5 SDs below age norms on two or more of four language tests. Results show an impairment in the SLI group relative to controls on the AGL and PCL-WP tasks (performance at chance level on both), with intact sequence learning on the SRT. Results show that the deficit in implicit learning is not restricted to either linguistic or to sequential information (as it was also evident in the PCL-WP, a non-linguistic, non-sequential task). They also show that the deficit is not evident in all implicit learning tasks, not even when sequence learning is involved, as shown by results of the SRT tasks. Children in both groups showed large individual differences in learning on each of the tasks. In the LI group, AGL performance showed significant correlations with TROG (grammatical comprehension) and non-word repetition scores, but not with vocabulary and non-verbal IQ, while PCL performance was not related to language measures. This pattern argues for stimulus and task-specific effects in implicit learning, and for a need to formulate more specific hypotheses on the nature of the implicit learning deficit in SLI.

**Keywords:** sequence learning, probabilistic categorization, grammar, language impairment

## Development of implicit learning across life-span

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It is widely accepted that children should be introduced to sports, music or languages early in their life if they are to develop high proficiency since late learners seldom become true champions or elite musicians, or gain command of a second language similar to that of a native speaker. This observation contradicts traditional measures of the ability of factual learning of declarative memories, which show that humans become increasingly better in many learning tasks up to their late twenties ( Craik & Bialystok, 2006). However, an important component of developing new abilities is related to implicit unconscious statistical learning processes (Hikosaka, Nakamura, Sakai, & Nakahara, 2002; Keele, Ivry, Mayr, Hazeltine, & Heuer, 2003) that underlie acquisition of not only motor but also cognitive and social skills (Doyon et al., 2009; Hikosaka et al., 2002; Lieberman, 2000; Poldrack et al., 2005; Ullman, 2001). Thus to understand complex skill acquisition, the characteristics of both explicit declarative and implicit learning such as the change in their efficiency during lifetime must be clarified. Unlike in the case of declarative memory (Tulving & Craik, 2000), the ontogenetic changes in humans' implicit learning abilities have not been characterized before, and thus their role in acquiring new knowledge efficiently during development is unknown. The main goal of our study is to examine human's ontogenetic development of implicit learning across human lifespan. We investigated such learning across the life span, between 4-85 years of age with an implicit probabilistic sequence learning task, and found that the difference in implicitly learning high vs. low probability events exhibits a characteristic and rapid decrement at around age of 12. These lifelong learning efficiency measurements support an extension of the traditional 2-stage lifespan skill acquisition model: in addition to a noticeable decline above age 60 reported in earlier studies, sensitivity to raw probabilities and, therefore, acquiring new skills is markedly more effective up to early adolescence than later. These results suggest that due to developmental changes in early adolescence, implicit skill learning processes undergo a marked shift in weighting raw probabilities vs. more complex interpretations of events, which with appropriate timing, proved to be an optimal strategy for human skill learning.

In the second part of the talk the relationship between language and probabilistic sequence learning will be discussed. During sentence processing we decode the sequential combination of words, phrases or sentences according to previously learned rules. The computational mechanisms and neural correlates of these rules are still much debated. Other key issue is whether sentence processing solely relies on language-specific mechanisms or is it also governed by domain-general principles. We investigated the relationship between sentence processing and implicit probabilistic sequence learning in a dual-task paradigm in which the primary task was a non-linguistic task (Alternating Serial Reaction Time Task for measuring probabilistic implicit sequence learning), while the secondary task were a sentence comprehension task relying on syntactic processing. We used two control conditions: a non-linguistic one (math condition) and a linguistic task (word processing task). Here we show that the sentence processing interfered with the probabilistic implicit sequence learning task, while the other two tasks did not produce a similar effect. Our findings suggest that operations during sentence processing utilize resources underlying non-domain-specific probabilistic procedural learning. Furthermore, it provides a bridge between two competitive frameworks

of language processing. It appears that procedural and statistical models of language are not mutually exclusive, particularly for sentence processing. These results show that the implicit procedural system is engaged in sentence processing, but on a mechanism level, language might still be based on statistical computations.

**Keywords:** skill learning, implicit sequence learning, automaticity, Alternating Serial Reaction Time Task (ASRT), development, aging, critical period, language

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**Abstracts – Posters**

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**Double dissociation in the rehabilitation of memory impairments***Mónika Albu*

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The main purpose of this lesion study was to provide new rehabilitational strategies of memory impairments and test the effectiveness of these different rehabilitational strategies in patients with prefrontal cortex (PFC) injury. Classical neuropsychological and rehabilitational studies provide evidence for material-specificity, but we used as a theoretical framework the so-called “production- monitoring” hypothesis, proposing that the left PFC is primarily involved in semantically guided production of information, while the right PFC is more active during monitoring processes. Involving two amnesic patients with left and right PFC impairments we used two, double dissociated ABAB designs, improving differently the production and the monitoring functions, resulting in better memory performance in both patients. The results showed that recognition-preceding-recall strategy would improve the productive memory performance in the patient with left PFC injury, while verbal recall-preceding-recognition strategy would improve the monitoring memory performance in the patient with right PFC injury. The results of the study can be used in the neuropsychological rehabilitation for developing new compensational strategies for subjects with memory impairments.

**Keywords:** memory impairments, neuropsychological rehabilitation, production-monitoring hypothesis, ABAB design.

**Implicit learning in different sense modalities: commonalities and constraints***Anna Anzulewicz, Maciej Taraday*

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Different theories have been proposed regarding the nature of knowledge formed as a result of implicit learning. Some theories postulate that the representation is abstract, amodal, not tied to the surface features of stimuli, while other postulate that it is modality-specific. This research project consisted of two studies: the aim of the first one was to examine if implicit knowledge is amodal or closely tied to the modality. The aim of the second study was to assess commonalities and constraints in implicit learning across the senses. The procedure used in the studies was a modified version of the artificial grammar learning task. The modifications allowed to assess learning in different modalities. Two finite-state grammars were used. Depending on the experimental condition sequences conforming the grammars were instantiated as color images (in visual modality) or/and tones (in auditory modality). In the first study 177 subjects participated. The study revealed that implicit knowledge is rather modality-specific than abstract. Furthermore, the results suggest that simultaneous learning can proceed independently in different sense modalities. In addition, it was found that the

learning performance is increased in auditory modality compared to visual modality. The second study is in progress, and further data is being collected.

**Key words:** implicit learning, multimodal learning, knowledge representation

### **The role of context in intentional forgetting**

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The aim of the study was to investigate the effect of context in intentional forgetting phenomena. 37 young (average age 21.7) adults participated in the item method directed forgetting experiment (McLeod, 1998). In the study phase 44 words in front of blue and 44 words in front of yellow background were presented; half were followed by Remember (TBR) and the other half by Forget instruction (TBF). In the test phase the subjects had to recognize each word in front of either the background of the study phase or different irrespective of the F/R instruction, as "old" (displayed in the study phase) or "new", by bottom press. In our control experiment we tested the intentional forgetting phenomena in a simple item-method test with words without background color. Our preliminary results have shown that the old/new recognition performance of the participants was not based on the remember/forget instruction but the manipulated context information. The following question will be whether there is any difference in performance between the study and the control condition. Effect of the contextual information points to the assumption that the words connected either to remember or forget instruction preserve the perceptual context information and the word within it.

**Keywords:** directed forgetting, episodic memory, source memory, context

### **Electrophysiological evidence for the implicit learning of the finite-state grammar**

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A finite-state grammar with 8 "grammatical" 5-letter strings has been constructed in order to elicit changes in ERP wave forms related to learning (N2). The grammar consists of one initial node that allows for two different, but interconnected "grammatical" paths. The grammatical strings always end in the same letter (S). Participants were given a non-related task (to press the button when they see a red letter "P" in the string) while they were presented with grammatical and ungrammatical strings. To ensure implicit learning, the first 40 strings are all grammatical. The second group of 240 strings is presented as an oddball paradigm with rare ungrammatical strings occurring at the ratio 1:5. The transition from the first to the second group of strings is invisible to the participants. The results show higher N2 amplitude

for the ungrammatical strings regardless of the explicit task thus confirming that the implicit learning mechanism is capable of generalizations even after only a few exposures.

**Keywords:** implicit learning, finite-state grammar, event-related potentials, N2, oddball paradigm

### **Pragmatic Preference for Round Numbers: A Modified Sternberg Paradigm**

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Speakers' preference for round numbers in conversation is a well known phenomenon in pragmatics and studied within Gricean, neo-Gricean or Relevance theory approaches. In this study *processing* evidence for this pragmatic phenomenon is sought for in a modified Sternberg paradigm in which participants recall numbers from a list that contains groups of either "precise" numbers (eg. 23, 47...) or "round" numbers (e.g 30, 50...). By controlling memory load between the precise~round number conditions (3-number list, 4-number list, 5-number list...) a pragmatic effect of round number preference will be demonstrated. This amounts to the claim that the results cannot be interpreted in terms of memory load alone, but that the reaction times are partly influenced by the preference for round numbers. This preference might be interpreted by the automatic activation of the pragmatic module in the "human-computer communication".

**Keywords:** Sternberg paradigm, pragmatics, memory load, round numbers, reaction times,

This study/experiment has been carried out within the work on the ESF programme in Experimental Pragmatics (xPrag) "The Preference for Approximation" by Stephanie Solt (ZAS Berlin), Chris Cummins (Cambridge University) and Marijan Palmović (University of Zagreb).

### **Polarity Correspondence in Artificial Grammar Learning Task**

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The aim of the current study was to examine whether polarity correspondence influences Artificial Grammar Learning (AGL) task performance. Polarity correspondence theory explains results obtained in speeded binary classification tasks. According to this theory linguistic markedness and types of responses are coded as plus and minus polarity. If polarities of stimuli and responses correspond, responses are facilitated. We hypothesized that polarity correspondence may also apply to AGL task. Therefore in classification phase, given assignment of responses ("regular" vs. "irregular") to responding hands (right vs. left) may influence overall task performance. Previous studies suggest that left hand and "irregular"

response are both coded as “-“ polarity whereas right hand and “regular” responses are coded as “+” polarity. A classical AGL task was used. Participants (N=74) were assigned to two groups: (1) “corresponding” and (2) “non-corresponding”, differing in hand-response assignment. Above chance level classification was observed in both groups. Contrary to our hypothesis classification accuracy was higher in group 2. No RTs difference was observed. We conclude that non corresponding polarities (with no time pressure) may require higher deliberation that could further increase task accuracy. A follow up study (currently in progress) aims to verify whether these results would change under time pressure.

**Keywords:** artificial grammar learning, polarity correspondence, stimulus-response compatibility, implicit cognition, time pressure

### **Response strategies and performance in Artificial Grammar Learning Task**

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Numerous artificial grammar learning (AGL) studies revealed between subjects task performance differences, which may result from response strategies (reflexive vs. confirmatory) applied in the testing phase. We aimed to examine the role of such strategies and hypothesized that time restrictions in classification phase induce different response strategies that influence overall accuracy and “regular”/“irregular” response ratio. The AGL paradigm was used. Participants (N=88) were assigned to three groups: (1) forced-accelerated response (feedback if RT>1.5s); (2) forced-decelerated response (feedback if RT<1.5s); (3) control (no feedback). Above chance level classification was observed across all groups. Groups did not differ in classification accuracy. Control group (3) differed in RTs from both experimental groups (RTs for group 1<3<2). Groups differed in “regular”/“irregular” response ratio (more “regular” responses in group 1 as compared to group 2). Therefore we assume that time pressure (group 1) evokes confirmatory strategy, whereas “inverted time pressure” (group 2) does not induce any strategy (“regular”/“irregular” response ratio around 1). Results indicate that strategies investigated in the present study did not influence task accuracy. Nevertheless, due to high level of difficulty of the grammar, overall accuracy was very low. Therefore, a simpler grammar should be used to verify how the strategies influence AGL accuracy.

**Keywords:** Artificial Grammar Learning, response strategies, time pressure, implicit cognition, reaction time

### **The effect of hypnosis on prospective memory performance**

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Prospective memory (PM) is defined as the ability to formulate, retain and carry out intentions at the appropriate time, or in the appropriate context. The aim of this study was identify the effect of hypnosis on PM performance and to analyze the cognitive mechanisms involved in hypnotically altered state of consciousness in intention maintenance and realization. In one experiment we explored event based PM performance in three conditions – baseline, expectation and execution - with twenty-six volunteers without any psychiatric or neurological disorders. Hypnotizability was measured by the Hungarian version of the Harvard Group Scale of Hypnotic Susceptibility. The study applied a within-subject design, participants performed the same task both in alert waking and in hypnotic state in a counterbalanced order. According to our results the PM instruction in the execution condition produced significantly more cost in terms of reaction time during the ongoing task compared to the baseline in the wake condition than in hypnotic state. Overall, the result show that the hypnotically altered state of consciousness produces significantly better performance in event based prospective memory task compared to waking condition. The results are interpreted in the frame of attention control and monitoring function of prefrontal executive system.

**Keywords:** hypnosis, prospective memory, monitoring functions, intention maintaining  
This work was supported by OTKA (Hungarian National Science Foundation) K84019

### **On the influence of causal beliefs on the feeling of agency**

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The sense of agency is the experience of being the origin of a sensory consequence. The study I would like to present investigates whether contextual beliefs modulate low-level sensorimotor processes which contribute to the emergence of the sense of agency. Specifically, we looked at the influence of causal beliefs on ‘intentional binding’, an implicit measure of self-agency which is considered to be generated by predictive mechanisms of motor control. To asses intentional binding participants had to judge the onset-time of either an action or a sound which followed the action. In addition, they were induced to believe that the sound was either triggered by themselves or by somebody else, although, in reality, the sound was always triggered by the participants. We found that intentional binding was stronger when participants believed that they triggered the tone, compared to when they believed that another person triggered the tone. These results suggest that high-level contextual information influences low-level sensorimotor processes responsible for generating intentional binding. Moreover, these findings suggest a reversal of David Hume’s conjecture. Indeed, if according to David Hume causality is inferred from temporal contiguity, we showed that people’s sense of time is warped by their beliefs of causality.

**Keywords:** Agency, Causal belief, Predictive mechanisms, Intentional binding, Top-down modulation, Time perception.

## **Deficits in automatic mental state attribution in Borderline Personality Disorder**

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Symptoms of Borderline Personality Disorder (BPD) are generally conceived of as manifestations of an underlying deficit to correctly mentalize about the self and other. The nature of these deficits, whether they occur only when circumstances require explicit, effortful inferential processes, or they are observable at a more basic level as well, is still unclear. To investigate this issue, the present study adapted the implicit ToM paradigm of Kovacs et al. (2010), to assess if a group of BPD patients (N=24), and matched controls (N=24) automatically compute the false beliefs of an agent, in a task where this is not required. Results show that only the control group's reaction times, but not that of BPD patients', was affected by the false belief of the agent. This suggests that BPD patients might have a deficit in automatically computing the beliefs of others. Such a deficit might, in part, account for the severe belief attribution distortions in situations when intense stress renders difficult to rely on strategies otherwise used to compensate for possible deficiencies in spontaneous mentalization. Results from Study 2, which required spontaneous mentalization while watching animated triangles (Castelli et al., 2000), help to further clarify the nature of implicit ToM deficits.

**Keywords:** Borderline Personality Disorder, automatic, belief computation

## **Learning a sequence with a memory load: Effects of age and learning conditions**

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The present study aimed at investigating the (potentially detrimental) role of a memory load on sequence learning, in young and middle-aged adults. Participants in both age groups performed a serial reaction time (SRT) task under two learning conditions: incidental versus intentional. Additionally, a secondary memory load task consisted in the concurrent maintenance of letters, and their serial recall at the end of each block. Significant learning and transfer effects were observed in all groups. In a subsequent generation task, participants were also able to reproduce the training sequence in the inclusion subtask and to exclude that sequence and produce the transfer sequence instead in the exclusion subtask. Intentional learning conditions yielded higher-quality sequential representations, as shown in generation scores. But more importantly, the analysis of both tasks suggests that the processes subtended in learning a sequence under dual task conditions, be it incidentally or intentionally processed, do not significantly differ in young and middle-aged adults. This confirms previous data from

our lab (Gaillard et al., 2009) showing no age-related differences in learning and generation abilities.

**Keywords:** sequence learning, middle age, intentional, memory load, dual-task

### **Influence of vowel harmony in implicit learning of structure phoneme sequences in Croatian and Hungarian**

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Vowel harmony is cross-linguistically a well-attested phenomenon that constrains the appearance of vowels in a word depending on their quality. Since the possible occurrence of vowels is limited to a certain set, vowel harmony produces a certain level of redundancy. The aim of this research is to see whether vowel harmony facilitates the implicit learning of structured sequences containing both vowels and consonants. The experiment will be conducted on a group of native Croatian and Hungarian speakers, whose task will be to evaluate the grammaticality of structured phoneme sequences. The participants will be instructed to base their grammaticality judgment on a set of structured sequences given previously during the training phase, in which all the stimuli are constructed respecting the front-back vowel harmony. In the test phase half of the sequences will observe the front-back harmony pattern. The success of implicit learning will be evaluated on the basis of the percentage of correct responses and on reaction time. The hypothesis is that vowel harmony, due to its increased regularity effect, facilitates implicit learning. Also, more prominent influence of vowel harmony is expected in the native Hungarian group, due to their exposure to vowel harmony from the beginning of language learning.

**Keywords:** implicit learning, vowel harmony, reaction time, Croatian, Hungarian

### **Effect of consolidation on intermanual transfer in probabilistic and deterministic motor sequence learning**

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Implicit motor sequence learning could be contributed by muscle-specific information (effector based learning) and the sequence of the response locations (response based learning). Intermanual transfer studies provide a well-developed method for investigating these components of motor skill learning. In this method, participants acquire a sequence with one hand and they are asked to perform the parallel and mirror version of the originally acquired sequence after switching to the other hand. As opposed to previous studies, in our research intermanual transfer was investigated after only one training session, both on probabilistic and deterministic sequences, measured by a Serial Reaction Time Task. In order to examine the

effect of consolidation on intermanual transfer, a 12-hour delay was administered for 2/3 of the participants, including or excluding sleep, while the rest of them were tested right after the training session. Intermanual transfer was found using the parallel sequence for both probabilistic and deterministic tasks, while the transfer of the mirror sequence was found only in the deterministic task, and to a significantly weaker extent than for the parallel sequence. Neither sleep, nor length of delay influenced intermanual transfer. These results have important implications in understanding the underlying mechanisms of implicit motor sequence learning and consolidation.

**Keywords:** intermanual transfer, implicit learning, Serial Reaction Time Task, Alternating Serial Reaction Time Task, consolidation, sleep effect, motor sequence learning

### **Spectral sleep EEG features of nightmare sufferers: evidence for a NREM disorder?**

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Nightmare disorder characterised by recurrent vivid, dysphoric dreams charged with negative emotions is one of the most common sleep problems. While there are two studies about the sleep architecture of nightmare sufferers (NS), as far as we know, the sleep EEG characteristics of them have not been investigated yet. Psychological (Beck Depression and State-Trait Anxiety Inventory) and two-night polysomnographic testing were conducted on 21 university students (10 NS, 11 control) without any prior history of mental or chronic somatic disease. EEG spectra were obtained by using Fast-Fourier Transformation on the second night recordings for REM and NREM separately. We examined the group differences by ANCOVA controlling for the BDI and STAI score. In the nightmare group higher NREM theta (4,25-7,5 Hz) and high sigma (12,75-15 Hz) activities were found mainly at the centro-parietal region and the frontal area, respectively. The frontal high sigma activity was correlated significantly with poor sleep assessed by the Groningen Sleep Quality Scale. No significant differences in REM spectra have been observed. The results suggest that NS differ from controls more in NREM than in REM sleep. The covert REM sleep phenomena might explain the higher theta activity in NS.

**Keywords:** nightmare, sleep, EEG, dreaming, covert REM sleep, sigma activity, sleep quality

## The time-course of implicit skill consolidation in young and elderly adults

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Implicit skill learning underlies not only motor but cognitive and social skills, it is therefore an important aspect of life from infancy to old age. We studied aging effects on the time course of implicit skill consolidation. Young and elderly adults performed a probabilistic implicit sequence-learning task before and after a 12-hour, a 24-hour and a 1-week interval. We found improvement of general skill for the young adults in all delay conditions. The elderly adults also showed enhancement after the 12-hour period. This improvement, however, disappeared in the 24-hour and the 1-week delay conditions. Regarding sequence-specific learning, no improvement was found in either age group and at either consolidation interval. In contrast, sequence-specific knowledge decreased in the elderly group independently of the delay. These results draw attention to the fact that implicit skill consolidation is not a single process; rather there are multiple mechanisms which are differentially influenced by time course and by aging. Based on these results, therapists can design more effective educational, training, and rehabilitation programs for age-related disorders.

**Keywords:** skill learning, implicit sequence learning, ASRT, aging, memory consolidation.

## Sequencing of two-digit numbers in dyslexic children

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Reading and writing are multimodal activities where graphemes have to be converted to phonemes and vice-versa, respectively. To convey meaning during this process their specific order should be followed. In order to recognize a two-digit number, not only identity, but also the position of constituent digits of a number has to be accurately processed. Since sequencing difficulties and transposing are the most common symptoms of reading and writing impairment (developmental dyslexia), in this study we examined the transposed number effect in auditory-visual number matching task in dyslexic children and children with no reading and writing difficulties. Participants had to decide whether the number presented on the screen was the same as the one auditory presented. While controlling the distance effect, reaction time and correct responses were recorded in three conditions: number matching (e.g. 54 - 54), mismatch condition (e.g. 54 - 27) and transposed number condition (e.g. 54 - 45). Differences within and between groups were examined. The results obtained by auditory-visual number matching task were discussed in reference to number processing theories and different approaches to dyslexia.

**Keywords:** dyslexia, sequencing difficulties, auditory-visual number matching task, transposed number, two-digit number processing

### **Crossmodal transfer and unimodal interference in Artificial Grammar Learning**

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One of the central research topics in artificial grammar learning (AGL) is whether transfer in AGL works across modalities, mediated by abstract amodal representation, or it is linked to modality, and is based on stimulus specific representations. Conway and Christiansen (2006) suggest that learning is closely tied to the perceptual characteristics of the input, resulting in higher performance if testing takes place in the same domain as training, but not if the domains of training and testing differ. The aim of the current study was to test the hypothesis that learning is strongly tied to stimulus features, and, at the same time, to show that modality-specificity can be task-dependent, and is not a necessary consequence of stimulus dependency. In the study participants were trained on an AGL task with auditorily presented category names, and tested on either auditorily (unimodal condition) or visually (crossmodal condition) presented category members. Results show that while both groups showed learning, performance on the crossmodal condition was higher than performance on the unimodal condition: both groups were able to transfer sequence information from category names to category members, but auditory test stimuli interfered with training stimuli, while this effect did not appear for visual stimuli.

**Keywords:** artificial grammar learning, stimulus dependency, modality constraints, amodal representation, transfer

### **Common mechanisms of test enhanced learning and retrieval induced forgetting**

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Testing target memories related to a cue leads to better recall of these target memories, however it also renders memories associated to that same cue less accessible. The former phenomenon is termed practice effect, the latter is termed retrieval-induced forgetting (RIF). RIF seems to be independent of the strength of the target memories: Simply restudying target memories without any testing does not lead to RIF, even though both restudying and testing leads to the same amount of practice effect. This finding has been used as an argument against non-inhibitory accounts of RIF. In an experiment using the retrieval practice paradigm (Anderson, Bjork, and Bjork, 1994) we question the strength-independence of RIF by showing that long-term target recall is different for restudied and tested items. Our finding is

consistent with data from experiments investigating the testing effect, i.e. that long-term retention is better for tested than restudied memories. We interpret our data in the framework of the new theory of disuse (Bjork & Bjork, 1992).

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### **Objective and subjective components of the first night effect**

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The first night effect – marked differences between the first and the second night spent in a sleep laboratory – is a widely known fact that accounts for the common practice of excluding the first night sleep from any polysomnographic analysis. The extent to which the first night effect is present in a subject and the duration of this effect (one or more nights) might have diagnostic value as well and should account for different protocols used for distinct patient groups. In the present study we conducted a two-night long polysomnographic recording on 20 (nightmare sufferer and control) subjects supplemented by data obtained from the Groningen Sleep Quality Scale for both nights. Differences were found in both the objective (sleep duration, sleep efficiency, wakings after sleep onset, relative S1 duration, relative S2 duration and relative slow wave sleep duration) and subjective (self-rating) variables between the two nights. Results suggest that contrary to previous findings data obtained from a self-rating questionnaire can be a useful measurement of the first night effect. Therefore we suggest the clinical use of the Groningen Sleep Quality Scale before and during polysomnographic recordings in order to have a “home baseline” sleep value.

**Keywords:** sleep, first night effect, polysomnography, Groningen Sleep Quality Scale

### **Do sequential and concurrent processes of auditory stream segregation interact?**

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Sounds are sorted in perception by two types of heuristic algorithms. Concurrent grouping separates sounds that occur at the same time, such as speech against street noise. Sequential grouping links temporally separated sounds, such as a series of footsteps, into coherent streams. Some previous behavioral and event-related potential (ERP) studies found signs of interaction between these two types of grouping processes. We investigated the possibility of

interaction using two ERP components, which allow testing perceptual sound organization without task-related biases. The object-related negativity (ORN) is elicited when the presence of concurrent sounds is detected within the acoustic input. The mismatch negativity (MMN) is elicited when a deviant sound is detected within a regular sound sequence. Participants were presented with two stimulus conditions. In one condition, if concurrent grouping preceded sequential grouping, a sequential regularity would not be detected and no MMN would be elicited. In the other condition, if sequential grouping preceded concurrent grouping, the emergence of a new concurrent sound would be prevented and no ORN would be elicited. The ORN and MMN responses observed in the respective stimulus conditions suggest that the two types of grouping cues may be processed in parallel, independently of each other.

**Keywords:** sound perception, stream segregation, ERP, object-related negativity

### **Pragmatic modeling of quantified expressions**

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Poor performance on logical tests that include quantified expressions (*all, some*) has been documented in a number of studies. Pragmatics offers conceptual tools to account for these empirical data in terms of presuppositions or implicatures as additional premises that the participants are usually unaware of. In this study the aim is (1) to analyse the scalar implicatures implied in utterances containing quantifiers; and (2) to propose a model of speaker's reasoning with quantified expressions. To these ends an eye-tracking experiment with a picture matching task has been set up. The participants' task was to choose the picture that matched the sentence containing quantifiers *all* and *some* in all combinations of the Aristotle's square of opposition. The timing of the eye-tracking results shows that the scalar implicature *some...are...->some...aren't...* is available to the participants from the beginning, i.e. that it is automatically activated, but that the meaning of the quantifier is vague in terms of the number of object that satisfy the condition given in the 'Some...are...' sentence. The results explain the poor performance on logical tests without implying that people are generally bad at logic.

**Keywords:** quantifiers, all, some, reasoning, inferences, pragmatics

The study was funded by the VAAG project of the ESF programme EUROCORES LogiCCC and the Croatian Scientific Foundation.

### **Does syntax drive language? A meta-review of the recent experimental literature**

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Results of a meta review of over 300 recent experimental studies on the interface between, and relative contributions of, semantics and syntax in sentence processing is presented. A main finding is that definitional problems make cross-study generalizations difficult. These definitional problems are illustrated with examples from operational definitions, procedures and general conclusions from specific experiments. Most salient are a tendency to conflate global (e.g. discourse and mental model) level semantic processes with local (syntax/semantic interface) level processes in general conclusions; and ambiguity about whether the experimental goal is to ascertain temporal or teleological priority. While conclusions about temporal priority and the teleological importance of local syntax versus local semantics are quite variable across experiments, at the global level, mental model considerations always override syntactic considerations in human performance.

**Keywords:** sentence processing, syntax, semantics, mental models, experimental

### **How do competent adults process multiplication facts?**

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Evidence is presented that the end product of multiplication fact learning in educated, mathematically competent adults is NOT adequately modeled by a simple semantic network, but that the smaller facts are best modeled as subitizable sets of subitizable numbers (e.g. 4 x 4), with only the larger, subitizably-untractable problems being handled by the less reliable and more-tedious-to-learn route of rote verbal memory. These findings suggests that innate, embodied numerosity abilities are enhanced and expanded by, but not replaced by, more advanced abstract cognitive processes in competent adults. It provides a motivated explanation for the “problem size effect” (that RT to multiplication facts increases with the size of the multiplicands). By enhancing our understanding of the “target” state (adult competence), it has implications for child development theory (cf. the Gelman-Carey debate); predicts a double dissociation between rote verbal memory and basic numerosity impairments in acquired and developmental dyscalculias; and predicts hitherto unexplained educational outcomes (advanced mathematical ability in a subset of students with impaired rote memory for facts and procedures). It also suggests rich new research paradigms for investigating visual-spatial vs. verbal memory and working memory in maths cognition, and in teasing apart the multiple components of maths cognition.

**Keywords:** maths cognition, multiplication facts, problem size effect, dyscalculia, numerosity, subitize, maths education

### **Visual implicit learning and semantic categories**

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The present experiment investigated whether participants can learn association between the background colour of the screen and the semantic categorical properties of the word displayed on the screen while solving an unrelated, attention demanding task. Participants were presented with nouns from seven semantic categories appearing one by one on the screen, in random order. Each semantic category was associated with a background colour. Participants were asked to check if the word displayed on the screen was presented among the pictures on the paper and to mark it, if it were. Each word was displayed for only 5 seconds and then replaced by another one. After solving the task, participants were asked to answer the questions in the questionnaire, aimed to determine whether they discovered the regularity in the relationship between background colours and semantic categories. As a final part of the experiment, participants were presented with words from the aforementioned seven semantic categories and asked to determine whether each word's background colour was correctly assigned. Apart from words already used in the first part of the experiment, new words belonging to the same semantic categories were presented as well.

**Keywords:** implicit learning, semantic categories, visual stimuli, color associations, learning associations

### **Executive functions in patients with obstructive sleep apnea syndrome**

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Patients with obstructive sleep apnea syndrome (OSAS) often show impairments in cognitive functions. The present study aims to evaluate executive functioning in patients with OSAS in comparison with healthy subjects. The study focuses on three main executive functions: updating of working memory, shifting between mental tasks and inhibition. These were measured with different subtests of the Test of Attentional Performance (TAP). Results indicate that sleep apnea can affect the examined executive functions, moreover the patients with OSAS showed impaired performance on at least one of the subtests. The biggest difference between the OSAS and the healthy subjects appeared in the updating function. However, very different patterns of executive functioning can be observed within the OSAS group: a general deficit in all examined functions can occur as much as the distinct impairment of one or two specific executive functions. The diversity in the pattern of executive disfunctions can be used as diagnostic cues in patients with OSAS together with sleep diagnostic results, like sleep efficiency or apnea-hypopnea index.

**Keywords:** sleep apnea, executive functions, Test of Attentional Performance, cognitive dysfunction

## Sequence specific interference on the Serial Reaction Time Task

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In previous studies with the Serial reaction Time (SRT) task a transfer block usually consisted of stimuli appearing at random locations, and transfer was measured as the increase of reaction time on the transfer block. Cross-domain transfer on the SRT task has been neglected so far. Our experiment tried to explore whether there is a transfer of sequence specific knowledge from the perceptual to the motor domain in the SRT paradigm. We employed four conditions: in all conditions participants faced a twelve-block SRT task with auditory target stimuli (RT-phase). The Control condition contained the RT-phase only. In the other three conditions there was a preceding observational phase too: the observational phase consisted of a six-block dot-counting task where the dots' appearance was either identical to (Sequence condition) or the reverse (Reverse condition) of the sequence in the later RT-phase, or random (Random condition). Results show that there is no transfer of learning from previous observation; what's more, an earlier visual sequence seems to interfere with later auditory sequence learning irrespective of whether the sequence is identical or reverse.

**Keywords:** sequence specific interference, implicit sequence learning, SRT, transfer effect, cross-modality.

## The Opposite Effect of Trait and State Anxiety on Iowa Gambling Task

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According to the somatic marker theory (Damasio, 1996), our decisions are based not only on higher-order cognitive operations but also on dispositional information about past experiences stored in somatosensory patterns of emotional states, called somatic markers. Based on this, state or trait differences in emotional reactivity should influence decision making. Notwithstanding that, the findings related to the effects of anxiety on decision making are controversial with reporting both positive and negative effects (de Visser et al., 2010; Werner et al, 2009). We suggest that this might be due to the treatment of anxiety as a unitary construct. Instead of this, we tested whether different conceptualizations of anxiety are differentially related to the learning performance on Iowa Gambling Task (Bechara et al, 1994), which assesses how the somatic markers implicitly bias our decisions. Our results show that state anxiety and trait worry were positively whereas trait anxiety was negatively related to decision-making. Moreover, high state anxiety was associated with more explicit knowledge on task contingencies. We suggest that our results are in line with the predictions

of Bechara and Damasio (2005), who propose that somatic markers associated with task-related anxiety are advantageous for decision-making whereas task-unrelated anxiety has deleterious effects.

**Keywords:** Iowa Gambling Task, Anxiety, Worry, Emotions in decision-making, Explicit/implicit learning

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### **Implicit learning and strategic adaptation in probabilistic environments**

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In iterated decisions adaptation of people's decisional strategies are shaped by explicit and implicit learning processes. In two experiments we studied, how implicit learning processes can contribute to strategic adaptation in different probabilistic environments. In the first experiment in a computer based economic simulation subjects had to choose between two investments. They directly experienced event frequencies of price fluctuation and could use a clue with constant predictive validity. This methodology allowed us to examine indirectly the extent to which probabilistic information is used by subjects. Reaction times and self reported event frequencies were recorded. In the second experiment I studied participants playing the iterated prisoner's dilemma against a simulated agent employing non-stationary stochastic strategies. Participants played for 190 rounds a repeated prisoners dilemma against a computer employing successively two kinds of probabilistic strategies (TFT, WSLS). Results showed that even in non-stationary probabilistic environment people can adapt their decisional strategies despite the fact that they couldn't consciously identify probabilistic regularities in the opponent's strategy. In both experiments decision times were significantly lower in the case of optimal decisions, suggesting that rapid choices are less influenced by conscious processes and can lead to better decisions in complex probabilistic environments.

**Keywords:** implicit learning, probability learning, game-theory, base-rate neglect, adaptation

### **Exploring the early stages of learning a foreign language**

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The theme of my presentation is artificial language learning. For experimental studies on implicit and explicit language learning, we created a set of digitized cartoon drawings of 20 animals performing 10 different picturable actions in dyadic pairs. The animals and actions can be combined freely to create a large number of different scenes corresponding to independent clauses of the type "The dog hugs the lion". Twenty Finnish-speaking university undergraduates learned the names of these animals and actions as well as two

morphosyntactic rules (object marking vs. grammatical gender marking) in the new language. Unsupervised learning was accomplished by viewing scenes with accompanying sentences like “Garomi poh+a tunuke+r”. Both lexicon and grammar were learned simultaneously, thus aiming at a more natural language learning process. Sentence-picture matching and picture description results indicated that learners are very quick to implicitly pick up regularities of a new language. The metalinguistic task showed that more participants became aware of the native-like morphosyntactic rule, the object-marking rule. This study attests to the efficacy of the word learning system: very limited exposures to novel items are sufficient for lexical learning and acquisition of embedded regularities, while explicit metalinguistic knowledge of the regularities develops not until later.

**Keywords:** artificial language learning, lexical and syntactical learning, metalinguistic knowledge

### **Implicit sequence learning and working memory in dementia**

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Several cognitive functions are impaired in dementia, like working memory, explicit memory. Implicit cognition got less attention in the literature. The first goal was to investigate implicit learning and its consolidation in dementia. Participants with dementia and healthy elderly control groups were tested on a modified serial reaction time task, the Alternating Serial Reaction Time task (ASRT), which unlike the previous implicit learning tasks, allowed measurement of the reaction times more precisely from the beginning with the separation of general motor skill learning from sequence-specific learning. The ASRT tasks were repeated after 24 hours. The patient group showed similar implicit learning in the learning phase to the control group. Consolidation of general motor skill learning was not impaired but the sequence-specific learning was in dementia. The second goal was to investigate working memory in dementia. The two groups showed significant differences on complex working memory measured by Counting Span Task and verbal and spatial short-term memory measured by digit span task and Corsi Block Tapping Task. However we did not find significant differences on Listening Span Task between the two groups. In sum, the neuropsychological profile of the group with dementia was different compared to the healthy control group. These results might help to develop new diagnostic tools for dementia helping the early prevention.

**Keywords:** dementia, implicit sequence learning, SRT, working memory

### **Processing pragmatic information in children with language impairment**

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While reading, a competent reader builds up not only the literal meaning of the sentence, but also makes assumptions about the relevant context. Recent studies in experimental pragmatics show that the processes involved in building up these assumptions are not sequential, but parallel, i.e. that the contextual information is integrated at the same time as the literal meaning is constructed on-line. To check these findings (that are based on the population of non-impaired adults) a self-paced reading task was given to the participants divided in two groups: children with developmental language impairment (LI group) and typically developing controls (TD group). The participants had to read two sentences: the first defining the context, and the second that either required an additional assumption (the “bridging sentence”) or not. While the TD group clearly shows the delay in the self-paced reading at the beginning of the second sentence, the LI group shows no such delay indicating the absence of the processes related to the “bridging sentence” assumption.

**Keywords:** experimental pragmatics, bridging inference, language impairment, self-paced reading

### **Intuition in patients with aphasia. The impact of speech comprehension on the semantic network activation.**

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The aim of the examination was to determine the impact that speech comprehension disorder in patients with sensory aphasia might have on the semantic network activation, which is the ground of intuition. It was assumed, that the phonematic hearing impairment observed in patients with this type of aphasia, might obstruct or disable both information coding in the short-term memory and its transposition to the long-term memory – in such a case the activation of the semantic network might not occur at all or be weaker in aphasics than in healthy persons. The task of the subjects was to pick up one of three possible endings of a story presented as a cartoon in a self-designed computer program (where one of the endings was earlier presented subliminally) and indicate the level of surety of the choice. Results of 14 patients suffering from sensory aphasia were compared to those of healthy persons. The examination showed no discrepancies between the groups when it came to priming, but the hypothesis relating to a greater level of surety in healthy subjects was not confirmed. The indications of surety were negatively correlated with correctness – the higher the surety indication was, the greater the probability that the subject would choose the answer incongruous with the prime.

**Keywords:** intuition, implicit learning, semantic network, sensory aphasia, priming

### **Strategies and performance in Artificial Grammar Learning.**

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There is controversy over whether knowledge acquired in implicit learning tasks is conscious. Recently, different scales have been introduced to measure the conscious status of this knowledge. The goal of the experiment was to check whether instructions accompanying different scales can influence the strategies that subjects use. I.e. people might feel more encouraged to base their judgements on intuition if they are asked to assess their intuitive feelings rather than to state their certainty. 183 students took part in an Artificial Grammar Learning Task (AGL). In the classification phase subjects were asked to assess their decisions by rating certainty, intuitive feelings, conscious knowledge about the rule or money wagering. After the test they were asked about the ways they dealt with the AGL task. The results showed that instructions did not influence subjects' strategies nor their performance. However there was a relationship between strategies used by subjects and their correctness - guessing was the least effective and using remembered regularities of previously presented strings was best. The results suggest that subjects might be to some extent conscious of the level of their implicitly acquired knowledge.

**Keywords:** implicit learning, artificial grammar learning, unconscious knowledge, cognitive strategy, subjective measures, intuition, confidence

### **Neuropsychological Characteristics of Nightmare Sufferers: Testing the Prefrontal Dysfunction Hypothesis**

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Nightmare Disorder (ND) is a sleep disorder characterized by frequent, emotionally negative and intense dream experiences that often – but not necessarily – end in abrupt awakenings. Recent research indicates that ND is not a mere symptom of waking psychopathology, but rather a special case for affective dysregulation during sleep. Inefficient regulation of emotional experiences may reflect impaired fronto-limbic emotional networks, known to manifest enhanced activation during REM sleep. Our aim was to examine if Nightmares Sufferers (NS) showed alterations in emotional as well as neutral information processing tasks, associated with prefrontal functioning. 35-35 NS and matched controls participated in our study. We applied a neuropsychological battery comprising an emotional GonoGO task, a Stroop task, a verbal Fluency task and the Porteus Maze task. We controlled our measurements for sleep quality and daytime anxiety. According to our results NS showed significantly worse performance in these different tasks, reflected in a slower response pattern in the GonoGo and Stroop tasks, and in more perseveration errors in the Fluency task. While the effects of sleep quality and waking anxiety were in some cases associated with these alterations, these factors could not solely explain the difference between the two groups. Our results indicate impaired prefrontal functions in NS and therefore provide partial support for the Prefrontal Dysfunction Hypothesis of ND. However, the effect of impaired sleep quality

in NS should be investigated more thoroughly, since altered sleep quality may modulate waking inhibitory functions.

**Keywords:** Nightmare, dreaming, emotional regulation, prefrontal inhibition, neuropsychological assessment

### **The role of number notation at children's numerical performance**

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While it is well-known that number notation has an effect on numerical processes, no former study investigated directly the nature of this effect per se. It is believed that place-value number notation systems, like the Indo-Arabic numbers, are easier to use than sign-value systems, like the Roman numbers, however, historical and computational considerations predict an opposite effect. To empirically investigate the effect of number notation artificial sign-value and place-value number systems were constructed. In a previous work it was found that adults were faster and more accurate in comparison and addition tasks in sign-value notation system than in place-value system. However, the results can be influenced by the former experience with Indo-Arabic notation. To test the effect of former experience, in the present study preschool and fourth grade children solved comparison tasks. The results of both age groups are consistent with the adult's performance: sign-value notation is superior to place-value notation. Interpreting these results, a natural multi-power number representation based on object representation is proposed. We hypothesize that sign-value notation is easier to transpose to this representation than place value notation.

**Keywords:** numerical cognition; comparison; number notation; sign-value notation; place-value notation

### **Measurement of foreign language proficiency with psycholinguistic tasks**

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There is evidence that reaction times in psycholinguistic tasks in a foreign language (L2) are longer than in an analogous task in the native language (L1). It is debated whether the individual size of this effect correlates with L2 proficiency. 25 subjects completed a standard language proficiency test, a lexical decision task, a two-way (L1-L2 and L2-L1) word translation task, a grammatical sentence completion task and a same language (L1-L1 and L2-L2) and a cross-language (L1-L2, L2-L1) priming task (with both categorical and associative priming) in both languages. For all tasks, RT differences between languages were measured and correlated with proficiency scores. The size of RT disadvantage in L2 correlated negatively with test scores in the lexical decision task, translation task, same-language and

cross-language categorical priming. No significant effect was found in the sentence completion and associative priming tasks. A GLM model of RT differences explains 40% of the variance of test scores respectively. Neural network test score predictions from RT differences have a high correlation to actual scores. Results show that online performance in linguistic tasks is sensitive to language proficiency. Increased speed of processing accounts for much of the variance of L2 proficiency.

**Keywords:** foreign language, language proficiency, priming, reaction time, translation task.

### **Category-specific aftereffects in the perception of bistable images**

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Bistable pictures (like the Necker-cube) have two possible perceptions. Perceptual adaptation usually biases perception away from the adaptor, but in bistable images, bias towards the adaptor has been demonstrated. Adaptation occurs at all levels of perception. However, bias of bistable images was mostly tested on simple images. I tested to what direction adaptation biases the perception of complex bistable images. Subjects had to assess the face-likeness of a picture on a 1-through-7 scale. 26 bistable images (with one possible perception being a face) and 18 controls were presented. In one session images were preceded by a face adaptor, while in the other by a fourier-randomized adaptor. Responses were compared across the two conditions with a paired-samples t-test. In the face-adapted condition, perceived face-likeness of bistable images was significantly higher than in the control condition ( $t=3.596$ ,  $p=0.001$ ). RTs were longer after face adaptation ( $t=2.261$ ,  $p=0.033$ ). The two effects are not correlated. Results are different from those of regular adaptation studies, as perception is biased towards the adaptor. A possible explanation is that since bistable images have two valid perceptions, decision happens at a higher processing level. An ERP study could further clarify the background of the phenomenon.

**Keywords:** perception, bistability, adaptation, aftereffect, higher-order processing

### **Predicting prejudice toward ethnic out-groups using explicit and implicit measures of attitudes**

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The present study focuses on people's attitudes and its subtle behavioral manifestation toward other ethnic groups. Explicit tests are widely used to measure attitudes toward ethnic out-groups and to predict behavioral manifestation of attitudes. The aim of this study is to test whether implicit attitudes toward ethnic out-groups are better predictors of cooperative behavior, altruistic behavior, equitability and reciprocation of trust manifested toward

members of those groups, than explicit measures. The attitudes of ethnic Hungarian and Romanian participants toward the other group were measured using two tests: an Implicit Attitude Test (IAT) specially constructed for this purpose and an explicit attitude questionnaire. Participants also played several rounds of ultimatum and trust games in different roles, with different simulated opponents in each round. Social information regarding the opponent's ethnicity and gender as well as the offers of the proposer was manipulated. Participants with stronger negative implicit attitudes manifested less equitability, and reciprocated trust infrequently toward members of the ethnic out-group. Results shows that implicit attitudes are significantly better predictors of the participants manifested behavioral differences attributable to the ethnicity of the simulated opponents. The study outlines the implications of these results for prejudice reduction and effects of social information on decision-making.

**Keywords:** implicit attitudes, behavioral manifestations, prejudice, game-theory, social information

### **Interaction between serial but overlapping prospective tasks**

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The general definition of prospective memory includes processes between the framing and the execution of a given behavioural goal. In our everyday life we usually have to remember more than one prospective task, and according to Lebiere and Lee (2001) in these cases, there is always a primary one among the prospective goals, and until this one ends, the context of the ongoing task is included as a source of activation in this prospective goal. When the task ends, the activation of this prospective goal decreases and the context becomes associated with the next prospective task. The aim of this study was to examine the interactions between serial but overlapping prospective tasks. According to the results the prospective task that has been given to the participants first became primary and therefore the context, which became associated with this goal, facilitates the execution of this task while it sets back the execution of the other tasks, which have been given after the primary one. The inhibition of the secondary tasks seems to be connected rather to the recall of these tasks than to the encoding: because after the primary task has ended, these “forgotten” tasks are recalled and accurately executed.

**Keywords:** prospective memory, ProM, overlapping prospective tasks, event-based tasks, executive functions, inhibition

### **Novelty recognition in artificial grammar learning**

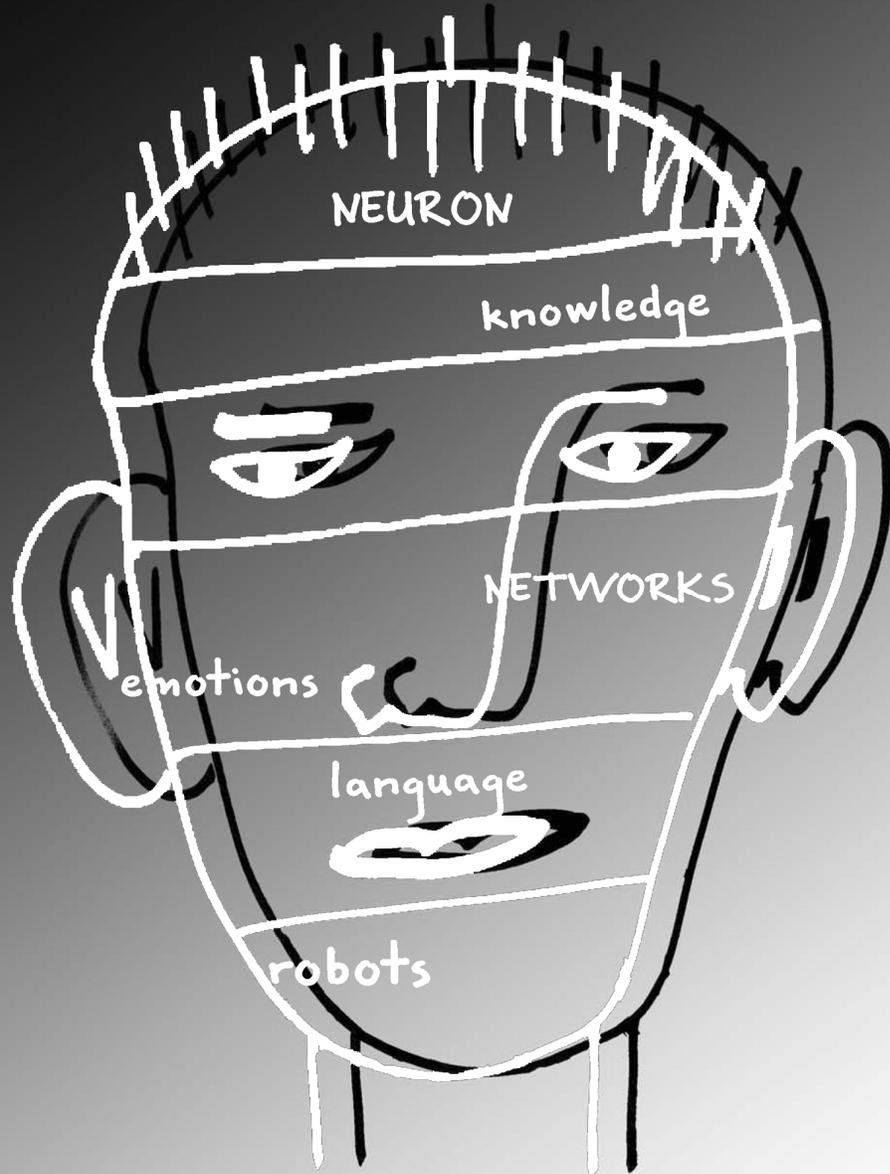
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Two studies were conducted to support the hypothesis of global and non-specific character of meta-cognitive signals of processing fluency. We postulate that the recognition of grammaticality is based on additive fluency signals related to processing of different stimuli. The fluency signals are indicative of the dynamics of the recognition process. In the first experiment subjects were first presented with grammatical sequences of sounds and were asked to rate new sequences for the grammaticality. During the recognition phase the manipulation was applied in the form of visual presentation of possible and impossible figures. In the second experiment subjects were learning grammatical strings of letters, presented visually and manipulated with grammatical or ungrammatical sequences of sounds. The results show the additive effect of fluency of processing stimuli presented in different modalities. Additional analyses proved that the process is implicit in nature. Both studies were conducted on psychology students aged 19 to 24.

**Keywords:** novelty recognition, implicit learning, fluency, AGL, cross-modal, meta-cognitive signals

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