INFORMATION COMPRESSION, SP-multiple-alignment, AND NEUROSCIENCE

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OUTLINE

■ The importance of **information compression** (**IC**) in human learning, perception, and cognition (HLPC).

■ The **SP Theory of Intelligence** and its realisation in the **SP Computer Model**.

■ The powerful concept of **SP-multiple-alignment** In **IC** and in modelling diverse aspects of HLPC.

■ **SP-Neural** is a first version of the SP Theory in terms of neurons and their interconnections.

IC AND THE WORKINGS OF THE BRAIN

■ From the 1950s, there has been research on IC and brain function by Fred Attneave, Horace Barlow, and many others. But the topic is now relatively neglected.

■ Barlow wrote (1969): "... the operations required to find a less redundant code have a rather fascinating similarity to the task of answering an intelligence test, finding an appropriate scientific concept, or other exercises in the use of inductive reasoning. Thus, redundancy reduction may lead one towards understanding something about the organization of memory and intelligence, as well as pattern recognition and discrimination."

■ Finding "a less redundant code" = IC.

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HOW IC MAY BE ACHIEVED

- In general, **IC** may be understood as a process of merging (or 'unifying') patterns that match each other.

- Example 1, to follow.

- Example 2, to follow.

- There are many other examples.

EXAMPLE 1: IC AND BRAIN FUNCTION

■ Close your eyes for a moment, and then open them again. The 'before' and 'after' views are merged, meaning **IC**.
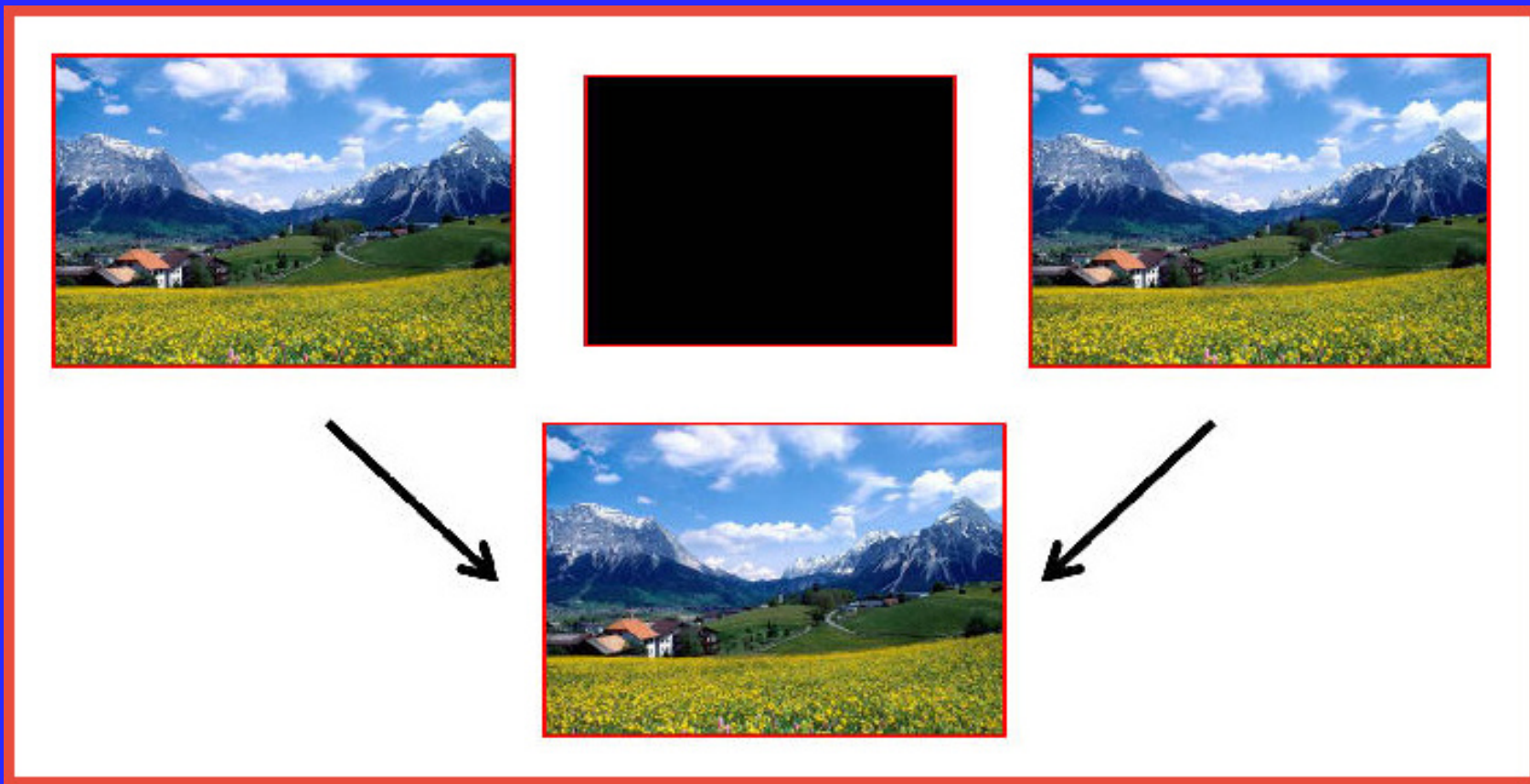
EXAMPLE 2: IC AND BRAIN FUNCTION

- **Chunking-with-codes**: This means using a short 'code' to represent a relatively large 'chunk' of information.

- There are many examples in our use of language:

    - "BBC" = "British Broadcasting Corporation"

    - "New York" = all the complex information in the geography, politics, economics, history, etc, of that city.

    - "house", "walks", "lovely", "energetically", etc = each word is a 'code', and its meaning, which may be quite complex, is a 'chunk' of information.

- In general, every **noun**, **verb**, **adjective**, and **adverb**, in any natural language, may be seen as an example of the **chunking-with-codes** technique for compressing information.

THE SP THEORY OF INTELLIGENCE

- Expressed in the **SP Computer Model**.

- It works entirely by **compressing information**.

- It demonstrates:

  - Versatility in aspects of intelligence: learning, perception, reasoning, problem-solving, and more.

  - Versatility in the representation of diverse kinds of knowledge.

  - Seamless integration of aspects of intelligence and kinds of knowledge, in any combination.

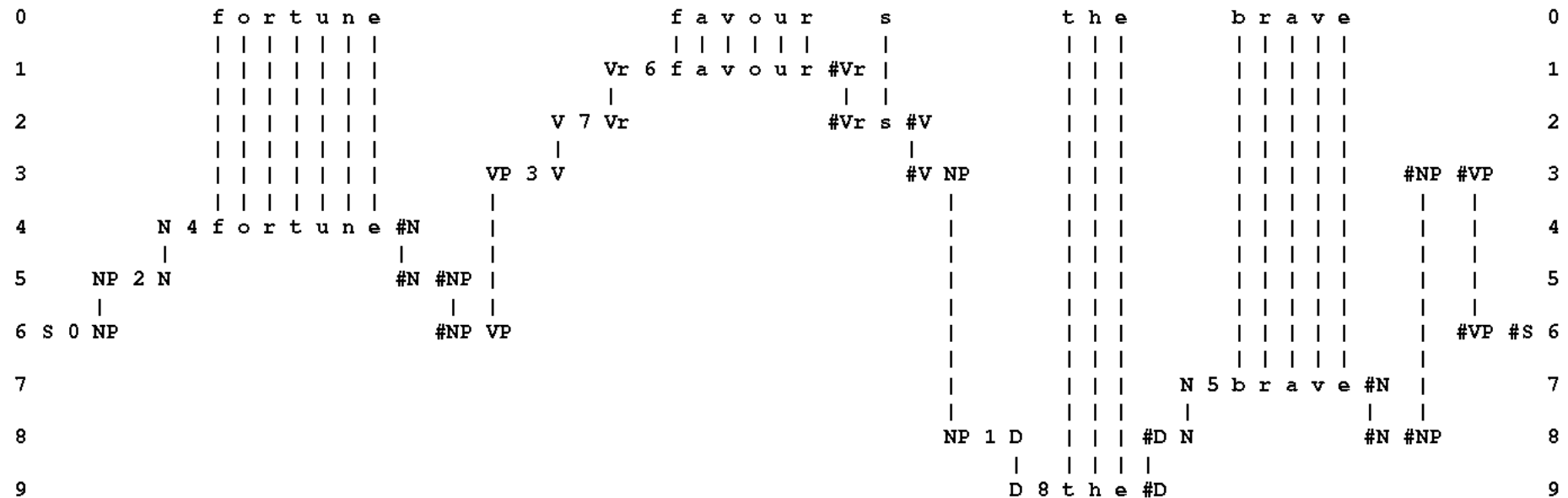- The key to these strengths is the powerful concept of **SP-multiple-alignment** (next but one slide).

MULTIPLE SEQUENCE ALIGNMENT

■ Borrowed from bioinformatics and adapted to become **SP-multiple-alignment**.

■ Used for the analysis of DNA sequences and sequences of amino acid residues.
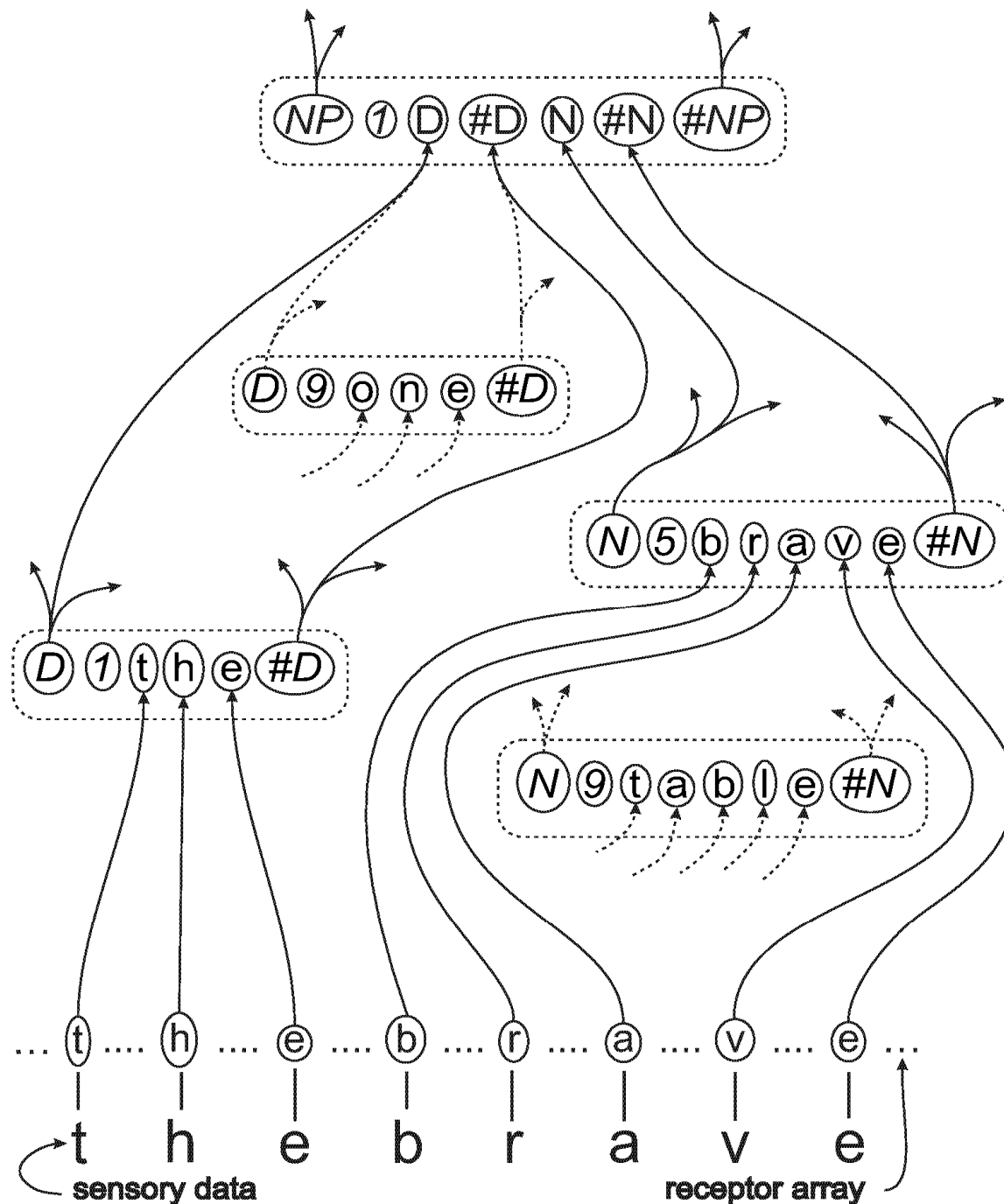
SP-multiple-alignment

```
0      f o r t u n e              f a v o u r   s        t h e     b r a v e            0
       | | | | | | |              | | | | | |   |        | | |     | | | | |
1      | | | | | | |          Vr 6 f a v o u r #Vr |      | | |     | | | | |            1
       | | | | | | |             |                |   |  | | |     | | | | |
2      | | | | | | |        V 7 Vr              #Vr s #V  | | |     | | | | |            2
       | | | | | | |             |                    |  | | |     | | | | |
3      | | | | | | |       VP 3 V                 #V NP   | | |     | | | | |   #NP #VP  3
       | | | | | | |             |                     | | | |     | | | | |   |   |
4      N 4 f o r t u n e #N       |                     | | | |     | | | | |   |   |    4
       |             |           |                     | | | |     | | | | |   |   |
5      NP 2 N               #N #NP |                    | | | |     | | | | |   |   |    5
       |                    |  |                        | | |     | | | | |   |   |
6  S 0 NP                  #NP VP                        | | |     | | | | |   |   #VP #S 6
                                                         | | |     | | | | |   |
7                                                        | | |   N 5 b r a v e #N |     7
                                                         | | |   |           |   |
8                                              NP 1 D   | | | #D N           #N #NP     8
                                                     |  | | | |
9                                              D 8 t h e #D                             9
```

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SP-Neural

- Modelled on the non-neural version of the SP Theory.

- It should inherit strengths of the non-neural SP Theory.

- Inhibitory connections are likely to be important in the compression of information.

Key:

- Character(s) in small envelope = a neuron.

- Large broken envelope = a "pattern assembly".

- Firm line between neurons = active axon.

- Broken line between neurons = inactive axon.

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THE POTENTIAL OF SP-NEURAL IN NEUROSCIENCE

■ **SP-Neural** may inherit empirical support for **non-neural SP Theory**:

  ■ There is much evidence for the importance of **IC** in HLPC.

  ■ A relatively simple SP Computer Model has versatility in many aspects of intelligence.

■ Building computer model(s) of SP-Neural may clarify precisely how it can work with neurons and their interconnections.

■ **IC** should be as important in SP-Neural as it is in the non-neural SP Theory.

■ Evidence that inhibitory neural connections have a role to play in **IC** suggests they may have the same role in SP-Neural.

■ It may be possible to get direct evidence for neural structures and functions like those in SP-Neural.

FURTHER INFORMATION

- www.cognitionresearch.org/sp.htm .

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