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Editorial

Neurobiology of language: Highlights from the second annual meeting

This special issue includes nine contributions from some of the research groups selected to give slide presentations at the second Neurobiology of Language Conference (NLC 2010), held in San Diego, CA, USA on November 10–11. Following in the steps of the first meeting that took place in Chicago in 2009, the second meeting was attended by over 400 scientists, clinicians and students from around the world, who met to discuss issues related to language neurobiology. The range of topics introduced in the meeting, with some highlighted in this special issue, confirms what researchers in the field are coming to understand: that the neurobiology of language is an immensely complex enterprise, as complex as the behavior itself, and that a comprehensive understanding of this domain necessitates strong interdisciplinary links between research in linguistics, psychology, rehabilitation, neurology and neurosciences. We consider NLC as the prime venue for the development of the field of language neurobiology. It is the largest, most inclusive meeting on language; its rapid growth is a reflection of the development of this field of research. The articles in this special issue encompass a wide range of topics, demonstrating the extraordinary diversity of the research questions, ranging from sensorimotor aspects of speech and language (Murakami, Simonyan, Zion Golumbic, Bedny), to plasticity (Bedny), syntactic processing (Bourguignon), syntactic deficits (Wilson), lateralization (Van Der Haegen) and the relation between language comprehension and mood or emotional content (Edigi, Citron).

The first four articles of the special issue focus on the neurobiology of sensory and motor aspects of speech and language mechanisms. The first article, by Murakami, Restle and Ziemann (2012), focuses on the functional anatomy of speech sensorimotor integration mechanisms. Using a paired-pulse TMS paradigm, the authors first demonstrate that connectivity between the lip representation of the left primary motor area and two areas of the left hemisphere involved in speech processing (left inferior frontal area and temporoparietal junction) is enhanced during listening to speech compared to white noise. They then show that TMS-induced (theta-burst) virtual lesions in these areas modulate connectivity amongst these regions. These findings demonstrate that the temporoparietal junction influences primary motor cortex excitability upstream of the inferior frontal area, suggesting that it is involved in transforming sensory information into a motor code for speech. The second article, by Simonyan, Horwitz, and Jarvis (2012), is a review examining the importance of dopaminergic regulation in the control of speech in humans and in songbirds. The authors draw interesting parallels between the two species, including some at the behavioral level – for instance, both species are capable of learning new utterances – but also in the anatomy and functioning of the basal ganglia across species. The authors demonstrate that beyond anatomical differences, in particular at the level of the pallidum,

there exist similarities in the organization of neural pathways between humans and songbirds that relate to learned vocal behaviors. This literature review provides a strong motivation for the development of songbird models for the study of speech and song production. In the third manuscript, Zion Golumbic, Poeppel and Schroeder (2012) develop the hypothesis that the entrainment of endogenous neural oscillations to the temporal structure of speech is a central component of speech perception in general, and particularly that it underlies the ability to select an auditory stream among competitors. The review initially discusses features of the temporal envelope of speech, including the finding that the auditory system is sensitive to fluctuations in speech envelope across multiple time scales. The author then link auditory system findings to similar ones found in other neural systems. The second part of the review outlines a model of how the tracking of the temporal envelope via oscillations at different temporal scales can serve to select an auditory stream out of a noisy environment. The proposed model goes beyond the assumption that stream segregation relies on sensitivity to particular input frequencies or attention to particular location, and suggests that sensitivity to the temporal envelope of various sound sources allows tracking unique streams as these have different profiles of temporal development. The fourth article in this series, by Bedny, Saxe, Pascual-Leone and Dravida (2012), is a research paper examining brain plasticity in sensory (visual) areas in a group of congenitally blind individuals and a group of late blind individuals, using functional magnetic resonance imaging (fMRI). The results show distinct patterns of plasticity in congenitally and late blind participants in the occipital lobe, with congenital, but not late blind participants associated with the recruitment of occipital regions during a sentence-processing task compared to a control (non-language) task. These interesting results suggest a sensitive period in the responsiveness of occipital areas to language.

The next three articles provide new insights into issues in language processing from syntactic processing to language lateralization. The first article of this series, by Bourguignon, Drury, Valois and Steinhauer (2012), investigates thematic reversal anomalies using event-related potentials (ERP). In their study, Bourguignon et al. examine potential ERP differences in the processing of thematic role anomalies in English for different verb types (agents vs. experiencers). Their findings show that anomalies in both types of verbs are associated with a common component –the semantic P600 (sp600), while experiencer-subject verbs were also associated with a unique N400 component not found for the processing of anomalies in the context of agent-subject verbs. These findings reveal the importance of considering verb type in studying the processing of thematic reversal anomalies. The next article, by Wilson, Galantucci, Tartaglia, and Gorno-Tempini (2012), thor-

oroughly reviews the literature on the neural basis of syntactic deficits in primary progressive aphasia (PPA), which has been associated with damages to various cortical structures and white matter tracts. The article discusses the nature of the syntactic deficits associated with the three different variants of primary progressive aphasia (PPA – fluent, semantic and logopedic), and examines structural and functional imaging findings in PPA patients. The data reviewed suggest that syntactic processing is dependent upon integrity of left frontal and posterior perisylvian regions, as well as connectivity between these regions through the dorsal pathway. Anterior temporal regions as well as the ventral pathway linking frontal to temporal language areas, also associated with PPA, appear to be less important for syntactic processing, which is shown by identification of many PPA patients with intact syntactic processing. The third article of this series, by Van Der Haegen, Cai and Brysbaert (2012) reports a neuroimaging (fMRI) study examining the degree of lateralization during language tasks. A word production task and a lexical decision task were used to target, respectively, IFG and ventral occipito-temporal cortex. Participants were all left-handed, but included both left-hemisphere and right-hemisphere language-dominant individuals. Results show that whereas the production task was associated with strong laterality effects, such effects were weaker for the lexical decision task. Nonetheless, there was a reliable relationship between the degree of laterality in the two tasks.

The last two articles of the issue consist of a research article examining the impact of mood on language processing (Egidi) and a review paper outlining new findings in the study of the comprehension of emotional words (Citron). In the first article, by Edigi and Nusbaum (2012) mood effects on discourse processing were examined using ERP. Specifically, the authors examined brain responses to auditory sentences that communicated positive or negative content in three groups of participants (happy mood, sad mood, neutral mood). They found that semantic content incongruent with participant's moods was associated with a stronger N400 evoked component, and that happy mood was associated with responses that were largely similar to those of neutral mood. Furthermore, it was mainly the negative information that was processed differently as a function of mood. On the basis of these findings the authors argue that current theories of the impact of context on sentential processing should take into consideration the comprehender's affective state during language comprehension. Last but not least, Citron (2012) presents an interesting re-

view on the processing of emotionally-valenced written words. The review focuses on recent EEG and fMRI findings, including the dissociation between early ERP effects associated with arousal and later effects apparently linked to valence, the importance of task relevance to the potential modulation of these ERP effects and fMRI studies identifying sensitivity to the degree of valence and degree of arousal. Drawing on behavioral and fMRI work the review also discusses potential interactions between the dimensions of valence and arousal including fMRI work showing that increasing arousal results in different effects for positive and negative valenced domains, and behavioral works further showing interactions between levels of these dimensions.

This representative snapshot of work presented at the second Neurobiology of Language Conference is a good illustration of the breadth of methods and topics that were discussed at the meeting. Their remarkable diversity illustrates the development of the field of language neurobiology and reveals the enormous variety of novel and important questions addressed as well as many new research techniques and research directions being introduced. In closing, we would like to thank all the attendees for their renewed interest in language neurobiology, as well as everyone who contributed to making the second annual Neurobiology of Language Conference an immense success, including the speakers, debaters, moderators, presenters, abstract reviewers and conference organizers. We hope that the Society for the Neurobiology of Language (SNL) continues to grow, and that its meetings continue to help the development of the neurobiology of language research.

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