

RESEARCH PLAN

My research program is to understand the fundamental nature of language by using an interdisciplinary approach (e.g., cross-linguistics, cognitive, and neurocognitive), with the goal of determining those characteristics that are universal and those that are specific to particular languages. To really answer this fundamental issue, it is not only necessary to disentangle how different aspects of language (e.g., lexical, semantics, and syntactic) would be processed and represented in different languages, but it is also necessary to understand how these differential levels of linguistic information are coordinated and integrated into the mental representation in different language systems. Thus, a central theme in my research is to examine the cognitive/neurocognitive bases of the way the language-specific properties of languages with topologically distinct writing systems modulate the interaction between syntactic and sequential constraints of a language and the semantic/pragmatic interpretation of linguistic inputs at different levels of cognitive activities. This theme is of practical consequence because the use and integration of semantic and syntactic information in memory have fundamental impacts in the way people interpret meanings from linguistic inputs for comprehension purpose. By studying the cognitive/neurocognitive bases underlying this theme, on the one hand, I hope to precisely specify the nature of cognitive mechanisms and its neural pathways exploited during language integration. On the other hand, I hope to examine how language experience shapes the function of, and the relations between the cognitive mechanisms and their corresponding cortical organization.

The Processing and Representation of Word-to-Referent Integration

My research to date has largely focused on the higher-order processing of language such as sentence and text integration by systematically comparing the language processing between English and Chinese. I use Chinese in my research program because Chinese is a logographic language with specific linguistic properties that could be used to test and refine theories of language processing using patterns that cannot be studied in English where the current theories and models have been built from. An initial step is to examine how the referents are processed and represented from linguistic entities, and how they are retrieved in memory during the word-to-referent integration. In a completed project (Yang, et al., 1999; Yang, et al., 2001; Yang, et al., 2003), I examined the cognitive mechanisms that drive syntactic constraints on the comprehension of referential expressions during the timecourse of reading Chinese and English discourse. The results identify syntactic prominence to be sensitive to structural relations rather than grammatical functions (e.g., subject and direct object) or semantic roles (e.g., agent and patient) as has been assumed in the psycholinguistic literature. Crucially, in light of generative grammar, I propose a distinction of simple-clause vs. bi-clause hierarchical discourse organization that interprets how the semantic scope can be framed upon across sentence boundary as a function of the dynamic interaction between syntactic prominence and the forms of referring expressions (Yang, et al., 2003, pp 307-313). This proposal provides a bridge between the domains that model knowledge of language, such as generative grammar and formal semantics, with the domains that model language processing, such as psycholinguistics and computational linguistics.

Electrophysiological Activities of Language Integration

One fundamental question regarding language processing is the temporal immediacy of the use of linguistic information from the basic (lexical/word) to the integrative levels (sentence/text). I am currently working with several faculty and colleagues on a variety of experiments that are

related to two basic lines of inquiry by measuring and analyzing brain's electrophysiological activities (event-related potentials, ERPs). The first focuses on the information integration across sentence boundaries, and how different language experience may shape this process. One goal of this work is to elucidate the cognitive mechanisms that drive the use of different kinds of linguistic information during text integration as a function of differential reading skills for different language users and learners. Another is to develop a comprehensive model of language processing that reflects the temporal function of language use and learning. To this end, the results of reading English text delineate the timecourse of integrating different linguistic information as the incremental integration temporally unfolded (Yang, Perfetti, & Schmalhoffer, 2004). We also found this integration process to reflect quality of lexical representations that people acquire as they learn new words (Perfetti, & Hart, 2002). While skilled readers utilize lexical-semantic and conceptual processes to interpret word meanings within the first ~300 ms (from word onset), less skilled readers failed to do so (Yang, et al., under review). The follow-up ERP studies will further investigate the timecourse as well as the specificity of the brain areas related to how first-language experience modulates the second-language learning by testing readers with different reading skills that have different second language experiences.

The second inquiry is to examine the working memory during sentence integration and was funded by a CCKF Research Grant for the Chinese part. This research will document the cognitive/neurocognitive significance of working memory that provides processing supports to integrate various linguistic information during language processing, and how different language experiences may shape the way the cognitive/neurocognitive systems are orchestrated (Yang, Martin, & Potts, 2002; Yang, & Perfetti, 2004). An important finding in English part shows an ERP complex effect that challenges the modular approach regarding the cognitive nature of ERP components. Significantly, this ERP complex shows modulation of working memory on detection of semantic anomaly and on subsequent integration efforts. Thus, results indicate a dynamic interaction among working memory, semantic and syntactic processing at the integrative levels of sentence processing while the brain mapped the current linguistic constituents incrementally into the mental representation. Furthermore, combined with source localization analysis, the results of Chinese part demonstrate that language experience plays an important role in shaping the cortical organization of cognitive mechanisms. The use of spatial information in Chinese word recognition implicated in anterior medial BA 10/11 and the right frontal BA 45 could be extend to sentence reading while mapping multiple nouns and verbs for word-to-referent integration. In addition, the reading of Chinese complex sentences indicates a dynamically distributed ERPs pattern of working memory operations that was spatiotemporally oriented with the locus of processing demands in terms of the immediate processing of syntactic mapping and semantic integration. This spatiotemporally dynamic pattern can be explained by the language-processing strategies imposed in language use due to some language-specific properties of Chinese.

Current Agenda and Future Direction

In the future, my research will continue along its current trajectory. I will continue to utilize both behavioral and EEG paradigms to address issues related to the use of semantic and syntactic information in memory during language comprehension within and between sentences. The fundamental question of how semantic and syntactic information are processed, represented, and integrated in our memory system will continue to be the hub of my research program. However, I do expect this program to be influenced by my involvement in the local academic

environment. For example, through my interaction with my LRDC and Carnegie Mellon University colleagues, my interest in higher-order language processing has been broadened to include vocabulary acquisition and metalinguistic awareness related to issues of bilingual processing and second language learning with a goal to develop a model of bilingual processing that will have pedagogical implication. These influences are evident in a research project of English vocabulary acquisition with Dr. Charles Perfetti, and in an invited chapter that I recently coauthored (Wang, & Yang, in press). This chapter outlined the critical linguistic phenomena at different levels of the development of metalinguistic awareness and their corresponding cognitive issues involved. More importantly, I am currently drafting two grant proposals to address further the cognitive/neurocognitive issues related to bilingual processing that attempt to bridge our knowledge of reading comprehension from the very basic perceptual constraints on word identification to the integration levels of sentence comprehension in bilingual brains. In these proposals, besides using behavioral and EEG paradigms, I will collaborate with Dr. Erik Reichle, an eye-tracking expert, to apply eye-tracking techniques and his model of *E-Z reader* (Reichle, Rayner, & Pollatsek, 2004), a computational model that provides a detailed quantitative account of how the major events in the cognitive and perceptual-motor systems determine *when* and *where* the eyes move during reading, to explore this issue. This project again illustrates an important aspect of my research—how the interdisciplinary approach I have adopted and my active involvement in local academic environment promote my competence in addressing cognitive/neurocognitive issues related to the processing of language comprehension from the very basic levels to a more integrative levels.