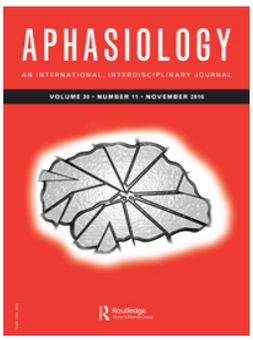

Aphasiology

ISSN: 0268-7038 (Print) 1464-5041 (Online) Journal homepage: http://www.tandfonline.com/loi/paph20

Beyond Chomsky versus Skinner: frequency, language processing and aphasia

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To cite this article: Lise Menn & Roelien Bastiaanse (2016) Beyond Chomsky versus Skinner: frequency, language processing and aphasia, Aphasiology, 30:11, 1169-1173, DOI: 10.1080/02687038.2016.1168920

To link to this article: https://doi.org/10.1080/02687038.2016.1168920

APHASIOLOGY, 2016
VOL. 30, NO. 11, 1169–1173
http://dx.doi.org/10.1080/02687038.2016.1168920

Routledge
Taylor & Francis Group

EDITORIAL

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Introduction

The background for this special issue of *Aphasiology* on Frequency, Language Processing and Aphasia reaches nearly 60 years into the past. In 1959, Chomsky, critiquing Skinner's *Verbal Behavior*, deployed an explosive set of arguments against the behaviourist analysis of language (Chomsky, 1959, 1967). Linguists in increasing numbers lined up behind Chomsky's powerful contentions, and the overall effects were far-reaching. But because behaviourism invoked frequency and probability as explanations and as measures, linguists (who had none of our present tools for getting good numerical information about linguistic events), in endorsing Chomsky, seem to have been convinced for many years that because frequency could not explain everything, it could not explain ANYTHING. Other differences also divided most linguists from most psychologists interested in language (Ervin-Tripp & Slobin, 1966), even after the "cognitive revolution" in psychology (Miller, 2003) was well underway and behaviourism had become history—in particular, psycholinguists attempting to test claims of linguistic theories often found it impossible to keep up with the relatively rapid evolution of those theories, so most of us just gave up on testing linguists' claims and set about trying to understand sentence production and comprehension on our own.

By now, most sub-areas of linguistics and psycholinguistics have rather different goals and different criteria for what constitutes progress towards them. Linguistics wants the "best" description of synchronic grammar (where what "best" means might be "most parsimonious grammar" or "most intuitively satisfying description of data from the largest number of languages" or something in between). And in general, linguists remain much more concerned with the mental representation of linguistic structures than how they are processed by speakers and hearers. Psycholinguistics, on the other hand, wants descriptions of human language processing that give the best approximation of people's responses to a large range of processing demands, over a full range of populations. The importance of this difference will be evident from the papers in this special issue.

One major implication of the work reported here is that psycholinguistics can and should look at the effects of a large set of potentially relevant variables rather than being constrained to considering just the variables that are sanctioned by particular linguistic theories. The variables discussed in this issue include (1) various kinds of morphological and lexical frequency measures—see Bastiaanse, Wieling, and Wolthuis; Baayen, Milin, and Ramscar; (2) expectedness/surprisal/conditional frequency—see Gahl and Menn; Gibson, Sandberg, Bergen, Fedorenko, and Kiran; Van Ewijk and Avrutin and (3) age of acquisition—see Brysbaert and Ellis; Baayen et al.

A second major implication is that because of the brain's capacity for both parallel processing and top-down processing, psycholinguistics is not constrained to the linear

processes suggested by, for example, the concatenation of discrete morphological units —see Duffield; Libben, Jarema, Derwing, Riccardi, and Perlak (2016); Clarke, Bellmann, De Ribaupierre, and Assal (1996) and Sigman and Dehaene (2008).

A third major implication is that psycholinguistics should continue to examine aspects of language processing that have historically been considered to be "heuristic" or "strategic" instead of "linguistic" (i.e., structural): for example, probabilistic (experience-based) predictions of upcoming morphemes, words, structures or interpretations based on statistical likelihood—see Jap, Martínez-Ferreiro and Bastiaanse; Libben et al., (2016); Van Ewijk and Avrutin; or on pragmatics and real-world knowledge—see Gahl and Menn and Jap et al. These probabilistic modes of processing seem likely to be working in parallel with strictly grammar-based parsing processes (in comprehension) or node-expanding processes (in production) in skilled speakers without brain damage, and to be contributing substantially to language processing in people who have limited morphosyntactic knowledge (e.g., children, beginning second language speakers) or limited processing capacity (e.g., adults with brain damage).

Aphasiology, experimentation, data

Clinical linguistics, whether observational or experimental, rubs our noses in messy data, like the variable performances found in many people with aphasia (e.g., sometimes he or she can name a particular picture or appear to comprehend a particular sentence, sometimes not). In addition to these kinds of performance variation, we find another type: variation due to factors that are usually called "non-linguistic", such as those listed in the preceding section—though whether that is an appropriate way to refer to them, we leave to our readers. The nine papers in this Special Issue on Frequency, Language Processing and Aphasia grapple with how language processing is affected by factors other than syntactic and morphological structure.

We group the papers of our contributors into three sets. The papers by Libben et al., (2016) Duffield, and Van Ewijk and Avrutin deal with different aspects of morphology; those by Baayen et al., Bastiaanse et al., and Brysbaert and Ellis concern various factors affecting lexical retrieval; those by Jap et al., Gibson et al. and Gahl and Menn examine factors affecting syntactic retrieval.

Several schools of linguistic thought are represented by these 25 contributors, and the co-editors themselves come from different linguistic traditions. Frankly, that is one of the reasons we are working together: given our differences, readers belonging to different theoretical persuasions should be less tempted to say that this collection must be the orthodoxy of one school, and that therefore they can accept (or dismiss) our various authors' conclusions without a serious critical reading. No potential factor in language comprehension or production should be rejected a priori just because a particular school of thought espouses, ignores or condemns it.

Clearly, a simple anti-structuralist view that lexical or structural frequency alone influences language use in aphasic people is just too simple. It is no more adequate than the view that grammatical factors alone (e.g., degree of embedding, lexical category, derivational history) determine aphasic language use. For example, Van Ewijk and Avrutin show that aphasic behaviour is better predicted by a combination

of inflectional entropy and frequency than by frequency alone. Bastiaanse et al. show that frequency may be a factor in the retrieval of nouns on an object-naming task, but that age of acquisition is a better predictor for retrieval of nouns and both finite and non-finite verbs. However, it is not entirely clear what "age of acquisition" refers to: is it acquisition of the concept, the lemma or the lexeme? This is discussed by Brysbaert and Ellis and by Bastiaanse et al. Baayen et al. contribute to this discussion, advising researchers to be very cautious about using frequency and age of acquisition lists: different corpora use different data sets and, thus, can be poor predictors when a different genre is used.

Age of acquisition and frequency play an important role in contemporary Universal Grammar (UG): the principles of grammar are innate, and only the parameters need to be set. However, parameter setting requires sufficient exposure to relevant data. Therefore, the less frequent a construction is, the later it will be acquired, that is, the later its parameters will be set. This has been used to explain why passives and embeddings in English tend to be lost in agrammatic aphasia: these are low frequency structures that are acquired relatively late. In Standard Indonesian, however, passives are frequent and acquired early. That implies that they should be relatively spared in agrammatic aphasia. This is the topic of the study of Jap et al.

Usage-based (UB) theories (Bybee, 2003, 2006; Goldberg, 2003; MacWhinney, 1999, 2005) take sequential co-occurrence frequency (at all linguistic levels), rather than innate grammar, as the major contributor to the creation of linguistic structures in the learner's mind. Instead of setting parameters, the learner's mind gathers co-occurrence information, learning to predict which items (or categories of items) predict which other ones are likely to occur next or soon. This development of predictive ability is considered to be domain-general rather than language specific; a simple example of its operation is the emergence of the "chunking" of information (Miller, 1956, 2003). Libben et al., (2016) show that phonological subparts of words indeed form chunks that correspond to the component morphemes—and also to suffix morpheme strings. In summary, while sheer lexical frequency does contribute to a word's accessibility (because of its high resting level of activation, in a connectionist model), it is very far from being the only statistical factor involved. Age of acquisition has not yet made an independent appearance in the UB literature, but one can see how it might also play a role.

Higher predictability from the various levels of context demonstrably reduces on-line processing load in both comprehension and production, helping expected forms (and hampering unexpected ones) in their competition with their semantic, morphological and phonological neighbours. So, as Van Ewijk and Avrutin, Duffield, and Gahl and Menn argue, frequency makes complex contributions to the retrieval of words and syntactic structures. It is, for example, the combination of some properties of a verb and the frequency of how these properties are realised on a verb (Duffield) or in a surface linguistic structure (Gahl & Menn; Gibson et al.) that determine how well it can be produced or comprehended by people with aphasia.

The work reported in this issue, then, indicates that aphasiologists need to consider surface structure as well as deep structure in understanding language processing. For those who are concerned that surface structure may be merely epiphenomenal, note that surface structure can be primed (Bock, 1986; Bock & Loebell, 1990; see also Mehler & Carey, 1967). So, surface structure is represented—or perhaps better, instantiated—in the workings of our mental machinery. This

finding does not contradict the assumption that deep structure is also represented in our minds. Information theory tells us that a substantial amount of redundancy is the only way to have a processing system that is reliable and capable of detecting and correcting its own errors. Our brains provide this redundancy by learning much more than they absolutely need to know (Godden & Baddeley, 1975). Nothing currently precludes the coexistence of both innate and learned structures, that is, of the structures posited by UG as well as those posited by UB.

Conclusion

In arguing for a multifactorial, processing-based approach to understanding aphasic deficits (based on the contributions to this Special Issue), we are saying that a synthesis is necessary and that its parameters need to be investigated systematically without claiming that any of them will give the whole story. How the variables discussed in this Special Issue will interact, and what all this will mean for the study of aphasia and the remediation of aphasic language problems will be a matter of research for some time to come, but to begin with, it implies the need for shared large databases of normal and aphasic output across many languages; we urge everyone to contribute video and audio recordings to AphasiaBank (http://talkbank.org/AphasiaBank/). Probabilistic analyses of the uses of words and morphosyntax should offer guidance in constructing tests and exercises with appropriate levels of difficulty for each language of interest. As predictions based on those analyses succeed or fail, we will gather more clues towards the answer to one of the basic questions of aphasia research and of psycholinguistics more generally: What makes some sentences harder than others to say, remember or understand?

Disclosure statement

No potential conflict of interest was reported by the authors.

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