Imaging Studies of Vision, Attention and Language

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Visual Cortical Areas in Humans

Over half of the total area of neocortex in non-human primates is occupied by visual areas. Over 25 visual areas beyond primary visual cortex (V1) have been identified in non-human primates using invasive techniques. Recent advances in fMRI, EEG, MEG, stimulus paradigms, and cortical surface reconstruction have finally made it possible to outline the borders of a number of these functionally distinct areas along the complexly folded cortical mantle of humans. These imaging studies are first reviewed. The implications of these studies for how higher level functions (like language comprehension) are implemented in the human cerebral cortex are then explored.

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Neuroimaging Studies of Attention in Humans

Event-related brain potentials (ERPs) are recorded from the scalp of subjects performing selective attention tasks. By comparing the waveforms and scalp distributions of ERPs elicited by attended and unattended stimuli, inferences can be made about the timing and anatomical localization of stimulus selection processes in the sensory pathways. Topographical mapping of ERPs and associated magnetic (MEG) fields have revealed specific sites of attentional control in extrastriate visual cortex and in supratemporal auditory cortex. These ERP and MEG findings are reinforced by complementary studies of cerebral blood flow patterns during attention
as revealed by positron emission tomography. The implications of these physiological data for psychological theories of attention will be discussed.

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Neuroimaging Studies of Developmental Plasticity Within the Visual and Language Systems of the Human Brain

I will review (a) our ERP and fMRI results during visual processing and language processing from adults who have had different early sensory and/or language experience and (b) ERP results from normally developing infants and children. Taken together these

studies suggest that within vision and within language different neural systems display considerable variability in the degree to which they are modified by early experience. Within vision, early auditory deprivation has most marked effects on the organization of systems important in processing motion information. The results raise the hypothesis that the dorsal visual system displays greater developmental plasticity than does the ventral visual pathway. In addition, different subsystems within language display varying degrees of modifiability by experience. The acquisition of lexical semantics appears relatively robust and invariant even in individuals with markedly different timing and modality of language input. By contrast, systems active during grammatical processing display marked effects of alterations in the timing and nature of early language input. These results converge with other lines of evidence that suggest it is important to distinguish these different aspects of language, and they raise hypotheses about the initial development of these different language systems. Different accounts for these differential effects of early experience on subsystems within vision and language will be discussed.