Source of Attentional Control Signals

Likely suspects as sources of attention signals:

- Posterior Parietal Cortex
- Prefontal Cortex
- Pulvinar Nucleus of the Thalamus
- Superior Colliculus

Visual Processing Streams

The "What" vs. "Where" streams

(Ventral-Dorsal)
(Temporal-Parietal)

(What-Where)
(Object Recognition-Spatial Awareness)
(Grasping-Reaching)

The ventral stream appears to be responsible for the analysis of the characteristics of an object.

The dorsal stream appears to be responsible for computing representations of space, such as where objects are.

Another possibility is that the dorsal stream encodes actions, such as arm movements. Space is represented in order to compute actions.

The Pulvinar Nucleus and Attention

The Pulvinar is a nucleus of the Thalamus. The thalamus is one of the regions of the brain that has become relatively enlarged during evolution. The pulvinar nucleus of the thalamus has been one of the biggest contributors to this enlargement.

Early anatomical studies have shown that there are many interconnections between the pulvinar and the visual cortex, suggesting that the pulvinar may have a visual function.

The lateral nucleus of the pulvinar (PL) has connections to cortical areas V4 and IT.

(Desimone paper) Deactivation of the lateral pulvinar in a hemifield caused difficulties in ignoring distracting stimuli in the unaffected hemifield and in focussing attention on a target in the affected hemifield.

If there was no distractor present then the deactivation had little effect.

The conclusion of Desimone is that the pulvinar deactivation causes a loss of an attentional control signal to extrastriate cortex, most likely IT.

Experimental results so far are consistent with a cell-gating model where stimuli at all points in the visual field are in competition with one another, and this competition is biased either by instruction to attend to one locationn (endogenous) or by the intrinsic properties (salience) of the stimuli themselves (exogenous).

Studies have shown that deactivation of a part of the pulvinar called Pdm (Pulvinar dorsal medial) leads to impairment in the ability to shift attention. Conversely, hyperactivation of this area leads to a facilitation in shifting attention.

Positron Emission Tomography (PET) studies have shown increased activity in the pulvinar when an object identification task in a cluttered visual field was performed, while no pulvinar activity was observed when the visual field was uncluttered. This suggests that the pulvinar becomes more active when there is a need to filter out irrelevant information.

Pdm has connections to the posterior parietal cortex, lesions of which cause similar impairments

Studies have shown that cells in PI and PL respond to a wide range of stimuli motions when the eyes are fixed, but do not respond when the eyes are moving. This could be used to filter out image motion that results from self-motion of the observor.

This is possibly related to the phenomena of *saccadic suppression*, which is a reduction in sensitivity to stimuli when the eyes are making a saccade.

Some pulvinar cell response also appear to be gated by eye position. For example, a cell may respond to a stimulus when the subject is gazing downwards, but does not respond when the subject gazes upwards.

Some neurons in the supperior colliculus have similar propperties. These enurons project to the PI and PL regions of the pulvinar.

The visual characteristics of the pulvinar cells appear to be dependent on the striate cortex and not the superior colliculus. It is thought, then, that the superior colliculus may be involved in the eye movement and eye position dependence of pulvinar cell activity.