J. Child Lang. **37** (2010), 217–228.
Printed in the United Kingdom

REVIEWS

doi:10.1017/S0305000909009441
First published online 17 April 2009

ANGELA D. FRIEDERICI & GUILLAUME THIERRY (eds), *Early language development. Bridging brain and behaviour*. Amsterdam & Philadelphia: John Benjamins, 2008. Pp. 277. ISBN 978-90-272-3475-9.

Research on first language acquisition has led to fundamental questions about the early cognitive processing that underlies linguistic development. In acquisition research, theoretical assumptions regarding issues such as the continuity of the nature of speech processing by young children versus adults have been hard to verify, since infants simply cannot be tested in the same way as adults on their behavioral responses to speech stimuli. Electrophysiological measures are being increasingly used in psycholinguistic studies with children. The edited volume *Early Language Development* aims to 'bridge brain and behaviour' by providing the reader with a selection of the most recent advances in the field of language acquisition research that makes use of 'traditional' behavioral methods combined with Event Related Potentials (ERPs). Papers combining the two have only recently begun to appear in the literature. Editors Friederici and Thierry introduce the topics and outline the goals of the book, and both contribute a research paper to the volume (chapters 5 and 9).

More than providing an overview of recent papers demonstrating the potential of ERP studies, *Early Language Development* aspires to be an introductory volume for researchers who intend to start conducting developmental ERP research. This aim partly determined the structure of the book. The volume opens with a tutorial-style chapter by Männel, introducing ERP methodology to help the inexperienced reader follow the studies in the next chapters at a deeper level. Männel discusses basic ERP data collection and analyses, and gives an overview of different ERP components (amplitude, latency, scalp distribution) as well as several key findings that have been described in ERP studies on language processing with adults (such as Mismatch Negativity, P600 and N400 effects). In addition to this tutorial, the volume contains a glossary and an extensive index, and in the last chapter Poeppel and Omaki provide a discussion of all studies, with a convenient table listing the domain of acquisition, age groups, tasks, languages tested and the ERP responses that were found. All of these tools make this an easy-to-use reference volume, even for those with little to no background.

Early Language Development covers a wide range of (psycho)linguistic subfields: the acquisition of phonetic features (Conboy, Rivera-Gaxiola,

Silva-Pereyra & Kuhl, ch. 2), word segmentation (Kooijman, Johnson & Cutler, ch. 4; Nazzi, Iakimova, Bertoncini, Mottet, Serres & De Schonen, ch. 5), word-form recognition (Thierry & Vihman, ch. 5; Conboy *et al.* ch. 2; Sheehan & Mills, ch. 7), lexical and conceptual semantics in word processing (Friedrich, ch. 6; Sheehan & Mills, ch. 7) and structural learning and processing (Conboy *et al.*; Friederici & Oberecker, ch. 9).

Conboy *et al.* provide a general overview of the behavioral literature and discuss how infants tune into their native language phonetic inventory over the first year of life. In their ERP experiments, Conboy *et al.* find that neural sensitivity to non-native speech sounds persists longer than behavioral discrimination, and that the type of neural response changes over time. This could indicate that ERP data can actually distinguish different levels of sound processing. Moreover, different ERP patterns in the first year of life are argued to be predictive of children's later language development. Both these findings are of great importance for psycholinguistic research in general. Recent studies by Narayan (2006) and Narayan, Werker & Beddor (under review) have indicated that the process of speech category perception might actually not be as straightforward as previous research assumed, because less salient native contrasts may not actually be perceived from birth, but only after some amount of exposure. This would call for an adjusted theory of phoneme inventory development; ERP studies would be a great tool to investigate if more or less salient contrasts are actually processed differently.

Two chapters discuss early word segmentation. Nazzi *et al.* discuss word segmentation in French-learning children. French has a different stress pattern from English, and behavioral studies have indicated that word segmentation in French-type languages (with syllable-based stress) emerges later. The time-course information of ERP data can help distinguish different segmentation strategies (e.g. based on stress versus transitional probabilities) and Nazzi *et al.* conclude that French-learning infants use cues differently from English-learning children. Kooijman *et al.* investigated Dutch-learning infants' word segmentation abilities by comparing their performance in behavioral (head-turn) versus ERP studies. They found evidence for word segmentation at an earlier age based on ERP data than based on behavioral data (7 versus 9 months), thus showing that ERP can be a more sensitive method for detecting emerging cognitive processes.

The papers by Thierry & Vihman, Conboy *et al.* and Sheehan & Mills investigated early word-form recognition in a passive listening task, and all found event-related negativity (200–500 ms post stimulus onset). With this, they may have found a precursor of the N400 effect, which is typically associated with semantic processing in adults, although adult data for direct comparison were not collected. Comparable adult data are often missing in child development studies. Indeed, as Poeppel & Omaki suggest in the last

chapter, it might be critical for the field to establish a normative database of basic EEG and ERP patterns of young children versus adults, to make a comparison with the end-state of language processing in the brain possible at all.

The experiments by Friedrich and Sheehan & Mills investigate the development of lexical semantics by presenting children with picture–word combinations. These studies, as well as Thierry & Vihman's, selected subjects around the age at which the famous 'word spurt' should occur; a phase that children are claimed to reach around age 1;4, or when the lexicon contains about fifty words. However, the existence and timing of the word spurt have been debated. For instance, Bloom (2004) wrote a critical discussion on whether such a word spurt actually exists. The chapters that discuss lexical semantics in this volume find that in the second year of life, an N400-like response is found, and at age 2;6 Conboy *et al*. and Friederici & Oberecker find adult-like N400 responses. These results do not mean that definitive evidence for the existence of a word-spurt stage has been found; but if any such phase would exist due to a reorganization of the brain (or the 'mental lexicon') ERP studies could be the perfect test case for any claim of reorganization made on the basis of behavioral data. A detailed theoretical discussion would have been useful here.

As for the processing of sentence structure, Conboy *et al*. and Friederici describe several experiments in which they find a P600 effect following morphosyntactic violations in children as young as 2;0. The P600 occurring in combination with the ELAN effect (negativity 150–350 ms after stimulus onset occurring mainly at the left anterior electrode sides) are typically associated with syntactic processing in adults. At age 2;6 both an ELAN and a P600 effect can be found, which suggests continuity between children's and adults' syntactic processing. ERP 'passive listening' studies would be a promising tool for testing younger children's responses to structural violations to verify this claim of continuity, since behavioral studies on structural violations often need to rely on yes/no responses without having access to a child's motivation for a response, making it hard to test very young children.

The chapter by Mehler, Endress, Gervain & Nespor gives a good overview of the 'rules-versus-statistical-learning' debate in the literature and on artificial language studies – but a direct link with ERP research on language development is missing. As a chapter discussing structural learning and processing of language, it would perhaps have fit better at the beginning of the book. The same is true for Sheehan & Mills' chapter, which, like the chapter by Conboy *et al*., discusses many linguistic subfields and provides a good overview of previous findings. The chapters are organized in the more 'traditional' way according to linguistic subfield, but this is not necessarily the clearest structure.

The most obvious advantage of brain imaging studies with children is that behavioral output is not required (or even desired). In addition, ERP data provide excellent temporal resolution, which cannot be easily obtained by most behavioral measures. The main disadvantage for studies with young children is that ERP data typically have a high noise rate. For instance, participant movement adds noise to the data, which makes the number of required trials in an experiment high. This is undesirable for infant studies, where subjects get bored, fussy or sometimes fall asleep when an experiment lasts longer.

The main advantages and disadvantages of ERP studies are discussed in the first and last chapters. This is crucial since unfortunately not all papers make the added value of ERP data very clear, which is a weak point of the book. What this volume does not address is the complexity of EEG recordings in general, the difficulties in averaging over the signal, and the different possible methods for analyzing EEG data (see Van Vugt, Sederberg & Kahana (2007) for a discussion of the use of spectral analysis methods). It thus seems somewhat oversimplifying to refer to this book as an introduction on how to design ERP experiments with young children.

Early Language Development demonstrates that ERP data can be used to gain insight in different domains of language acquisition. Despite the fact that a large part of the research in this field typically investigates the (monolingual) acquisition of English, this book discusses several other languages (French by Nazzi *et al.*, Dutch by Kooijman *et al.*, Welsh by Thierry & Vihman, German by Friedrich & Friederici). Additionally, Conboy *et al.* and Sheehan & Mills discuss studies with (English–Spanish) bilinguals. Cross-linguistic and bilingual acquisition studies can benefit most from brain-imaging methods, which might be able to distinguish different processes that take place during the perception and production of different languages.

The wide range of topics and covered languages does not mean that there is no overlap in the different papers in this volume. As acknowledged by the editors, some chapters contain quite a lot of overlap in their discussions of the methodology and previous findings. While this can be useful for readers interested in only some of the chapters, the added value of a volume such as the current one is to have several papers on the same topic grouped together. The overlap of information in several chapters seems redundant at several points, considering that the reader has access to the introductory chapter.

On the final page of the last chapter, Poeppel & Omaki note that 'The experimental situation is at its most interesting when the two types of data go against each other or complement each other' (p. 252). It may be unavoidable for research using relatively new methodology to aim to some extent at replicating or finding further evidence for results that were

obtained with older (in this case, behavioral) methods. However, the papers in this book that really attempt to answer new questions are by far the most interesting ones: for example, Kooijman *et al*. conducted the only study where behavioral and ERP data are directly compared, trying to maximize the possibilities of combining the two methods. Nazzi *et al*. add a cross-linguistic perspective to the investigation of word segmentation using ERP, and Friedrich extensively discusses the predictive power of ERP and the possible nature of the N400 effect. However, other experiments merely provide a confirmation of behavioral results, without clearly linking this to a theory of the mechanisms of language or brain development, for which this volume could have provided an excellent opportunity.

The main question that arises from this book is whether ERP data can really help us reveal the different processing levels of sound, structure and meaning in the developing linguistic system and give us insight into how these levels interact. It seems that ERP research on language development is most fruitful when it is aimed at answering these types of questions. A combination of ERP with behavioral data can show us how behavior is reflected in the brain, and how brain patterns are reflected in behavior. Although *Early Language Development* does not discuss enough methodologicalissues to be a true introduction on how to the use ERP data, and this probably always requires experience in a laboratory setting, some of the best studies in the volume show us exciting future potentials for this field: in particular the possibility to validate theories of cognitive development by combining brain and behavioral studies.

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