Projects

Functional imaging

Neural sites encoding numerosity

This project investigates the neural sites that show selectivity for the number of items in a display, and are affected by *adaptation* to number. Classification imaging techniques reveal number encoding in area IPS, and show that adaptation affects the encoding strategies of this area.

Researchers involved in the project include Burr, Morrone, Castaldi, Murphy and Tosetti.

Size-adaptation affects the perceived size and the neural representation of the stimulus in primary visual cortex

Most perceptual properties can be affected by adaptation. In this study we show that prolonged viewing of a large, peripherally displayed stimulus causes smaller test stimulus presented to the same region to be perceived smaller than its actual size, while adaptation to a smaller stimulus causes the test to appear larger. Adaptation to a stimulus of the same size did not change perceived size. To explore the neural correlates of this effect, we measured the spatial extent of the BOLD activation of the retinotopically defined primary visual cortex (area V1). We found that the size of the activated V1 surface *decreased* by 26% after adaptation to a larger stimulus and *increased*
by 20% when preceded by a smaller adapter. Adaptation to a stimulus with the same size did not change the size of the activated V1 surface. The pattern of V1 activation closely matched the behavioral effects of size adaptation. These results corroborate recent findings showing that activity in V1 reflects the perceived size of a stimulus even when this perception is illusory and

non-veridical.

People involved: Morrone, Arrighi, Pooresmaeli, Tosetti, Biaggi.

Clinical and translational research

Adaptation in autism

Studies by our group have shown that children affected with autism demonstrate reduced levels of adaptation to faces compared with age-matched peers. This has important implications for how perception processes in people with autism may differ from typically developing children, as outlined in a recent opinion article in Trends in Cognitive Sciences (Pellicano and Burr, 2012). We are pursuing this line of research, with several projects, in studying particular adaptation to numerosity in autism, as well as other projects, such as perception of time.

Researchers in this project include Burr, Morrone, Murphy, Turi, Tancredi, Tinelli and Elizabeth Pellicano (Institute of Education, University of London).

Blindsight in children with cerebral lesions PDF

It has been shown that unconscious visual function can survive lesions to optical radiations and/or primary visual cortex (V1), a phenomenon termed “blindsight”. Studies on animal models (cat and monkey) show that the age when the lesion occurs determines the extent of residual visual capacities. Much less is known about the functional and underlying neuronal repercussions of early cortical damage in humans. We measured sensitivity to several visual tasks in four children with congenital unilateral brain lesions that severely affected optic radiations, and in another group of three children with similar lesions, acquired in childhood. In two of the congenital patients, we measured blood oxygenation level dependent (BOLD) activity in response to stimulation of each visual field quadrants. Results show clear evidence of residual unconscious processing of position, orientation and motion of visual stimuli displayed in the scotoma of congenitally lesioned children, but not in the children with acquired lesions. The calcarine cortical BOLD responses were abnormally elicited by stimulation of the ipsilateral visual field and in the scotoma region, demonstrating a profound neuronal reorganization. In conclusion, our data suggest that congenital lesions can trigger massive reorganization of the visual system to alleviate functional effects of early brain insults.

People contributing to this project include: Tinelli, Cicchini, Arrighi, Tosetti, Cioni, Morrone and Guzzetta.

Visual stability during saccadic eye movements

Transient spatiotopic integration across saccadic eye movements mediates visual stability PDF

Eye movements pose major problems to the visual system, because each new saccade changes the mapping of external objects on the retina. It is known that stimuli briefly presented around the time of saccades are systematically mislocalized, whereas continuously visible objects are perceived as spatially stable even when they undergo large transsaccadic displacements. In this study we investigated the relationship between these two phenomena and measured how human subjects perceive the position of pairs of bars briefly displayed

around the time of large horizontal saccades. We show that they interact strongly, with the perisaccadic bar being drawn toward the other, dramatically altering the pattern of perisaccadic mislocalization. The interaction field extends over a wide range (200 ms and 20 degrees) and is oriented along the retinotopic trajectory of the saccade-induced motion, suggesting a mechanism that integrates pre- and postsaccadic stimuli at different retinal locations but similar external positions. We show how transient changes in spatial integration mechanisms, which are consistent with the present psychophysical results and with the properties of "remapping cells" reported in the literature, can create transient craniotopy by merging the distinct retinal images of the pre- and postsaccadic fixations to signal a single stable object.

People involved: Burr, Cicchini, Binda, Morrone

Spatiotopic neural representations develop slowly across saccades PDF

One of the long-standing unsolved mysteries of visual neuroscience is how the world remains apparently stable in the face of continuous movements of eyes, head and body. Many factors seem to contribute to this stability, including rapid updating mechanisms that temporarily remap the visual input to compensate for the impending saccade [1]. However, there is also a growing body of evidence pointing to more long-lasting spatiotopic neural representations, which remain solid in external rather than retinal coordinates [2-6]. In this study, we show that these spatiotopic representations take hundreds of milliseconds to build up robustly.

Burr, Morrone, Zimmermann