

# Preface

As a cognitive scientist, I realize that in the study of the brain, challenges of epistemological nature match those of empirical nature. Issues have to be resolved on both fronts, and with matching impetus. On the empirical forefront, one has to deal with complexities of measurement, system identification, and experimental paradigms. On the epistemological side, function has to be outlined, analyzed, localized, discussed, explained. The two sides must be alloyed if the explanatory summit is to be achieved.

And as a mechanical engineer, I find it difficult to dispel my natural tendency to see mechanism in everything. The meaning of the mechanism analogy in the study of organisms and brain function has to be put under adequate light to be serviceable. In the brain, mechanisms are dynamical processes, highly context dependent, that subserve an incredible breadth of organismic behavior. They are evanescent, but reliable. They are expressible through words and theories, but are exhausted by neither.

I found no common denominator for my conflicting quandaries until I was introduced to cybernetics through the works of von Foerster, Braitenberg, Wiener, Pask, and Ashby, and more recently, Varela, Maturana, Pasemann, and Beer. So pervasive as to be invisible, cybernetics percolated through most of the sciences in the second half of the previous century, and is, to my mind, the only true method of achieving understanding amid the vast amount of knowledge that all sciences currently amass. It was not only once or twice that a powerful epiphany of mine could be retraced 60 years into the past, back to those of the magnificent set of revolutionary scientists who understood what it means to understand. It is to them that I pay dues where dues are due, and in all humbleness offer this book as a cybernetic contribution from a mechanical engineer, turned cognitive scientist, converted cyberneticist.

Some words about the format of the book are required. Skimming the table of contents, one will notice that I took the liberty of dividing it into two parts. Had I heard some good advice "keep it short," it would perhaps indeed have been shorter, more to the point, more concise, and would primarily consist of Part II. But then it would not serve a particular purpose I wanted it to play, which was to make explicit the path towards conclusions. I wanted it to be a complete snapshot, or better, a long-exposure picture, of the considerations leading to subsequent results. For that reason primarily I have very intentionally laid emphasis on epistemology and

theoretical aspects of the problem, hence Part I. This discussion seems to me to be essential to frame both problems that can be fractally complex and conclusions that are strengthened when contextualized. I believe that the process of committing complex ideas to paper has paid off immensely, and I hope to be harvesting dividends of the extra effort in times to come. For that, I must beg to be excused of a certain independence and perchance unevenness in the treatment of topics, at times introductory, at times technical, at times controversial. For that reason also, the references are introduced in the individual chapters. If the reader shall indulge me, I believe that he or she may come to appreciate my choice that more (not less) is more.

Finally, parts of this book have appeared in print before as journal articles (Chaps. 5, 8), a book chapter (Chap. 7), and a newsletter article (Chap. 9). They have all undergone substantial revision in an attempt to deliver a more unified package. Finally, in the spirit of an open work, the book can also be said to be ongoing. The ideas in it, especially the role of invariance in the study of behavior, and constancy and variability in neural systems and behavior, are vast, unexplored, and, I feel, immensely rich. If blinded by my excess enthusiasm I failed to offer the precision and depth the ideas deserve, as a way of apology I urge you to keep on listening. There is more to come.

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