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The Unity of Consciousness: The Binding Problem before 100 B.C.E.

Jonathan Holmes

“We must not be too sure of the ignorance of our ancestors”

– Will Durant

When I was in graduate school in the mid-1990s, one of my main interests was consciousness. What exactly was it? How did it work? How exactly did a three-pound piece of meat in my head produce a person with internal, qualitative, subjective states with a unified perceptual and overall mental experience? This part about unified mental experience is referred to as neural binding, and, since we don't really know exactly how it works, it is called the binding problem.

In brief, the binding problem is the question of how it is that the brain puts all the various simple features of objects from the multiple senses together to (a) create a perception of coherent objects that are distinct from others, and then (b) to put all these coherent objects into a conscious scene where everything is unified in conscious

perception. A major researcher in the area, Anne Treisman, makes the following statement on the problem:

The binding problem in perception deals with ... how we achieve the experience of a coherent world of integrated objects, and avoid seeing a world of disembodied or wrongly combined

shapes, colours, motions, sizes, and distances ... how do we specify what goes with what? (from *Philosophical Transactions of the Royal Society of London*, 1988)

Thus, the binding problem is pretty important. Without such binding, I wouldn't be writing this, as our species would not have survived very long or evolved in the first place. This is because without such binding, consciousness from moment to moment would be a chaotic jumble of sensory and perceptual features in an incomprehensible collage of overlapping and incoherent conscious experience. Figures one and two are attempts by the author to illustrate this, though in simplified form. Figure one represents a picture of a cat correctly bound together. Figure two is a rough idea of what the image might look like if perceptual binding was not working correctly in some fashion.

Moreover, it is not restricted to external stimuli. When we remember something, say the last lunch date we had, various features of that memory are stored all over the brain in various areas. Somehow, they must all come together into a coherent subjective experience. Some think of memory as



Figure 1: (Author's Photo)



Figure 2: (Author's Photo)

a filing cabinet, where memories get filed away, they get stored, and when you want them you open up the correct file and there is your memory just the way things happened. Unfortunately, a better analogy would be that memory is like a jigsaw puzzle made of millions of pieces all scattered about a large number of neural connections that one has to put together in real time, moment to moment, with no picture on the box to go by. Even our train of thought, and whatever comes to mind during it, must be bound together. Whenever I am reminded of this, I am continually amazed that the whole system works at all.

During graduate school I came across a series of papers by Francis Crick and Christof Koch on feature binding in the visual cortex. Francis Crick is the Crick from Crick and Watson that won the Nobel Prize in 1962 for their work on the helical structure of DNA. Crick apparently had a seriously flexible mind, allowing him to switch from expertise in genetics to expertise in neuroscience. At any rate, these papers attracted significant attention as they proposed a measurable mechanism for feature binding in the visual cortex – that is, how we put together various simple features of visual stimuli to build up a conscious experience of something far more complex, like seeing a person or an object. Earlier work had certainly been done decades before, but these papers still stand as a landmark concerning the binding problem. In short, it was proposed that neurons across different areas fire in synchronous patterns or wavelengths to bind visual contents together. It is an idea akin to an orchestra with all the separate instruments playing a coherent song, but with no conductor. Much work has been done since then. Binding is vital to our psychological functioning and it is still a very hot topic in neuroscience and a variety of other areas – so much so that some may think that it is a new

topic, a recent advance, something that was not much considered before. This is inaccurate and, also, where things get interesting.

Some Remarkably Early History

The general idea behind the binding problem, the unity of conscious experience, is far from a new question. One famous person to consider is Descartes in the 1600s. Descartes had ideas about how it all comes together for us, as if there were some little ‘me’ inside our mind watching experience on a movie

Despite such difficulties, and the fact that it is a popular place to start philosophical discussions on the unity of conscious experience, Descartes is a path too well trodden by those who study philosophy of mind. When one looks back further, issues surrounding the unity of conscious experience crop up again and again, and down through history for a long, long time. Therefore, I’d like to share some thoughts on the binding problem from three periods in history more than 1600 years *before* Descartes, to explore some hopefully less familiar territory.

Alcmaeon proposed that a primary distinction between animals and humans was that animals have sense perception, but only humans have understanding. ... This has led some scholars to propose that Alcmaeon was saying that humans can bring together the various senses in a way that animals cannot.

screen in an area of the brain called the pineal gland. This setup is referred to as the Cartesian Theater. It is quite famous for being very intuitive, as well as for arriving at the beginnings of a more modern age that was ready to receive Descartes’ thoughts and build upon his ideas. However, it is also quite impossible, partly due to ignoring the mind-body problem, but partly too in terms of infinite regress with the little ‘me’ – who’s watching the movie in their head, and so on to infinity?

Two words of warning, however. First, when going back into time this deeply, sometimes all we have are fragments of sayings, or comments by others on the original sayings. In a sense, sometimes it is akin to reconstructing a whole dinosaur from a tooth and two leg bones. Second, even experts in the field continue to be perplexed by some early philosophical sayings. Indeed, the Presocratic philosopher Heraclitus was referred to as ‘the obscure’ even in his own time – what is one to make of this

millennia later? So, just a quick caution, there is some wiggle room concerning what exactly these folks were talking about, particularly the further back one digs into their writings and systems. Nonetheless, though the choices I've made may perhaps be obscure or even incommensurable in their details and connections within entire philosophical systems, the selections I've made are very clear examples concerning the binding problem.

Stoicism

The relevant Stoic thinkers lived during a period in time roughly 300 to 100 B.C.E. I will not go into the over-all system of Stoics nor the folks that follow. Rather, I will try to remain restrained to what is directly important to the binding problem. Nonetheless,

modern brain around, but the term originally meant 'breath,' and a kind of vital force that allowed for life and psychological functioning. I might refer to it as more of a pseudo-physical-immaterial breath-like fluid-like thing (I realize that's a bit vague). At any rate, pneuma was a single theoretical entity which the Stoics used to explain the functioning of everything from rocks to the soul or mind (the current distinction between the soul and the mind had not quite fully arrived on the scene yet). In essence, there was a continuum of pneuma tension corresponding to a continuum of degree of unified functioning. The lowest degree of tension simply referred to holding things together, like rocks. A couple levels up was for the soul, which provided for perception and action,

In discussing the human soul or mind, they referred to it, or sometimes a part of it, as the hēgemonikon or the 'governing part.' The hēgemonikon was thought to be a centralized communication mechanism that received information from all parts of the organism, made sense of it, and provided for coherent psychological functioning and understanding. Here is where the binding problem comes into play. The Stoics claimed that it spoke a language common to all the senses, and that it was involved in all mental events. In essence, it allowed for sensory and psychological integration and organization, a requirement for reason and understanding. This ability is at the heart of mental binding.

Aristotle

Aristotle (roughly 382–322 B.C.E.) discussed across several works how, at least in part, the unity of the soul or mind was achieved. In short, for Aristotle there was apparently a 'common sense' or single sense where perceptions all came together. Two quotes from two works of Aristotle are of note here:

But the various senses incidentally perceive each other's proper objects, not as so many separate senses, but as forming a single sense... (from *De Anima*)

Now every sense has both a special function of its own ... but there is also a common faculty associated with them all, whereby one is conscious [the word conscious is probably a somewhat anachronistic translation for the original terminology] that one sees and hears ... for it is not by sight that one is aware that one sees; and one judges and is capable of judging that sweet is different from white not by taste, nor by sight, nor by a combination of the two, but by some part which is common to all the sense organs ... (from *Parva Naturalia*)

... memory is like a jigsaw puzzle made of millions of pieces all scattered about a large number of neural connections that one has to put together in real time moment to moment with no picture on the box to go by. Even our train of thought, and whatever comes to mind during it, must be bound together.

some background may be required to provide context – when this is needed, I will try to be brief!

The key to the Stoic world view was their theory of pneuma. Pneuma is tough to wrap one's much more

such as in animals, and the final level served for intelligence, understanding, and rational thought in humans. Interestingly, this is actually the binding problem right here, in terms of the degree of pneuma tension, but more for physical and mental things overall than just for psychological functioning.

Thus, the common sense allowed for judgments between the senses, necessarily bringing them together in some way to help provide a unified psychological experience. Again, this is the binding problem.

they are incapacitated if it is moved or displaced; for it obstructs the passages through which the senses work.” It is a bit unclear how one’s brain becomes “displaced,” though it does not sound comfortable. Nonetheless, such work

problem I have ever encountered. It is sweet, simple, and really gets to the point. He states, “One vision is produced by both [eyes],” or alternatively, “One vision of two eyes is born.” In fact, when introducing the binding problem to students in my classes, I will often start with this quote, as it is so straightforward and to the point, even if, ironically, it was written roughly twenty-five hundred years ago.

Binding is vital to our psychological functioning and it is still a very hot topic in neuroscience and a variety of other areas – so much so that some may think that it is a new topic, a recent advance, something that was not much considered before.

Epilogue

It seems that the concept of the binding problem, something vital for psychological functioning that is still a very hot topic in neuroscience, has some very, very deep roots. Every discipline of course has its own unique history that is ‘bound’ together with the culture and history of everything else. It is humbling, fascinating, frustrating, and beautiful, that we can go back thousands of years and see modern ‘new’ ideas, current hot topics and the fashionable research of our times, presented so long ago, and to see how they are ‘bound’ to our modern concepts across vast swaths of time via the progression of intellectual history.

The Presocratics

The time of the Presocratics started with Thales (roughly 636–546 B.C.E.) and ended around the time of Socrates and Plato about three hundred years later. During this time period, two people are particularly worth mentioning.

The first is Alcmaeon (roughly 510–440 B.C.E.), one of the first physicians on record to have moved away from archaic, mystical, or religious medical thought toward more biogenic and naturalistic ideas about human functioning. Interestingly, he was earlier than Hippocrates (460–370 B.C.E.), who is often considered the ‘father’ of more rational and modern medicine.

Alcmaeon is said to have done a number of non-human dissections excising eyes and noting their connections to the brain. One fragment attributed to him states that, “All the senses are somehow connected to the brain. That is why

led him to conclude that the various sensory modalities were unified in the brain – this is the binding problem again, more or less, specifically in terms of, “Where does it all come together?”

Additionally, Alcmaeon proposed that a primary distinction between animals and humans was that animals have sense perception, but only humans have understanding. The interesting part here for this paper is that the term used for understanding at one point in time roughly meant ‘to bring together.’ This has led some scholars to propose that Alcmaeon was saying that humans can bring together the various senses in a way that animals cannot. This idea is tantalizing, as it suggests again a binding together of psychological experience from differing modalities into something unified.

It is our second person however, Empedocles (roughly 495–435 B.C.E.), who provides perhaps the simplest, most elegant framing of the binding



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