



International Workshop

Language, Music, and Cognition: Psychological and neurocognitive Modelling of Action, Perception, Processing and Learning.

Thursday, 27th September: **Syntax and Semantics**

10.45 – 11.00 am	opening
11.00 – 11.45 am	Petra Schumacher (University of Mainz/ University of Cologne) <i>Adjusting meaning in real-time</i>
11.50 – 12.35 pm	Steven Frisson (University of Birmingham) <i>Online semantic interpretation during reading</i>
12.35 – 02.00 pm	lunch break
02.00 – 02.45 pm	Andrea E. Martin (University of Edinburgh) <i>Cue-based retrieval interference during sentence comprehension: ERP evidence from ellipsis</i>
02.50 – 03.35 pm	Ina Bornkessel-Schlesewsky / Matthias Schlewsky (University of Marburg/ University of Mainz) <i>Dorsal and ventral streams in language: Puzzles and possible solutions</i>
03.40 – 04.25 pm	Mante S. Nieuwland (University of Edinburgh) <i>ERP evidence for animacy processing asymmetries during Spanish sentence comprehension</i>
04.25 – 04.45 pm	coffee break
04.45 – 05.30 pm	Jutta Mueller (Max-Planck-Institut, Leipzig) <i>First steps towards language: Auditory artificial grammar learning across development</i>
05.35 – 06.20 pm	Gert Westermann (Lancaster University) <i>Experience-dependent brain development as a key to understanding the systematicity of linguistic representations</i>
8.00 pm	informal get-together restaurant / bar will be announced

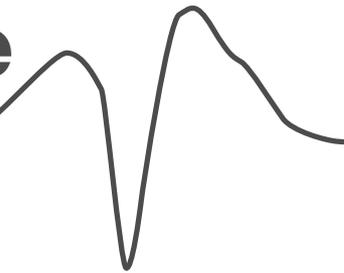
UNIVERSITÄT ZU KÖLN

Research Group Language, Music, and Cognition
lmc.uni-koeln.de



language music cognition

workshop



Friday, 28th September: **Language and Music**

- 10.00 – 10.45 am Barbara Tillmann (Lyon Neuroscience Research Center CRNL)
Music and language structure processing: What is shared?
- 10.50 – 11.35 am Evelina Fedorenko (Massachusetts Institute of Technology)
Syntactic processing in language and music: Existence of overlapping circuits does not imply lack of specialized ones
- 11.40 – 12.25 am Yun Nan (Beijing Normal University)
Cross-domain Pitch processing in music and Mandarin: perceptual and post-perceptual basis
- 12.25 – 02.00 pm ***lunch break***
- 02.00 – 02.45 pm Kazuo Okanoya (Department of Life Sciences / University of Tokyo)
Segmentation in Language and Music: Statistical and Emotional Cues
- 02.50 – 03.35 pm Julie Chobert (Laboratoire de Neurosciences Cognitives, Marseille)
Influence of musical training on the preattentive processing of syllables in normal-reading children and children with dyslexia
- 03.40 – 04.25 pm Daniela Sammler (Max-Planck-Institut, Leipzig)
Neuroanatomical overlap of syntax in music and language
- 04.30 – 05.50 pm ***poster session (coffee break included)***
- 06.00 – 06.45 pm Thomas Bever (University of Arizona, Tuscon)
There are at least two “normal” neurological organizations for language and music.
- 08.00 pm ***informal get-together***
restaurant / bar will be announced

UNIVERSITÄT ZU KÖLN

Research Group *Language, Music, and Cognition*
lmc.uni-koeln.de



language music cognition

workshop

Saturday, 29th September: **Prosody, Sign language, and Gesture**

- 10.00 – 10.45 am Richard Wiese (University of Marburg)
Formal representations of rhythm in speech and music
- 10.50 – 11.35 am Mara E. Breen (Mt. Holyoke College, Mass.)
Empirical investigations of the role of implicit prosody in sentence processing
- 11.40 – 12.25 pm Martha Tyrone (Haskins Lab, Long Island University – Brooklyn)
Prosody and Limb Movement in American Sign Language
- 12.25 – 02.00 pm ***lunch break***
- 02.00 – 02.45 pm Markus Steinbach (University of Göttingen)
When gestures become signs - The integration of gestures into sign languages
- 02.50 – 03.35 pm Ulrike Domahs (University of Marburg)
Language specific processing of word prosody

coffee break / departure of attendees

UNIVERSITÄT ZU KÖLN

Research Group *Language, Music, and Cognition*
lmc.uni-koeln.de



There are at least two “normal” neurological organizations for language and music.

Thomas G.Bever¹

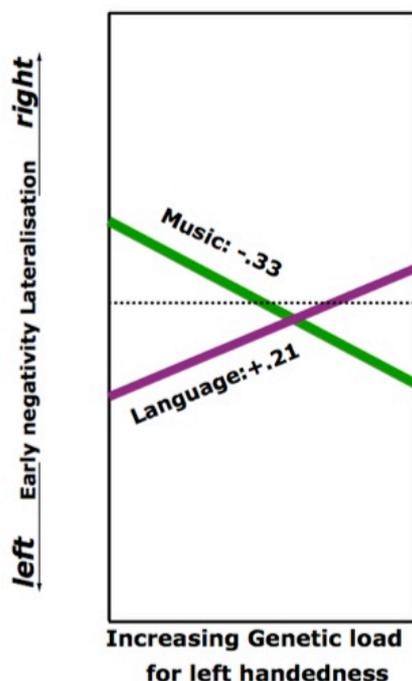
(with Daniela Sammler², Roeland Hancock¹, Angela Friederici²)

¹University of Arizona, USA, ²MPI for Human Cognitive and Brain Sciences, Leipzig

Sixty years ago, A. Luria noted that right handers with familial left handedness (FS+) recover from left-hemisphere aphasia relatively fast, and show crossed aphasia (right hemisphere lesion) more often than people with only right-handed family members (FS-). Since roughly 40% of people are FS+ this is a significant finding. We report on recent behavioral and imaging studies exploring the possible neurological basis for the effect of familial handedness on language and music in right- handers. Our research (with right handed non-musicians) so far has shown:

- It is possible to construct a genetic model of the genetic load for left handedness (GLLH), based on 4,000+ 3-generation family handedness pedigrees.
- FS+ right handers show selectively greater right hemisphere early EEG activation to individual target words, as a function of their GLLH.
- FS+ right handers show a smaller ELAN than FS- right handers, when hearing phrase-building lexical violations (The trumpet was in-the **blown**)
- FS+ right handers show a smaller ERAN than FS- right handers, when hearing a musically odd sequence: (I, IV, V, VI.)
- FS- subjects show a strong differentiation between the ELAN for language violations and the ERAN for music violations. FS+ subjects do not show a consistent pattern.
- The correlation between GLLH is towards an ERAN for language and towards an ELAN for music. That is, the more likely a right hander is to have been left handed, the more likely s/he shows an opposite pattern from the usually assumed pattern. (See graph).

The most interesting consideration is that there is normal wide variation in how language and music are represented neurologically: this supports the idea that such capacities are not the result of a universal fixed set of neurological structures. Rather, the neurological organization of such skills is variable depending on more global aspects of an individual's cerebral organization.



**Opposite effect
of genetic load
for left handedness
on Early Negativity
Lateralization
in music vs. language.**

Dorsal and ventral streams in language: Puzzles and possible solutions

Ina Bornkessel-Schlesewsky¹ and Matthias Schlewsky²

¹*University of Marburg*, ²*Johannes Gutenberg-University Mainz*

The dorsal and ventral streams have attracted a considerable amount of attention as possible pathways of speech/language processing. However, existing approaches posit mutually incompatible functions for individual streams (e.g. form-to-meaning mapping vs. local syntax for the ventral stream), and raise questions regarding basic assumptions of brain function (e.g. hierarchical processing; correspondence between space and time).

In this presentation, we will describe several puzzles posed by current approaches and will discuss potential solutions. Specifically, we will outline a new dorsal-ventral framework for language comprehension based on an extension of the extended Argument Dependency Model (Bornkessel & Schlewsky, 2006) in which the ventral stream performs conceptual processing, including time-independent concept unification, while the dorsal stream engages in the time-dependent combination of elements. Language-inherent processing mechanisms are confined to temporal regions, with frontal cortex accomplishing more general aspects of cognitive control in the service of action planning/execution. This architecture helps to resolve a number of theoretical and empirical puzzles within the existing dorsal-ventral pathway literature as well as generating novel – and sometimes surprising – hypotheses (e.g. regarding the neural bases for syntactic structure building).

Empirical investigations of the role of implicit prosody in sentence processing

Mara Breen

Mount Holyoke College, South Hadley, MA; mbreen@mtholyoke.edu

Recently, psycholinguistics has seen an increase in the number of empirical studies investigating the role of implicit (silent) prosodic representations in reading. Many of these studies purport to investigate Fodor's (2002) Implicit Prosody Hypothesis, which maintains that even during silent reading, readers generate representations of sentence phrasing and stress, and that these representations can affect readers' interpretation of the text (cf., Bader, 1998). In this talk, I will describe two lines of research exploring the role of implicit prosody in sentence processing. The first set of studies, from behavioral and event-related potential (ERP) studies, demonstrates that readers form an implicit metrical representation during silent reading (Breen & Clifton, 2011). Specifically, we observe that syntactic analysis which requires concurrent metrical reanalysis (as in (1a)) is more costly than syntactic analysis alone (as in (1b)), as evidenced by longer reading times and waveform differences (i.e., longer reading times, and a larger left-anterior negativity (LAN), on the disambiguating material in (1a) than (1b)). The second set of eye-tracking studies explores the extent to which sentence length affects readers' comma preferences during silent reading. In these studies, we demonstrate that the longer the material before or after a comma, the more helpful the comma is, as evidenced by shorter reading times on the region following the comma (i.e., shorter reading times on *and I'll* in (2d) than any other condition). I will argue that these and other results suggest that prosodic factors like phrasing and stress can influence online sentence interpretation. In the final section of the talk, I will discuss several proposals about the purpose of implicit prosody and the implications these results have for theories of sentence processing.

(1)

- a) The famous **recall** *their coverage* in the press.
- b) The famous **study** *their coverage* in the press.

(2)

- a) You will wash the **dishes** *and I'll* dry them.
- b) You will wash the **dishes**, *and I'll* dry them.
- c) You will wash the **dishes** *and I'll* dry them when you're done.
- d) You will wash the **dishes**, *and I'll* dry them when you're done.

Bader, M. (1998). Prosodic influences on reading syntactically ambiguous sentences. In J. Fodor & J. Ferreira (Eds.), *Reanalysis in sentence processing* (pp. 1–46). Dordrecht: Kluwer.

Breen, M. and Clifton, C., Jr. (2011). Stress matters: Effects of anticipated lexical stress on silent reading. *Journal of Memory and Language*, 64 (2), 153-170.

Fodor, J. D. (2002). Prosodic Disambiguation in Silent Reading. In NELS 32: Proceedings of the North Eastern Linguistics Society, vol. 1, Masako Hirotsu, ed., Amherst, Mass.: GLSA, University of Massachusetts, Amherst, 113-132.

Influence of musical training on the preattentive processing of syllables in normal-reading children and children with dyslexia.

Julie Chobert & Mireille Besson

Laboratoire de Neurosciences Cognitives, CNRS & Aix-Marseille Universités.

We conducted four studies to examine the influence of musical expertise and musical training on preattentive processing of syllables in normal-reading children and in children with dyslexia. Children were presented with a sequence of syllables that included standards (syllable “Ba”) and deviants in vowel duration, vowel frequency and Voice Onset Time (VOT), either close to or far from the standard (small and large deviants). Children were asked to watch a silent movie without paying attention to the sounds. We analyzed the Mismatch Negativities (MMNs) elicited by the different deviants.

The comparison of musician and non-musician children showed enhanced pre-attentive processing of duration and VOT with musical expertise. Next, we conducted a longitudinal study with non-musician normal-reading children to examine the causal link between musical training in 8-year-old children and facilitation in the pre-attentive processing of speech sounds. On the basis of results before training, that included both standard neuropsychological tests and electrophysiological measures (MMN), children were pseudo-randomly assigned to music or to painting training programs. After 6 months and after 12 months of training, they were tested again by using the same tests. Results showed that 12 months of musical but not of painting training enhanced the pre-attentive processing of duration and VOT of speech sounds in non-musicians children. We concluded that these effects were causally related to musical training and did not only result from genetic predisposition for music.

By contrast to musician children, children with dyslexia showed deficits of preattentive processing of syllable duration and VOT. Importantly, six months of musical training improved the preattentive processing of VOT in children with dyslexia, suggesting that musical training can be considered as an aid for the phonological remediation of dyslexia.

Musical training, by improving children’ sensitivity to acoustic parameters (e.g., duration) in music and speech (common processes), possibly also enhances their sensitivity to associated phonological parameters (e.g., VOT). This in turn allows for the building up of more robust phonological representations (transfer of training effects from music to speech processing).

Language specific processing of word prosody

Ulrike Domahs

Philipps-University of Marburg, Germany

This contribution presents neurolinguistic data on stress perception in German, Cairene Arabic, Russian, and Turkish. The main objective is to investigate how different properties of metrical systems are reflected in the mental representation of words and in the processing of stress information. In this respect, the factors lexicality, predictability and metrical structure are studied in languages for which we expect these factors to play different roles.

In order to test the effects of lexicality, predictability, and structure on the processing of stress manipulations, i) languages with predictable (Turkish; Kabak & Vogel, 2001 and Cairene Arabic, Watson, 2002) are compared with languages exhibiting lexical stress (Russian; Melvold, 1990 and German; Wiese, 1996) and ii) languages with metrical structure (German and Cairene Arabic) are compared with those for which the existence of structure is under debate (Russian and Turkish). The given sample of languages allows us to investigate whether the representation and processing of stress depends mainly on the presence or absence of lexical stress specifications or also on the metrical structure of words.

In a series of experiments utilizing event-related potentials (ERPs), native speakers of Turkish, German, Russian, and Cairene Arabic were presented with bisyllabic or trisyllabic words which were either correctly or incorrectly stressed. Participants were instructed to judge the correctness of the perceived stress items. Behavioral data revealed that speakers of Turkish were less accurate in their evaluation of stress patterns than speakers of the other three languages. With respect to the ERP data, a P300 reflecting task specific processes was found for Turkish only if non-default stress patterns were involved in violations, for German and Cairene Arabic if stress shifts lead to foot structure violations, and for Russian in each violation type. Thus, the results of the ERP experiments show that sensitivity to stress shifts can be reduced depending on the language-specific predictability of word stress and on the metrical structure in which strong and weak syllables are organized. Moreover, it will be discussed how different latencies of ERP effects are correlated with language specific processing of prosodic cues.

References:

- Kabak, B., Vogel, I. 2001. The phonological word and stress assignment in Turkish. *Phonology*, 18, 315-360.
- Melvold, J. (1990) Structure and stress in the phonology of Russian. Doctoral Dissertation, MIT.
- Watson, J. C. E. 2002. *The phonology and morphology of Arabic*. Oxford: Oxford University Press.
- Wiese, R. 1996. *The phonology of German*. Oxford: Oxford University Press.

**Syntactic processing in language and music:
Existence of overlapping circuits does not imply lack of specialized ones**

Evelina Fedorenko
Massachusetts Institute of Technology, Boston

Over the last several years, a number of behavioral, ERP, MEG, and fMRI studies have argued for overlap in processing musical and linguistic structure (e.g., Patel et al., 1998; Maess et al., 2001; Koelsch et al., 2002; Koelsch et al., 2005; Fedorenko et al., 2009; Slevc et al., 2009; Hoch et al., 2011; see e.g., Koelsch, 2005, Slevc, 2012, or Tillmann, in press, for reviews). The presence of this overlap in cognitive/neural mechanisms that support syntactic processing in music and language is sometimes taken as evidence against functional specialization in each domain. However, the presence of overlapping circuits in no way bears on whether additional specialized circuits exist (e.g., Patel, 2003). Indeed, double-dissociations between high-level linguistic and musical processing in patients with brain damage suggest at least some degree of independence between these two domains (e.g., Luria et al., 1965; Peretz, 1993; Dalla Bella & Peretz, 1999; Peretz & Coltheart, 2003). I will summarize recent fMRI evidence for functional specialization for linguistic and musical structural processing. In particular, we find a number of brain regions in the left frontal and temporal lobes that robustly respond to the presence of structure in the linguistic signal that show little or no response to musical structure (Fedorenko, Behr & Kanwisher, 2011; also Rogalsky et al., 2011). Furthermore, we find several regions in the temporal cortices that respond to the presence of structure in music that are not sensitive to linguistic structure (Fedorenko, McDermott, Norman-Haignere & Kanwisher, submitted). I will further argue that the overlap that has been observed between syntactic processing in language and music arises within a highly domain-general fronto-parietal network, the “multiple demand” network (e.g., Duncan, 2010), which includes parts of Broca’s area (Fedorenko, Duncan & Kanwisher, in press). I will conclude with some hypotheses about the roles of the specialized vs. domain-general regions in syntactic processing in each domain.

On-line semantic interpretation during reading

Steven Frisson

School of Psychology, University of Birmingham

In order to understand what we're reading, we need to activate the semantics of the words we encounter. Given how fast and seemingly effortlessly we process language, with average reading speeds of around 250 words a minute, what is it that ensures that we get to the right interpretation of a word so quickly? I will discuss research on polysemous words, which are words with multiple interpretations that are semantically related to each other (in contrast to words like *bank*, which have multiple unrelated interpretations). For example, *Vietnam* in *They protested during Vietnam* is used metonymically to refer to the event that happened at that place. Other examples include words like *book*, which can refer to an object, as in *The book is stained*, or to the content, as in *The book is scary*. Findings from this research suggest that at the earliest stages of processing, we don't seem to make a distinction between different established interpretations and instead of activating a specific interpretation, readers tend to use a semantically underspecified meaning which encompasses all known senses. As a result, semantic processing can proceed much more flexibly and misinterpretations are an exception rather than rule-governed. In addition to these findings, I will present data on how novel interpretations of a word are learned on-line, and how readers switch between senses of a word (e.g. ...the scary book is stained).

In the second part, I will discuss data on complement coercion (as in *began the book*). In these constructions, there is a mismatch between the requirements of the verb (*begin* requires an event) and the semantics of the noun (*book* is an object), which makes a straightforward compositional interpretation of the expression impossible. Instead, additional semantic structure needs to be generated in order to arrive at an event interpretation of the complement, and this is a costly process. I will show that an alternative explanation, i.e. that the effect is related to competition between different interpretations, is unlikely. In addition, I will present data that suggest that comparable operations are in play even in constructions that do not need to be coerced.

Cue-based retrieval interference during sentence comprehension: ERP evidence from ellipsis

Andrea E. Martin

Department of Psychology, PPLS, University of Edinburgh

Successful language use requires access to products of past processing in an evolving discourse [1]. The role of memory variables during language processing then becomes central to a neurocognitive theory of language. Under cue-based retrieval accounts, linguistic dependency resolution (e.g., retrieving antecedents) is subject to interference from other information in the sentence, especially information that occurs between the words that form the dependency (e.g., between antecedent and retrieval site) [1, 2]. Retrieval interference may then shape processing complexity as a function of the match of information at retrieval with the antecedent versus other recent or similar items in memory - one way to characterize this relationship between the retrieval cue, the antecedent, and other representations is by how *diagnostic* a cue is to a unique antecedent in memory [3]. However, little is known about how the content and structure of the linguistic information that is already in memory determines how diagnostic a cue is.

To address these issues, we recorded ERPs while native speakers read sentences containing noun-phrase ellipsis (NPE) in Spanish, a language with frequent morphological gender agreement. NPE was indicated by the determiner *otro/a* ('another') [cf. 4], which had correct or incorrect grammatical gender with respect to their antecedent nouns. In a relative clause modifying the antecedent, another (structurally unavailable) noun occurred, and matched antecedent gender half the time (i.e., a local agreement attractor). In contrast to extant P600 results on agreement violations, and inconsistent with predictions from neurocognitive models of sentence processing, grammatically incorrect determiners evoked a sustained, broadly-distributed negativity between 400-1000ms, possibly related to sustained negativities observed for referential processing difficulties. Crucially, this effect was modulated by the attractor: an increased negativity was observed for correct determiners that did not match the attractor gender, suggesting that structurally unavailable nouns were at least temporarily considered for or intruded upon correct ellipsis.

Experiment 2 asked if changing the syntactic structure of the information in memory affects measures of retrieval interference; we changed the intervening material to an object-extracted relative clause. A reliable interaction occurred on the determiner between 100-400ms; no main effects. Correct conditions differed from one another, but, in contrast to Experiment 1, an increased negativity was observed for correct determiners that matched the attractor gender. In the Attractor-different conditions, the Incorrect condition was more negative than Correct. On the post-determiner word between 700-900ms, the interaction and pairwise effect pattern seen in Experiment 1 was replicated on the P600 component.

These datasets constitute the first ERP evidence that cue-based retrieval interference occurs even under grammatical circumstances, and suggest that agreement and structural information form a composite retrieval cue. We take the patterns seen in both experiments to suggest that structural aspects of the current contents of memory determine what 'counts' as diagnostic and therefore modulate the ERP signature of retrieval interference.

Stimuli: Marta se compró la camiseta... (<i>Marta bought the t-shirt that...</i>)	
<u>Experiment 1</u>	<u>Experiment 2</u>
[que _estaba al lado de [<u>la falda/de</u> <u>jersey</u>]] y Miren cogió otra/*otro [...] para salir de fiesta.	[con la que [<u>la falda/el jersey</u>] iba bien_] y Miren cogió otra/*otro [...] para salir de fiesta.
(..._was next to the skirt/sweater and Miren took another to go the party.)	(...the skirt/sweater went well with_ and Miren took another to go the party.)

[1] McElree, B., Foraker, S. & Dyer, L. (2003). *JML*, 48, 67-91.

[2] Lewis, R. L., Vasishth, S., and Van Dyke, J. A. (2006). *TiCS*, 10:44-54.

[3] Nairne, J.S. (2002). *Memory*, 10, 389-395.

[4] Eguren, L. (2010). *Lingua*, 120, 435-457.

**First steps towards language:
Auditory artificial grammar learning across development**

Jutta Mueller

Max-Planck-Institut for Human Cognitive and Brain Sciences, Leipzig

Artificial grammars are an established model to simulate the learning of different aspects of language in the laboratory. While grammars containing adjacent dependencies between linguistic units are robustly learned by young infants and adults, this is not the case for grammars containing non-adjacent dependencies, which are the foundation of complex grammar in human language. I will present behavioral and electrophysiological studies in adults and infants that tested stimulus-related and learner-related conditions under which non-adjacent dependencies can be learned from exposure to speech. The results suggest that the ability to learn non-adjacent dependencies depends on both input characteristics (e.g. phonetic saliency, task) and learner characteristics (e.g. phonological ability, developmental stage). I will discuss the possible impact of interindividual differences and neurocognitive development on grammar learning and how this relation may be generalizable to domain-general perception and learning.

ERP evidence for animacy processing asymmetries during Spanish sentence comprehension

Mante S. Nieuwland

Department of Psychology, University of Edinburgh, Scotland UK

Introduction: In many languages of the world, some direct objects receive morphological case marking whereas others remain unmarked (differential object marking; e.g., [1]). In Castilian Spanish, animacy is among the most important features that controls object marking: for definite and/or specific objects the differential object marker, the preposition 'a', is required if the object is animate (1a/b, N.B. 'a + el' is contracted into 'al'), whereas its use is ungrammatical for inanimate objects (2a/b).

(1a/b) *El papa besó **al**/***el** obispo en un gesto de bienvenida.*

(2a/b) *El papa besó **el**/***al** suelo en un gesto de bienvenida.*

(1a/2a) *The pope kissed the bishop/floor in a welcoming gesture.*

In an ERP study, we investigated the processing consequences of correctly marked animate or inanimate objects, as compared to incorrect ones. Unmarked animate and marked inanimate objects might evoke case reanalysis and as such both elicit P600 effects, as observed for grammatical violations. However, absent case marking on animate objects (but not present case marking on inanimate objects) might also incur a problem with thematic interpretation because the object and subject are equally agentive [2-3], eliciting an N400 effect [4].

Methods: We created 120 Spanish sentence quadruplets that crossed object marking (marked-al/unmarked-el) with animacy (animate/inanimate). Animate/inanimate critical words were matched for frequency, familiarity, imageability and concreteness. In a pre-test, marked-animate and unmarked-inanimate sentences were rated as equally plausible. In the ERP experiment, 16 native Spanish speakers read 120 experimental sentences (30 per condition) word by word, mixed with 60 plausible fillers, from 4 counterbalanced lists. A comprehension question followed 1/3 of the sentences.

Results: Marked inanimate objects elicited a P600 effect compared to unmarked inanimate objects (*al suelo vs. el suelo), whereas unmarked animate

objects only elicited an N400 effect compared to marked animate objects (*el obispo vs. al obispo).

Conclusion: We interpret these results as indexing thematic distinctness of sentential arguments (e.g., [5]). Difficulty with assignment of thematic roles arose in sentences with animate objects, but not with inanimate objects because argumenthood can be diagnosed via the animacy contrast with the subject. Our results are consistent with earlier reports on the processing of case conflict and the role of animacy in its resolution, except for the absence of P600 modulation for animate objects. This discrepancy will be discussed with regard to task-demands, as well as related to the differential impact of neglecting versus overextending a grammatical rule (see also [6]).

References: [1] Bossong, G. (1991). Differential object marking in Romance and beyond. in D. Wanner and D. Kibbee (eds) *New Analyses in Romance Linguistics: Selected Papers from the XVIII Linguistic Symposium on Romance Languages, Urbana-Champaign, April 7-9, 1988*. Amsterdam: John Benjamins.

[2] García García, M. (2011): Attributive subjects and case-marked objects: a concatenation of mismatches? In: Elisabeth Stark & Natascha Pomino (Hgg.). *Proceedings of the V Nereus International Workshop "Mismatches in Romance"*. Konstanz: Universität Konstanz, 13-32.

[3] Primus, B. (2011): Animacy, generalized semantic roles, and differential object marking. In: Lamers, Monique / de Swart, Peter (Hrsg.) (2011): *Case, word order, and prominence. Interacting Cues in Language Production and Comprehension*. Dordrecht: Springer, 65-90.

[4] Frisch, S., Schlesewsky, M. (2001). The N400 reflects problems of thematic hierarchizing. *Neuroreport*, 12, 3391–3394.

[5] Bornkessel-Schlesewsky, I., & Schlesewsky, M. (2009). The role of prominence information in the real-time comprehension of transitive constructions: A cross-linguistic approach. *Language and Linguistics Compass*, 3:19–58.

[6] Choudhary, K. K., Schlesewsky, M., Roehm, D., & Bornkessel-Schlesewsky, I. (2009). The N400 as a correlate of interpretively-relevant linguistic rules: Evidence from Hindi. *Neuropsychologia*, 47, 3012–3022.

Segmentation in Language and Music: Statistical and Emotional Cues

Kazuo Okanoya

JST-ERATO Okanoya Emotional Information Project and Department of Life Sciences, The University of Tokyo, JAPAN.

Segmentation of ongoing acoustic stimulus is a crucial step towards acquisition, comprehension, and appreciation of language and music. Because of shared faculties between language and music, understandings of this process would help our theoretical construction of language emergence and evolution. Using birds and humans, we show that statistical cues are processed by the basal ganglia and the pre-frontal cortex. In the early part of segmentation learning, the basal ganglia and the anterior cingulate cortex work together to conduct trial-and-error learning and in the later part the pre-frontal cortex performs top-down processing. Emotional modulation would supplement and facilitate the segmentation learning and we suggest that the ending form in classical music, Cadenza, may be a formalized version of emotional modulation. We measured evoked brain responses for weak and strong ending forms and found that these can provide punctuations to music. As a comparative data, we performed amygdala lesions in male mice showing modified syllable constructions in courtship songs. Additional considerations would be given validity and limitations in artificial grammar learning paradigm in relation to phonological and syntactical pattern learning. Results reinforce the idea that emotional modulation and statistical cues facilitate segmentations and these processes may be common grounds on which music and language stand. (Work supported by JST-ERATO and MEXT)

Shared but not the same: Co-localizing syntax in music and language

Daniela Sammler

Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

Institute of Neuroscience and Psychology, Glasgow, UK

Despite general agreement on shared syntactic resources in music and language, the neuroanatomical underpinnings and the extent of this overlap remain largely unexplored. Particularly, the demonstration of the necessity of “language areas” for musical syntax processing and the comparison of syntactic operations in music and language within subjects remain sparse. We addressed these questions (1) by probing whether patients with lesions in Broca’s area exhibit deficits in processing musical syntax, and (2) by co-localizing syntactic processes in music and language (i.e. within-subject) in the temporal lobe of epilepsy patients using subdural EEG recordings. The lesion data show that Broca’s area is relevant, but not sufficient, for the processing of syntactic irregularities in music. The subdural recordings show considerable overlap of the music and language networks in the superior temporal lobe, but also differences in the hemispheric timing and relative weighting of fronto-temporal network constituents. Both these studies illustrate that syntactic processes in music and language partly share functional and neuroanatomical characteristics, but are not the same.

Adjusting meaning in real-time

Petra B. Schumacher

University of Mainz / University of Cologne, Germany

Propositional content is often incomplete but comprehenders appear to effortlessly enrich interpretation, adjust meaning and infer the speaker's intended meaning (as in the a-cases in the examples below).

- (1) a. The ham sandwich wanted to pay.
b. The ham sandwich was delicious.
- (2) a. My grandmother read Goethe.
b. My grandmother met Goethe.
- (3) a. The wooden turtle was next to the globe.
b. The wooden trunk was next to the couch.
- (4) a. The decision was merciful.
b. The monk was merciful.

In this talk, I explore the time-course of the mechanisms that are involved in meaning selection and meaning shift. The following issues will be addressed: i) What is the contribution of context to meaning shift? ii) To what extent does the availability of cognitive routines influence meaning composition? iii) What is the role of the target of meaning shift in cases of predicate and reference transfer respectively?

I present data from event-related brain potential studies that support a two-stage architecture and indicate that context information facilitates early stages of comprehension but absence of contextual support cannot block subsequent pragmatic operations involved in meaning shift. This is particularly pertinent to the reference transfer exemplified by (1a) since its dependence on contextual licensing has been discussed controversially in the literature (Nunberg 1995; Recanati 2010). Cognitive routines also modulate the underlying processes revealing an advantage for more typically available meaning shift (2a), confirming previous findings from the eye-tracking literature (Frisson & Pickering 1999). Yet, the ERP data also show processing differences for this type of meaning shift when context information is kept minimal. A further processing distinction emerges for predicate and reference transfer, suggesting that the former (4a) is subject to meaning selection. Type composition logic appears to be a promising starting point to account for these patterns in a uniform manner.

When gestures become signs - The integration of gestures into sign languages

Markus Steinbach
University of Göttingen, Germany

Sign languages, like spoken languages, are subject to diachronic changes due to external and internal factors. Recent studies on grammaticalization in sign languages have shown that, for the most part, the attested grammaticalization pathways are modality-independent (for overviews see Pfau & Steinbach (2006, 2011) and Janzen (2012)). In both modalities, lexical elements may diachronically develop into grammatical markers. These changes are typically characterized by desemanticization, decategorization, and phonological erosion. In addition to these familiar pathways from a lexical to a grammatical element, sign languages have the unique possibility of integrating and grammaticalizing manual and nonmanual gestures. Since gestures use the same articulatory channel that is also active in the production of signs, it is not uncommon for manual and nonmanual gestures to become grammaticalized in sign languages. Hence, the visual-gestural modality of sign languages, unlike the oral-auditory modality of spoken languages, offers the unique property of integrating and grammaticalizing manual and nonmanual gestures.

In this talk, I focus on the interface between gesture and language and the specific functions grammaticalized gestural elements express in sign languages. Manual gestural elements used in sign languages are, for instance, pointing signs, question markers, and classifier handshapes. These markers are frequently used in many different sign languages. Classifiers, for example, have a completely different origin in spoken and sign languages. In spoken languages, classifiers can develop (possibly via incorporation) from nouns such as 'branch', '(wo)man', and 'piece'. By contrast, in sign languages, classifiers do not originate from nouns but result from a modality-specific grammaticalization process. Classifier handshapes reflect the handling or the shape of objects in the real world. Still, they are clearly grammatical elements in that they can be argued to form a closed inflectional paradigm and license certain grammatical processes. Likewise, question markers and pronominal pointing signs have developed from corresponding gestures used in the surrounding hearing and deaf community.

The development of nonmanuals is another interesting modality-specific property of sign languages. Nonmanual markers such as eyebrow movements (for questions and topics), squint (for shared information), and body shift (for reported speech) fulfill various intonational and semantic/pragmatic functions in sign languages. These markers also evolved from culture-specific nonmanual gestures used in the hearing and deaf community. In their sign language use, these nonmanual markers are again subject to specific grammatical restrictions: they have a clear onset and have scope over clearly defined syntactic domains. The eyebrow raise, which marks yes/no-questions, conditionals, and topicalized constituents, has, for instance, developed from a corresponding non-linguistic gesture. Likewise the squint, which signals shared knowledge, has evolved from an affective facial expression used in the hearing and deaf community. And finally the development of body shift into a nonmanual grammatical device systematically marking reported speech is also a modality-specific characteristic of many sign languages. This device has developed from the modality-independent ability of speakers and signers to use a shift of the upper part of the body (accompanied possibly by a change of eye gaze, voice quality, and/or facial expression) to shift into another character or perspective in discourse and narration.

Music and language structure processing: What is shared?

Barbara Tillmann

Lyon Neuroscience Research Center

For music and language, structured systems have been described, and cognition research has investigated how perceivers process these structures, build up knowledge and develop expectations for future events. Research findings have led to the hypothesis of shared resources for syntactic processing of both types of structures, which motivated new experimental approaches testing patient populations or cross-modal paradigms.

However, in contrast to language, musical structures of the Western tonal musical system are strongly correlated with acoustic structures and similarities. This feature thus requires the use of controlled experimental material to allow revealing knowledge-based structure processing rather than sensory memory-related processing, which would provide a more parsimonious explanation of the observed effects. In addition, more recent research extended the observation of interactive influences between music-syntactic processing and linguistic-syntactic processing to interactions with semantics, action and arithmetic processing. These findings suggest the hypothesis of shared resources for more general, structural and temporal integration and highlights the need to go beyond the comparison of two material types to investigate brain functioning.

Prosody and Limb Movement in American Sign Language

Martha E. Tyrone

Haskins Laboratories and Long Island University - Brooklyn, USA

American Sign Language (ASL) is a natural, signed language used by Deaf people in the United States and Canada. (The term 'Deaf' refers to the community of ASL users rather than to clinical hearing loss.) Unlike spoken languages, signed languages use the hands and arms as their primary articulators, and signs are perceived visually rather than auditorily. While researchers have been studying the linguistic structure of signed languages for several decades, investigation of the physical/articulatory structure of the language has been more limited. This study examines the structure of ASL using the theoretical framework of articulatory phonology, which proposes that the basic units of speech are articulatory gestures. Thus, according to this theory, the articulatory and linguistic structure of spoken language are inter-related. We hypothesize that articulatory gestures are also the structural primitives of signed language, and we are investigating what the gestures are and how they are timed. For this study, sign production data were collected using an optical motion capture system that tracked the positions of the arms, head, and body over time as Deaf signers produced ASL phrases. The signers were asked to produce specific target signs occurring in various phrase positions. The target signs included movements either toward or away from the body, allowing us to compare superficially-similar but linguistically-distinct movement phases: as the arm moves toward a location on the body, spends some time at that location, and then moves away from the body. Our findings suggest that signs, like spoken words, are lengthened at phrase boundaries in a manner consistent with the predictions of a task-dynamic model of prosodically-induced slowing. These findings could ultimately assist with the automatic parsing of American Sign Language or other signed languages.

Experience-dependent brain development as a key to understanding the systematicity of linguistic representations

Gert Westermann

Department of Psychology, Lancaster University

An influential view of the nature of the language system is that a system of rules (grammar) is combined with a lexicon that contains the words of the language together with, depending on the particular viewpoint taken, a more or less rich representation of their context. Alternative views, often based on connectionist modelling, attempt to explain the structure of language on the basis of complex associative processes. The English past tense has emerged as a focus for the exploration of different language theories because here we find a model system for language as a whole: regular past tense forms (such as look-looked) appear to be generated by a rule process and irregulars are memorized, thereby creating a system of rules and exceptions.

Here I extend work on the English past tense by considering the shortcomings of both the words-and-rules and the connectionist approaches. I argue that the adult language system cannot be understood properly unless we consider how it has arisen through development. The recently emerging field of cultural neurolinguistics acknowledges that a specific language environment shapes the brain structures responsible for processing this language in an experience dependent way. Taking on board the importance of experience dependent brain development I describe a 'neuroconstructivist' connectionist network model of past tense acquisition, adult processing and impaired processing after brain damage, and I show how it can account for the empirical data better than static, non-developmental models of either theoretical persuasion. This model puts experience dependent brain development in response to a specific language environment at the heart of understanding not only language development but the systematicity of adult language processing as well.

Formal representations of rhythm in speech and music

Richard Wiese

Philipps-University of Marburg, Germany

The Metrical Organization Hypothesis as proposed by Liberman (1975: 313) claims that "All temporally ordered behavior is metrically organized." If true, the hypothesis leads to the question what the commonalities and differences of metrical organization across different domains of behavior are. This contribution will discuss this question for language and music and compare these two domains.

The formal theory of rhythm in music has taken a step forward by the analyses provided by Lerdahl & Jackendoff (1983). They propose a grid theory of rhythm, where beats can be represented by marks on layered levels, and alternations on some level of rhythmical organization are represented by beats on this level which are accompanied by intervening beats on the next lower level.

In Western tonal music, such alternating rhythms are (nearly) completely regular, but it is obvious that this highly constrained rhythmical organization cannot hold for linguistic utterances in general. Thus, rhythm in speech is not regular to the same extent. This observation leads to a reconsideration of a distinction established in studies of musical rhythm: divisive vs. additive types of rhythm. The latter has been found (in various varieties) in European medieval music and in African styles of music. In contrast to a proposal by Liberman (1975), I will pursue the hypothesis that rhythm in speech shares properties with the additive type of rhythm, but not with divisive rhythm as is characteristic for classical European music.

References:

Lerdahl, F., & Jackendoff, R. (1983). *A Generative Theory of Tonal Music*. Cambridge MA: MIT Press.

Liberman, M. (1975). *The Intonational System of English* (Ph. D. dissertation). MIT, Cambridge MA.

Cross-domain Pitch processing in music and Mandarin: perceptual and post-perceptual basis

Yun Nan

*State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal
University, Beijing, China 100875*

Accumulating research shows that pitch processing in tone language and music is closely linked (Bidelman et al., 2011; Wong et al., 2007). However, it is yet clear to what extent and at which levels are these two processes shared. The current talk draws upon recent evidence suggesting that, although pitch processing across music and Mandarin are perceptually related, the observed shared neural substrates might mainly underpin post-perceptual pitch processes, e.g., at levels higher than pitch perception. First of all, experience with lexical tone does not necessarily decrease the occurrence of musical pitch deficits, known as congenital amusia (Nan et al., 2010). Furthermore, not all Mandarin speakers impaired with amusia were also suffering from lexical tone agnosia. Only a small subgroup showed shared pitch deficits across music pitch and lexical tones (Nan et al., 2010). These evidences based on the neurodevelopmental condition of amusia indicate that perceptual pitch impairments in one domain does not necessarily cause overall similar deficits in the other domain. This might be explained by the different manifestations of pitch in music and Mandarin. Alternatively, it also suggests that the link between pitch processing across-domains might not only be perceptual, but also involves high level mechanisms. Our data with Mandarin-speaking musicians corroborates these results from another direction: ERP and fMRI evidence suggests overlapped pitch processing center across domains originating from frontal area, especially the left inferior frontal gyrus (Nan et al., 2009; Nan and Friederici, 2012). More interestingly, our most recent work manipulated pitch deviants either at acoustical (perceptual) or at both acoustical and semantic (post-perceptual) levels across Mandarin and music and found that amusics' music pitch deficits and tone agnosics' shared pitch deficits were present only at post-perceptual, but not at perceptual levels. Overall, from the perspective of pitch processing, this line of work will shed light on the general neural connectivity between music and language as well as the much-debated issue of modularity in music and language.

References

- Bidelman GM, Gandour JT, Krishnan A (2011) Cross-domain effects of music and language experience on the representation of pitch in the human auditory brainstem. *J Cogn Neurosci* 23:425-434.
- Nan Y, Friederici AD (2012) Differential roles of right temporal cortex and Broca's area in pitch processing: Evidence from music and Mandarin. *Hum Brain Mapp*.
- Nan Y, Friederici AD, Shu H, Luo YJ (2009) Dissociable pitch processing mechanisms in lexical and melodic contexts revealed by ERPs. *Brain Res* 1263:104-113.
- Nan Y, Sun Y, Peretz I (2010) Congenital amusia in speakers of a tone language: association with lexical tone agnosia. *Brain* 133:2635-2642.
- Wong PC, Skoe E, Russo NM, Dees T, Kraus N (2007) Musical experience shapes human brainstem encoding of linguistic pitch patterns. *Nat Neurosci* 10:420-422.