

Language Processing in Real and Artificial Neural Networks

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Abstract

The first part of this thesis reports a computational simulation work on *modelling language processing*. The motivation was from a study that attempted to show that contemporary connectionist models, the simple recurrent networks being the exemplar, fail to exhibit a kind of generalisation that is essential for acquiring natural language. A replication of the simulation, however, revealed a pattern that was to the contrary. I extended the simulation to investigate the plausible causes of the discrepancies and I argued that generalisation is possible in connectionist models as long as the knowledge of categories is successfully induced by the networks.

The second part of the thesis reports an investigation of how *the real brain functions* during tasks of language processing. To be more specific, during a task of reading for comprehension. I employed a high temporal resolution brain imaging technique known as electroencephalography (EEG), through which the electrical potentials, in terms of micro-volts, as a consequence of participants' engagement of the reading task were measured from electrodes that were placed on their scalps. Event-related-potentials (ERPs), also referred to as "brain waves", were then derived from these measured time

series of voltages. In this ERP study of reading, I identified the earliest brain responses to semantic processing and I argued that within one fifth of a second the brain has already started to process the meanings of a word.

Despite the fact that the two parts of the thesis represent research work of two different disciplines, the central theme of my thesis remains clear—to study how language is possible in a brain.

序

本論文首先討論利用電腦模擬之方法去研究語言處理的問題。這部份研究的動機來自一項其他學者之文章。該文指出現今流行的一種連結論模型 (connectionist models) — simple recurrent networks, 缺乏一種對語言習得很重要的特質, 概括能力。本論文先把該文章的實驗重複, 發現結果跟原文有所不同。本論文將匯報由此而引申的一系列仿真實驗及其分析。

本論文的第二部份將報告一項腦電圖研究, 此研究的目的是探討人在閱讀時大腦是如何運作的。我們把電極放在參加者之頭皮上以量度他們因閱讀而產生的電位反應。此腦電圖研究發現在不到五份一秒的時間, 大腦已對文字的語意有所反應。

此兩項研究雖代表著兩門學科的研究方法, 但兩者皆指向同一方向 — 探討語言及大腦之間的關係。殊途而同歸。