PLASTICITY AND BLINDNESS:

Pascuallenone et al (1995) mapped the sensitivity of muscles of the hand (using TCS) in 6 blind proficient Braille readers.
Maps were compared from days when the readers worked at Braille proof reading for 6 hours (both before and after work) and morning and evenings on days off work.
The area of sensitivity for a target muscle of the reading hand were much larger after the working shift than before it. These changes were not seen on the days off work, or for other hand muscles.

Sadato et al (1996) used PET scans to measure activation in the visual cortical areas in normal subjects and Braille readers blind from early life.
Scans were taken during Braille reading, but the Braille readers were also compared to normal controls during 3 tactile discriminations (e.g. of angles) and one "sweep" task that involved tactile sensation but no discrimination.
Blind subjects showed activation of primary and secondary visuals areas during Braille reading and to a lesser extent during the tactile discriminations, but not for the "sweep" task. Normal subjects showed deactivation of visual areas during tactile tasks.

Kujalia et al (1997) studied event-related brain potentials to sequences of standard and unusual tones in subject either blind since before 2 yrs, or between 12-28 yrs, or sighted adults.
When subjects were detecting deviant auditory stimuli, it is claimed that both groups of blind participants have evoked potentials that were more posterior (over the visual areas of the brain) by comparison to the sighted subjects There was no evidence of a difference between the early and late onsets of blindness.

Cohen *et al* (1997) used repetitive transcranial magnetic stimulation to interfere with the activity of different brain regions in early blind subjects. This transient interference of occipital cortex led to the impairment of braille reading and to the perception of "phantom dots". But the same interference applied to somatosensory cortex did not interfere with braille reading.

Büchel (1998) reviewed several recent studies which support the claim that occipital activation is related to tactile processing in congenitally and early blind subjects and suggests that cross-modal re-organization may occur at the thalamic level in early blind subjects.

Sadato *et al* (1998) using PET scanning, also found that secondary somatosensory cortex did not seem to be being used for braille reading by blind subjects, but occipital cortex was activated instead.

There are some reports that blind subjects who lost their sight as teenagers do not show the same kind of unusual activations of visual cortex as early blind subjects, but **Büchel *et al* (1998)** found the same kind of use of secondary visual cortex for braille reading as occurs in early blind subjects in a group of participants who started to learn Braille at the age of 5, because their eyesight was deteriorating, but who did not lose their sight completely until after puberty. Moreover, the late blind subjects, unlike the early blind subject, had activation in **primary** visual cortex, in addition to that in secondary visual cortex, during the Braille-reading task. This suggests that relative use of tactile versus visual information, rather than the complete absence of visual input, is sufficient to induce profound changes in the functional organization of sensory cortex..

Zangaladze *et al* (1999) provided evidence that the extra striate visual cortex is involved in some kinds of geometric tactile discriminations even in normal subjects. (Sathian and Zangaldze, 2002, is a longer review article discussing this material)

Sadato et al. (2002) continue to maintain that with some tasks (for instance reading Braille characters rather than whole words in Braille) primary visual cortex is used by early blind subjects for tactile discriminations. However, they agree that "V1 is unlikely to be the 'entry node' of the cortex for the redirection of tactile signals into visual cortices after blinding. Instead, the visual association cortex may mediate the circuitry by which V1 is activated during tactile stimulation."

Boven et al. (2000) found that blind subjects had heightened tactile spatial acuity, which they suggested might represent a behavioural correlate of cortical plasticity.

Noppeney et al. (2003), using fmri, found that both early blind and sighted subjects activated the same left fronto-temporal regions when performing a visually based semantic decision task when listening to words, while the blind subjects differed from the controls in that they activated additional extrastriate (visual) regions for all the semantic retrieval tasks.

Ptito et al., (2005) showed using PET that congenitally blind subjects, but not normal controls, used occipital cortex after but not before training on a difficult tactile discrimination task requiring the detection of the orientation of a capital "T" presented as a pattern of electrical pulses delivered to a 3cm x 3cm matrix of 144 electrodes placed on the tongue.

Summary: brain imaging studies strongly suggest that brain organization is changed by either early or late blindness, and that blind subjects make more use of visual cortical areas for non-visual tasks.

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