

Notes for slides about “Information compression, SP-multiple-alignment, and neuroscience”*

J Gerard Wolff[†]

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Introduction

The *SP System*, meaning the *SP Theory of Intelligence* and its realisation in the *SP Computer Model* has been developed in a lengthy programme of research. The main emphasis has been on developing the SP System in terms of abstract concepts like *SP-multiple-alignment*. But there is also a version of the system called *SP-Neural* which maps the abstract concepts in the main SP System into neurons and their interconnections and intercommunications.

These notes are to accompany slides to introduce SP-Neural and its theoretical foundation in a Keynote presentation as a webinar¹ held during June 08–09, 2020.

For convenience, the slides may be viewed in one window and the notes in another.

The presentation and slides are based on the peer-reviewed paper: “Information compression, multiple alignment, and the representation and processing of knowledge in the brain” [3].

The slides are largely self-explanatory but some of them need more commentary, given where appropriate in the sections below.

*Keynote presentation as a webinar at the *7th International Conference on Neuroscience and Neurological Disorders* held during June 08–09, 2020. The slides are in two versions: streaming and download.

[†]Dr Gerry Wolff, BA (Cantab) PhD (Wales) CEng MBCS MIEEE, ORCID ID 0000-0002-4624-8904. CognitionResearch.org, Menai Bridge, UK; jgw@cognitionresearch.org; +44 (0) 1248 712962; +44 (0) 7746 290775; *Twitter*: @gerrywolff65; *Web*: www.cognitionresearch.org.

¹For links to the slides in streaming form or PDF format, please see the first footnote on this page, or the “Further information” section at the end of these notes.

Title slide: information compression, SP-multiple-alignment, and neuroscience

Information compression has been central in my research for many years, first in developing computer models of language learning, and later in developing the SP System. There is much evidence for the importance of information compression in human learning, perception, and thinking [4].

The concept of *SP-multiple-alignment* and what it can do, is a major discovery in the SP programme of research. It is largely responsible for the versatility of the SP System in aspects of AI, in the representation of diverse kinds of knowledge, and in their seamless integration in any combination.

The main focus of the talk is on how the SP ideas can be useful in understanding neural structures and functions.

Outline

IC and the workings of the brain

How IC may be achieved

Example 1: IC and brain function

Follow the simple instructions at the beginning of this slide. The left picture represents the 'before' view, the black rectangle represents one's eyes closed, the right picture represents the 'after' view, and the picture at the bottom represents the merging of the before and after views, so that one perceives a single view.

If the before and after views are similar but not exactly the same, our brains can cleverly see what is the same and what is different.

People are completely different from old-style cine cameras which has none of these abilities and will extravagantly record many copies of a single scene.

Example 2: IC and brain function

The SP Theory of Intelligence

Developing the SP Theory of Intelligence, its realisation in the SP Computer Model, and exploring some of their applications has taken about 20 years of work.

The SP Theory and Computer Model are described most fully in the book *Unifying Computing and Cognition* [1], and as a shortened version of the book [2].

Multiple sequence alignment

This slide illustrates the concept of ‘multiple sequence alignment’, used in biochemistry for the analysis of DNA sequences and sequences of amino acid residues. It provided the inspiration for the development of the concept of *SP-multiple-alignment*, the most important part of the SP Theory of Intelligence.

In a multiple sequence alignment, DNA sequences or sequences of amino acid residues are arranged one above the other (or side by side), and then by judicious ‘stretching’ of sequences in a computer, symbols that match each other from one sequence to another are brought into line. The aim is to bring as many symbols as possible into alignment.

SP-multiple-alignment

This example shows how an SP-multiple-alignment may achieve the effect of ‘parsing’ or analysing a sentence into its grammatical parts and sub-parts.

The main differences between a multiple sequence alignment and an SP-multiple-alignment are:

- One of the sequences (called *SP-patterns* is a ‘New’ SP-pattern (with a capital ‘N’) which represents information received from the system’s ‘environment’. By convention it is always shown in row 0 of the SP-multiple-alignment.
- The SP-patterns in rows 1 to 9 in this example are ‘Old’ SP-patterns (with a capital ‘O’) representing previously-stored knowledge. There is always one Old SP-pattern in row.

- The aim in creating SP-multiple-alignments like this is to find or create an arrangement that allows the New SP-pattern to be encoded economically in terms of the Old SP-patterns (using a method described in [1] and [2].)

The SP-multiple-alignment concept is very versatile and may be used for modeling several different aspects of intelligence including, natural language analysis (as shown), retrieval of information, probabilistic reasoning, planning, problem solving, and more.

SP-Neural

The figure on this slide shows how, in SP-Neural, three SP-patterns from the SP-multiple-alignment (bottom right) of the previous slide, and the connections between them, may be translated into a structure of neurons and axons between neurons. The three SP-patterns are ‘D 8 t h e #D’ (in row 9), ‘N 5 b r a v e #N’ (in row 7) and ‘NP 1 D #D N #N #NP’ (in row 8).

Other features of the figure are shown on the slide.

The potential of SP-Neural in neuroscience

Compared with the non-neural version of the SP Theory, SP-Neural is at a relatively early stage of development. Probably the most useful thing to do next is to develop a computer model for the theory. To the extent that it can model aspects of human learning, perception, and cognition, it is likely to inherit the strengths and potential of the non-neural SP Theory.

Further information

- *URL:* www.cognitionresearch.org/sp.htm.
- Slides for webinar: streaming, download.
- Contact:
 - *Email:* jgw@cognitionresearch.org.
 - *Mobile:* +44 (0) 7746 290775.
 - *Landline:* +44 (0) 7746 290775.

References

- [1] J. G. Wolff. *Unifying Computing and Cognition: the SP Theory and Its Applications*. CognitionResearch.org, Menai Bridge, 2006. ISBNs: 0-9550726-0-3 (ebook edition), 0-9550726-1-1 (print edition). Distributors, including Amazon.com, are detailed on bit.ly/WmB1rs.
- [2] J. G. Wolff. The SP Theory of Intelligence: an overview. *Information*, 4(3):283–341, 2013. arXiv:1306.3888 [cs.AI], bit.ly/1NOMJ6l.
- [3] J. G. Wolff. Information compression, multiple alignment, and the representation and processing of knowledge in the brain. *Frontiers in Psychology*, 7:1584, 2016. arXiv:1604.05535 [cs.AI], bit.ly/2esmYyt.
- [4] J. G. Wolff. Information compression as a unifying principle in human learning, perception, and cognition. *Complexity*, 2019:38 pages, February 2019. Article ID 1879746. viXra:1707.0161v3, hal-01624595 v2.