How Does the Marmoset Visual Cortex Develop?

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- **Background:** The neocortex is the outermost structure of the brain and is responsible for processing the sensory information coming from the periphery. The visual cortex, located at the occipital (posterior) end of the brain, comprises of many areas, each in charge of processing a unique aspect of the visual message (e.g. colour, shape recognition, direction of movement). The visual areas are organised into two functional streams: the dorsal "*Where*" stream analyses the location of objects in space while the ventral "*What*" stream recognises and identifies objects according to their characteristic features including size, colour etc.
- **Aim:** Previous research has suggested that the areas forming the dorsal stream mature before their ventral counterparts, however there is no clear demonstration of the sequence in which the visual area forms. The neocortex is comprised of six distinct layers which form in an inside-out pattern; layer 6 on the inside to layer 1 on the outer most edge. Taking advantage of this we propose to trace the birthdate of cortical neurones in visual areas belonging to either streams following a pulse during embryonic development (E days): E85, E100 and E135 and track the distribution of BrdU+ (bromodeoxyuridine) cells across the newborn marmoset neocortex to map cortical areas according to the embryonic stage they were formed. BrdU is a thymidine analogue that is incorporated into the DNA of dividing cells.
- **Methods:** Brains were harvested at birth (~ E145 in marmosets), cut into series using a cryostat (40µm thick) and stained with a rat anti-BrdU antibody. The labelled sections were analysed using an epifluorescence microscope and counted using the Fiji Cell Counter plugin.

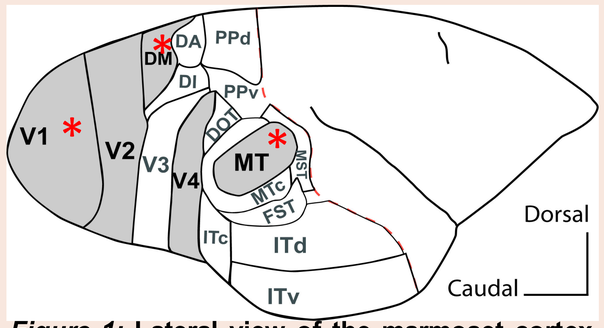

Figure 1: **Lateral view of the marmoset cortex, with the areas of interest for this study highlighted in grey**
V1 primary visual area, V2 secondary visual area, MT medial temporal area, DM dorsal medial area,V4 visual area 4, dorsal stream areas indicated with an asterisk

Figure 2: **Coronal section of the marmoset cortex at E85**
CP cortical plate populated with NeuN+ neurones
IZ intermediate zone
SVZ subventricular zone
VZ ventricular zone
VZ &SVZ are the neurogenic layers and thus are positive for the proliferation marker Ki67

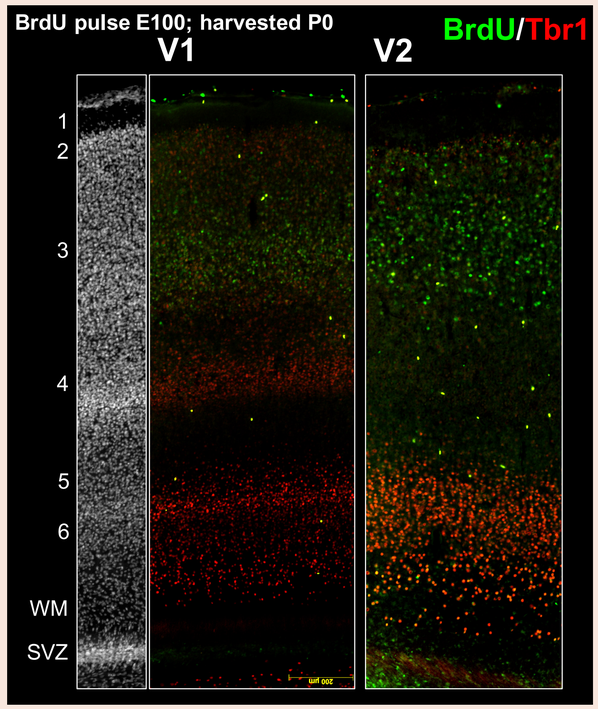

Figure 3: **Comparative distribution of BrdU+ neurones in V1 and V2 at birth (P0) following pulse at E100** *BrdU+ cells in V1 are located in the deeper compartment of layer 3 but are also found in layer 2 in adjacent V2 suggesting that layer 2 neurones in V1 are born at a later stage, therefore V2 appears to form before V1 in the marmoset*

	V1	V2	MT
Layers 2/3	6.33	12	11
Layers 4/5	9.33	11	14.5
Layer6/White Matter (WM)	10.33	10.67	23.5

Figure 4: **The average number of BrdU+ cells in specified layers across three areas of the visual cortex (V1, V2 and MT) at E135** *Cells distribute across all layers however the number of BrdU+ cells varies dramatically across the areas.*

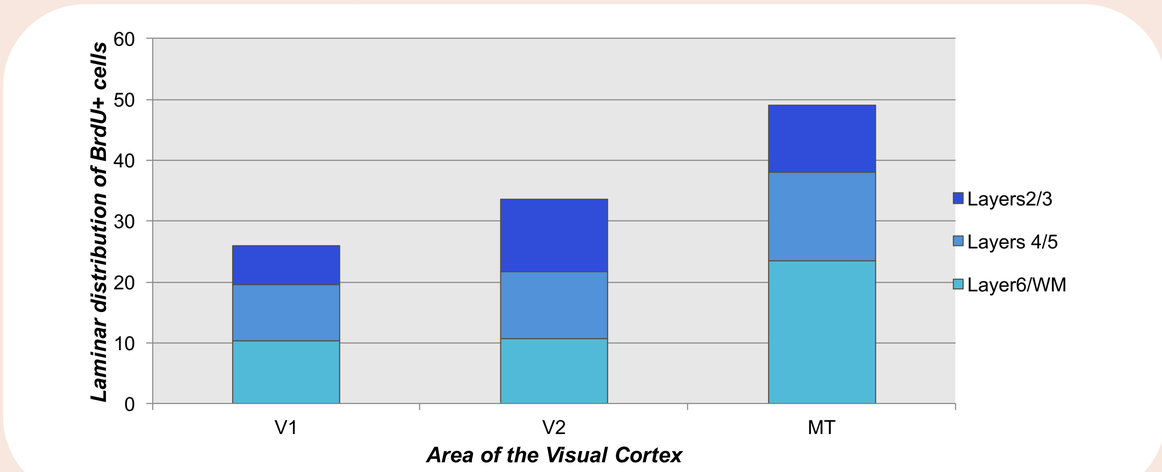

Figure 5: **Graphical representation of the number of BrdU+ cells found over different layers in three areas of the brain at E135** *Twice as many BrdU+ cells are found in MT compared with V1. There are also significantly less BrdU+ cells in layers 2/3 of MT compared with layers 4/5 and layers 6/WM.*

Conclusion:

- **E85 -** Proliferative cells are in the VZ and SVZ. The cortical plate has begun to develop through the inside-out migration of pyramidal neurones. This means that layer 6, the closest layer to the SVZ, forms first and layer 1 forms last. *(Figure 2)*
- **E100 -** Neurones have reached layer 3 in V1 and layer 2 in V2 indicating that V2 forms at an earlier stage than V1. *(Figure 3)*
- **E135 –** BrdU+ cells appear across all layers however the number varies drastically. In MT there are twice as many BrdU+ cells in layer 6/WM compared with layers 2/3 suggesting that layers 2/3 were not mature at E135 and migration is still occurring. *(Figures 4 and 5)*

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