Hemispheric interaction: when and why is yours better than mine?

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A thesis submitted for the degree of Doctor of Philosophy of the
Australian National University,
Canberra, Australia

September, 2005

Declaration

I, Nicolas Cherbuin, hereby declare that, except where acknowledged, that this work is my own and has not been submitted for a higher degree at any other university or institution.

Nicolas Cherbuin

Acknowledgements

I would like to thank my family, my dearest friends, Camille, Jacques, and Nicola for their unconditional support without which this research would not have been possible.

Special thanks go to Dr Cobie Brinkman. Since my undergraduate days, Cobie has been inspiring and has taught me much of what I know about the human brain. She has also provided help and support during my honours' year as well as throughout my PhD. Importantly, although Cobie's door was always open to me, she trusted me to conduct valuable research, even when I spent reclusive periods in the lab or in my office, or when I steered my research in unexpected directions.

I would also like to thank Mark Edwards and Anne Aimola Davies who, as members of my supervisory panel, have provided invaluable advice and encouragement, and have reviewed my work in detail.

Thanks also go to Dr Michael Smithson for his generous, and apparently limitless, sharing of statistical knowledge, and to Dr Elinor McKone for her meticulous advice.

The study of individuals with dyslexia presented in Chapter 6 has been conducted in collaboration with Judy Buchholz. Judy is a qualified clinical psychologist and I am grateful that she performed the neuropsychological assessment of participants as well as part of the experimental tests for this study.

The ANU School of Psychology has provided me with a stimulating, understanding, and caring environment which has made my research most enjoyable even during difficult times. The School also provided me with valuable resources without which some aspects of this research would not have been conducted. Ricardo Gallardo and Mary Dalton should be particularly thanked for their assistance in developing the software and hardware used in this research.

Publications arising from the thesis

Experiments 3, 5, 6, and 7 have been published in the following articles:

Cherbuin, N., & Brinkman, C. (in press). Efficiency of callosal transfer and hemispheric interaction. *Neuropsychology*.

Cherbuin, N., & Brinkman, C. (2005). Practice makes two hemispheres almost perfect. *Cognitive Brain Research*, 24, 413-422.

Cherbuin, N., & Brinkman, C. (2005). Hemispheric activation and interaction: past activity affects future performance. *Laterality,* 10, 563-579.

Cherbuin, N., & Brinkman, C. (2004). Cognition is cool: can hemispheric activation be assessed by tympanic membrane thermometry? *Brain and Cognition*, 54, 228-231.

Abstract

The performance of most tasks requires some interaction between the cerebral hemispheres. Despite this fact, research has focused on demonstrating that each hemisphere is specialised for certain processes and has largely neglected this interaction.

Recent research has recognised the need for a better understanding of how resources are shared between the cerebral hemispheres. While these studies have shed light on factors external to the participants being tested, such as the type of task and stimuli used, presentation times, and different measurement methods, they have neglected variables that differ between individuals. The studies reported here focused on factors internal to the participants. They include sex, age, handedness, functional lateralisation, practice, attention, and hemispheric activation, which vary between individuals or within individuals across time, and have been shown to influence the structure and morphology of the corpus callosum which is the main pathway for hemispheric interactions.

This thesis examines the relationship of these variables to the efficiency of hemispheric interactions.

A literature review of the factors affecting hemispheric interactions and interhemispheric transfer is presented in Chapter 1, and methodological issues relating to the measurement of these variables in Chapter 2. Based upon this research, two tasks, the Poffenberger paradigm and a letter-matching task, were selected to assess interhemispheric transfer time and hemispheric interactions, respectively, and to investigate the relationship between these two variables.

Chapters 3 and 4 present the findings of the principal study, using a large sample of participants and regression analysis, which demonstrate that both faster interhemispheric transfer and more extreme left-handedness are associated with greater efficiency of hemispheric interaction. Surprisingly, other factors which were expected to influence hemispheric interactions (age, sex, functional lateralisation, and attention) did not have a significant effect on this variable.

A strong practice effect found in the task used in Chapters 3 and 4 is analysed in Chapter 5. Contrary to previous findings, this practice effect seems not to be due to a shift from sequential, rule-based processing to memory-retrieval, but rather, is a more general practice effect consistent with progressively more efficient use of neural resources.

Chapter 6 shows that individuals with dyslexia not only demonstrate an abnormally fast interhemispheric transfer, but also attentional deficits, due probably to decreased efficiency in hemispheric interactions. Because some clinical populations, such as individuals with dyslexia, have been shown to have hemispheric interaction deficits, the study of such clinical samples can provide valuable information about the relationship between hemispheric interactions and other individual variables.

In Chapter 7 it is demonstrated that both latent and induced patterns of lateralised hemispheric activation affect hemispheric interactions. This suggests that

assessment of hemispheric activation is important not only in this field, but probably also more generally in neuropsychological research. These findings highlight the need for a simple, inexpensive measure of hemispheric activation that can be applied routinely in cognitive experiments.

Chapter 8 presents a new technique to measure lateralised brain activation in typical psychological experiments using functional tympanic membrane thermometry (fTMT). This measure relies on the measurement of ear membrane temperature as an index of hemispheric activation. The technique is simple and inexpensive, and is shown to be suitable for the assessment of hemispheric activation patterns during typical experiments.

In conclusion, individual characteristics such as the efficiency of interhemispheric transfer, handedness, functional lateralisation, attention, and hemispheric activation are important factors to consider when researching hemispheric interactions in both normal and clinical populations. Furthermore, future research will benefit from this newly developed measure, fTMT, by allowing the systematic study of the effects of hemispheric activation in brain processes.

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