

# **Emotion and Modulation of Behaviour Type Probability**

## Higher level control signals

General internal circumstances could indicate a type of behaviour that is more likely to be appropriate

food seeking behaviour

HUNGER

General external circumstances could indicate a type of behaviour that is more likely to be appropriate

aggressive behaviour

ANGER

flight behaviour

FEAR

rejection behaviour

DISGUST

General circumstances could indicate a constraint on behaviour

delay behaviour, record information

SURPRISE

avoid behaviour because of radical change

SADNESS

continue current behaviour type

HAPPINESS

System could detect conditions within general circumstances and modulate probability of different general types of behaviour

**General circumstances may carry limited information on specific behaviour of general type**

There could be general circumstances indicating that a major type of behaviour is appropriate

Low blood sugar would favour food seeking behaviour

Columns activated by general circumstances could have strengths in favour of the general type of behaviour but not the specific form of the behaviour

Specific form of food seeking would be determined by visual or other inputs from the environment

General signals need to act on longer time frame than environmental inputs

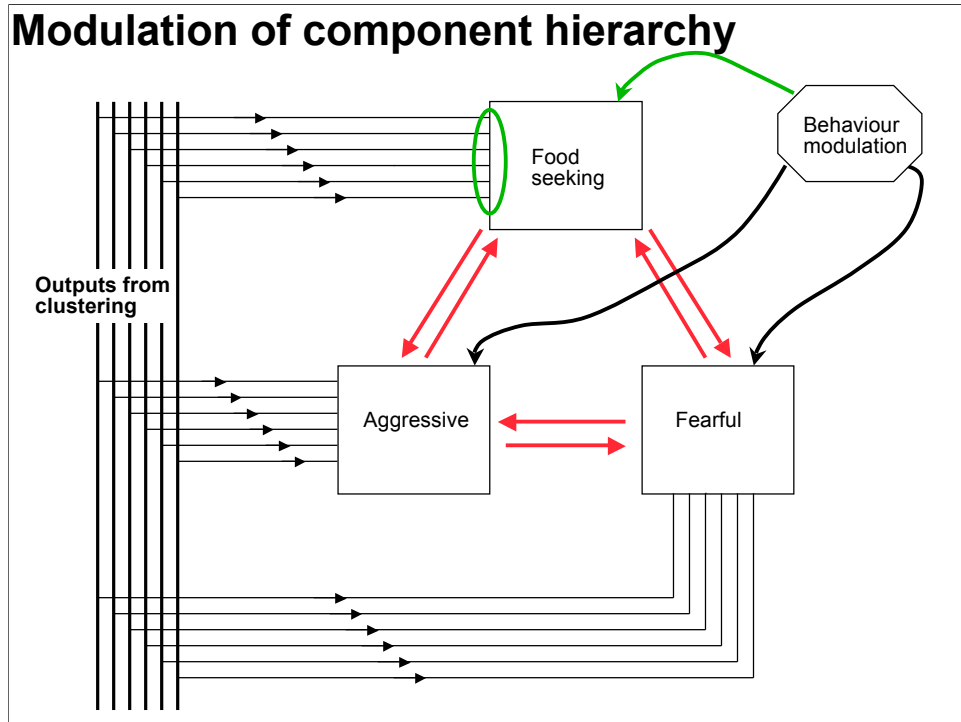
## **Implementation routes for modulation of behaviour type probabilities**

### **Modulate component hierarchy**

Increase arousal of components corresponding with behaviours of general type  
For given population of activated columns, will increase probability of type

### **Modulate modular hierarchy**

If there are specialist modules for behaviour types, reduce thresholds for condition detection in those modules



In the diagram, the same outputs from clustering generated by an input state target three general behaviour modules, but one of the modules has its input level thresholds decreased, increasing the probability that a behaviour of that type will be accepted.

## Modulation of Modular Hierarchy

In order to conserve resources, one column will have recommendation strengths in favour of many different behaviours

Suppose there are several major types of behaviour

At a given level of condition complexity, the array of columns with optimal discrimination for one type of behaviour may be different from the array with optimal discrimination for another type

If differences are significant

value of better discrimination > biological cost of separate arrays for the different behaviour types

Generally only for a limited number of behaviour types of critical biological importance, and for a limited range of levels of condition complexity

Control signals could then act on different arrays to modulate the probability of condition detection within a specific sensory input

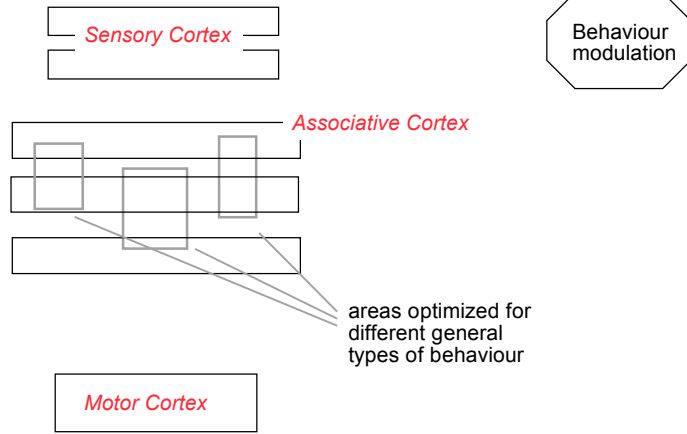
As discussed earlier, although sharing of columns array resources across all possible behaviour types is the most resource efficient, separate resources in separate cortex regions for different behavioural types may have behavioural advantages because conditions can be optimized for the different behavioural types. The mechanism for such optimization would be that behaviorally targetted column resources would be identified in advance (genetically), and the contradictory consequence feedback mechanism for improving discrimination would be applied to the resources only for contradictory consequences for the targetted behaviour (i.e. behaviours selected by the corresponding behavioural type component)..

The duplication of resources would not in general be from sensory all through to motor control, to reduce resource requirements it would generally be limited to the levels of condition complexity at which different discrimination capabilities provide the most value. Furthermore, it would be limited to a small number of general behaviour types rather than a wide range of more specific behaviours.

Existence of such specialization is suggested by the observations that major associative cortex brain damage generates shifts in personality.

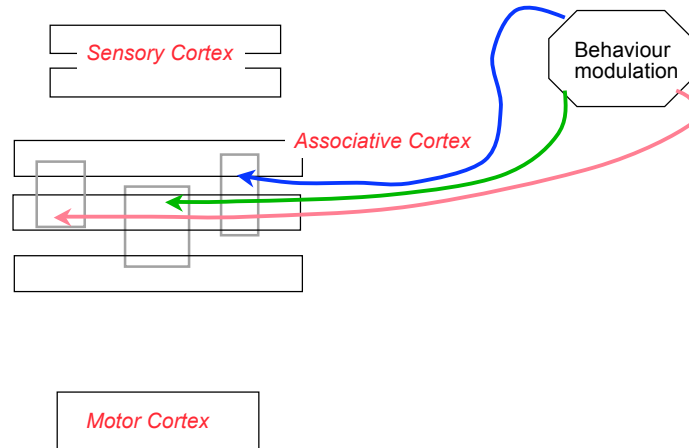
Existence of such regions means that the emotion neurochemicals targetted on major behavioural components in competition could also target the appropriate specialized cortex regions, reducing input thresholds and increasing the probability of condition recording in the targetted region. The result would be high probability of the targetted behaviour.

## Modulation of modular hierarchy



Cortex behavioural regions are conceptually illustrated.

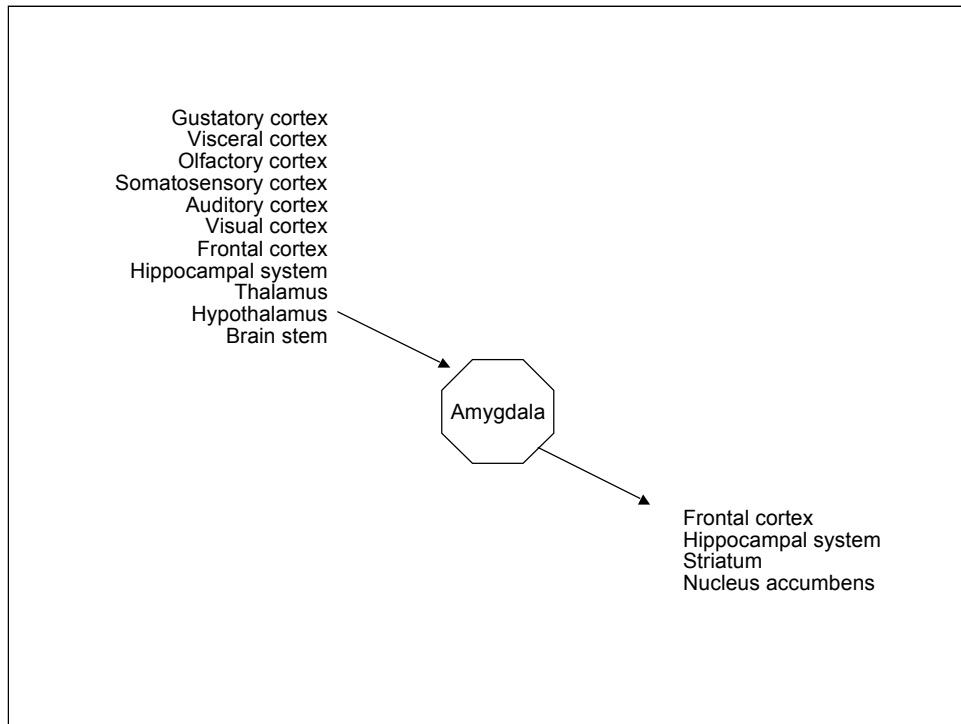
## Modulation of modular hierarchy



Targetted modules would detect conditions that were a smaller proportion of usual condition definitions

And would record conditions to achieve a higher than regular level

Cortex behavioural regions are conceptually illustrated.



As expected on this model, the amygdala gets inputs from sensory cortices and targets the frontal cortex and striatum

## Emotions and behaviour modulation

### Primitive emotions

hunger sexual arousal

### Basic emotions

anger surprise happiness  
fear disgust sadness

Identified very reliably in facial expressions across different cultures

### Social/moral emotions

guilt shame embarrassment  
pride jealousy sympathy

More difficult to show just on the face

## Higher level control signals

### System needs

- Detect conditions appropriate for a priority
- Modulate the system to achieve priority
- Increase level of condition recording during priority

### Side effects

- Modulation in a specific way is a behaviour which must be recommended and accepted
- Other conditions present just before acceptance of a successful modulation behaviour could acquire recommendation strengths in favour of the modulation behaviour

## **Additional aspects of capability**

### **On the basis of frequent simultaneous activity**

Columns detecting of conditions within the presence of a modulating neurochemical or of its effects could acquire recommendation strengths in favour of saying name of emotion

Auditory columns could acquire recommendation strength in favour of modulating neurochemical release behaviour

### **On the basis of past simultaneous receptive field expansion**

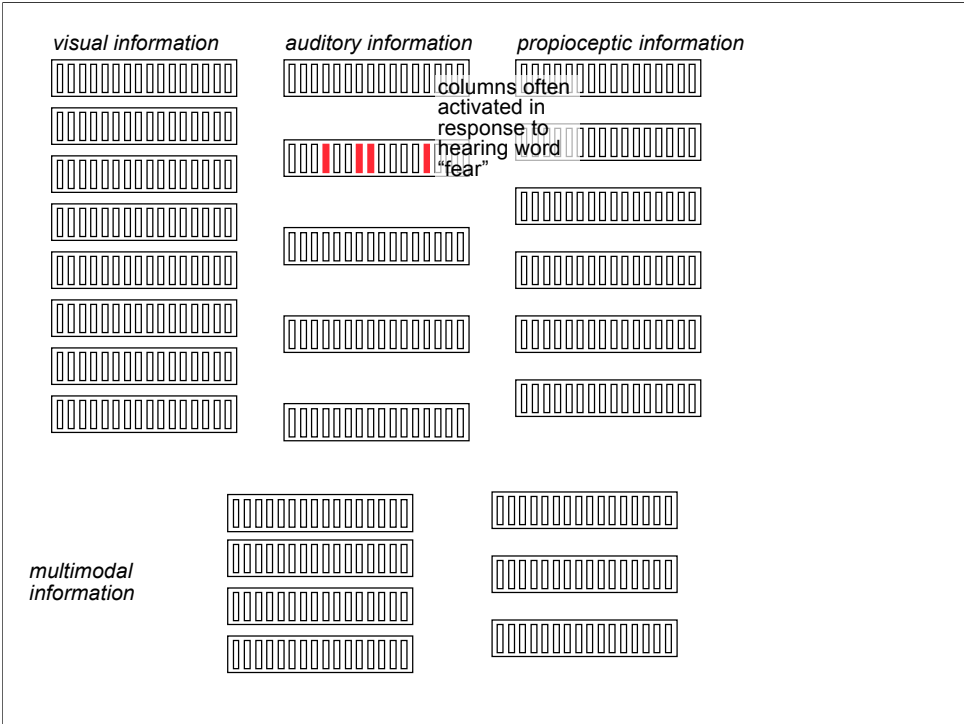
Recall of an experience could generate the emotion

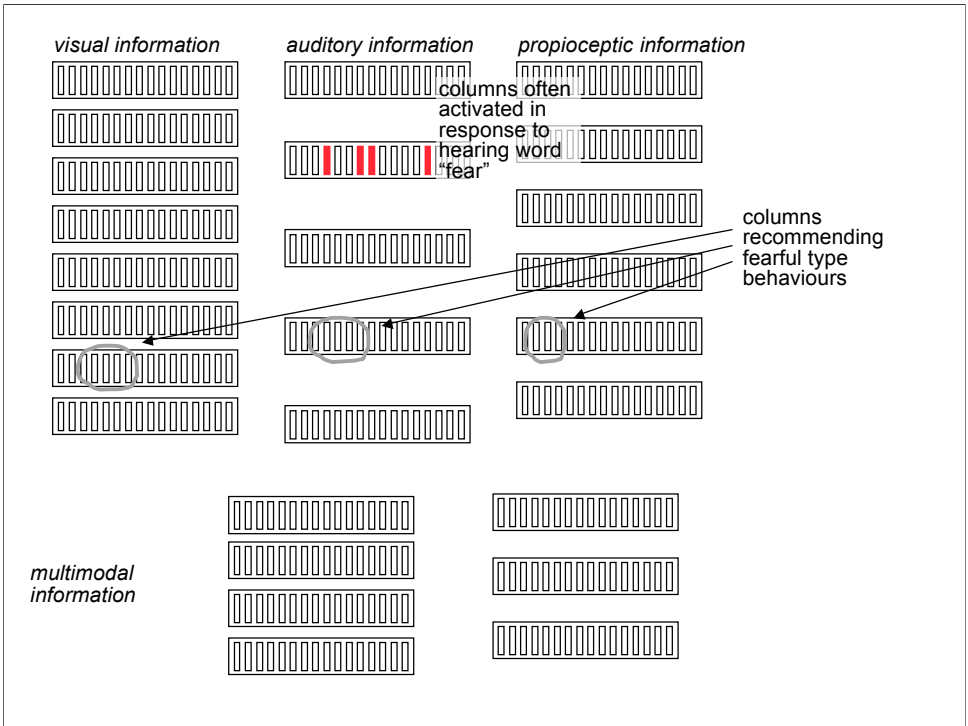
In summary, emotions would correspond with release of a neurochemical that increases the probability of one general type of behaviour, by targetting both the competition component corresponding with that behaviour and the limited cortex region that detects conditions optimized for discrimination within more specific types of the general behaviour.

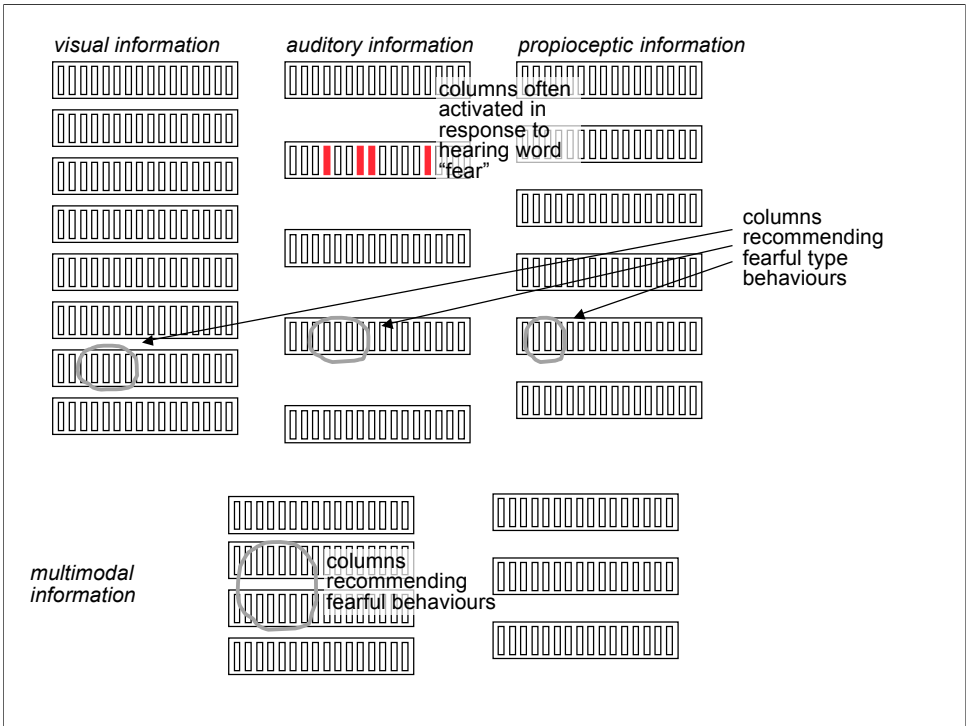
The release of the neurochemical will be triggered by detection of conditions within general circumstances. There will be some genetic programming of these conditions, but additional conditions could gain recommendation strengths into the neurochemical release behaviour.

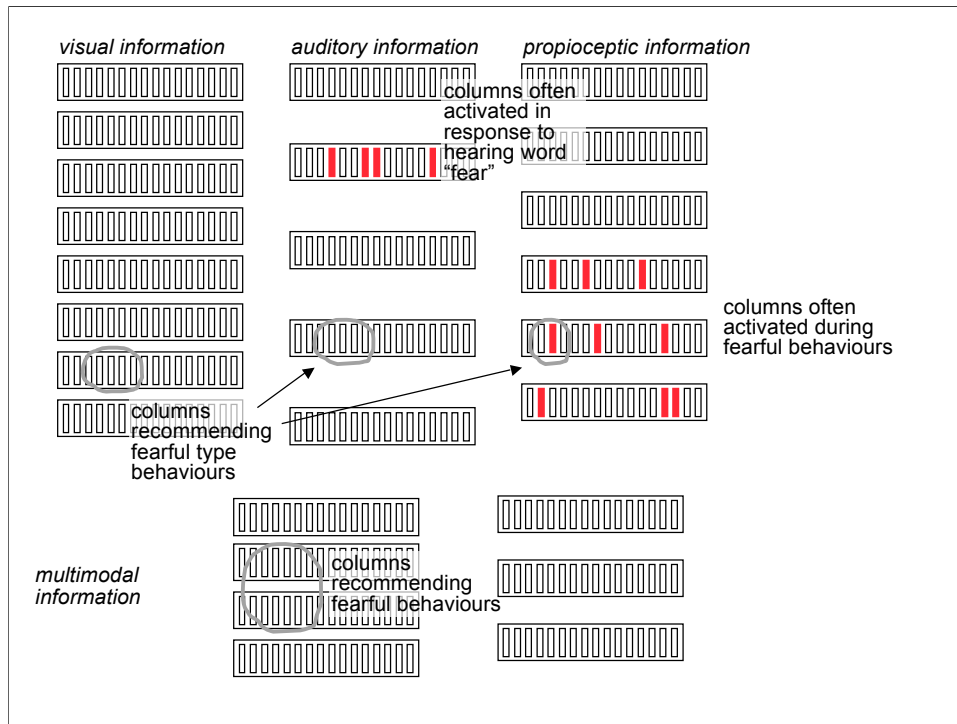
The presence of the neurochemical, or the higher activation of a cortex region, could themselves result in condition detections in columns which could recommend behaviours like saying "I feel angry" etc.

Furthermore, auditory columns within the sound of the word angry could (on the basis of frequent past simultaneous activity) acquire recommendation strengths in favour of the release of the aggressive neurochemical.



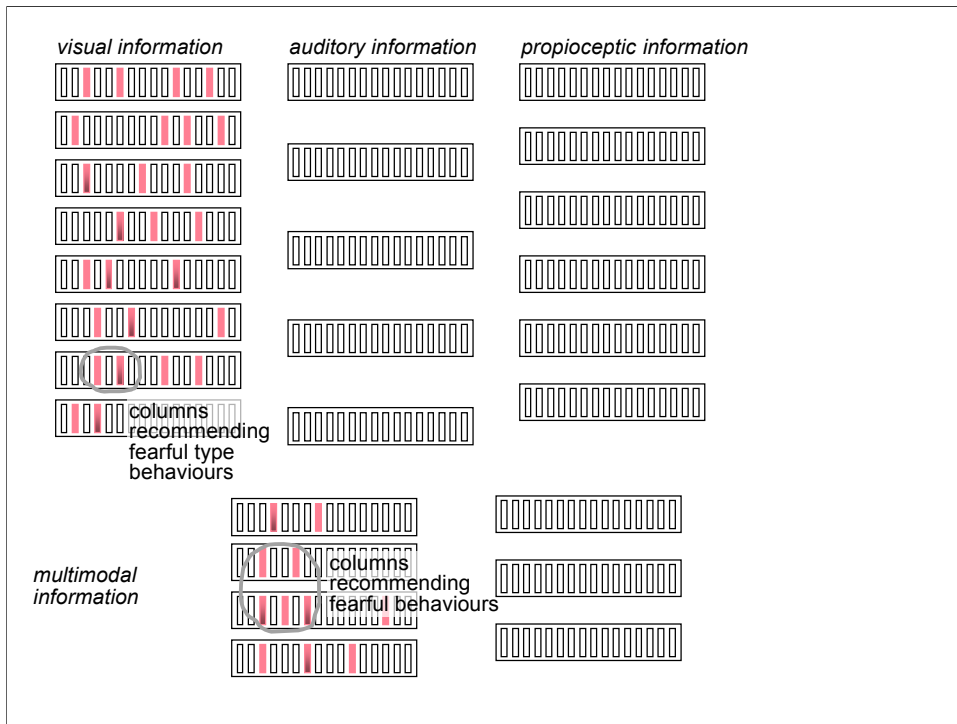






Columns often active at the same time as columns activated at the time the word "fear" is heard include: columns that recommend general fear type behaviours (i.e. those that recommend release of neurotransmitters implementing a bias in favour of fearful behaviours, and result in a subjective perception of fear); columns that often recommend fearful behaviours; and columns often active when movements typical of fearful behaviours occur.

Hence the word can result in activation of many of these columns



Recall of the event can result in activation of columns that recommend fearful type behaviours – feel fear

Recall of event can result in activation of columns that recommend fearful behaviours, you feel like running away

Enough active columns to recommend saying word fear (i.e. the columns recommending fearful and fearful type behaviours)

## Summary of emotion

Emotion triggered by detection of receptive fields  
recommending that a particular general type of behaviour be  
selected

Recommendation implemented by neurochemical release

- modulating receptive field detections in cortical areas recommending specific behaviours of the general type

- modulating the probabilities of acceptance in the basal ganglia in favour of specific behaviours of the general type

Word for emotion often present in past when emotion present

- hearing word can trigger emotion

Simultaneous receptive field expansions occur during novel  
emotional experiences

- recollection of experience can trigger emotion