Understanding Physical Objects

Object Conception, Semantic Memory, Abstraction and Association

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Contents

1 Introduction

Commonly we have thought of physical objects merely as consisting of indivisible atoms. But since the development of quantum theory, atoms have not only been divided, but also transformed into nuclear energy. As physical objects can appear in various different forms, their fundamental nature has proven difficult to determine. And since different people also have various different interpretations of these appearances, their associated significance can be even more difficult to discern. Yet they play a central role in our worldly understanding as we use them daily in thought as well as communication. But perhaps there is another perspective that can be more helpful to shed some light on the ontology of objects; perhaps we can understand how we conceive of and understand these objects to begin with. Such an inquiry does not limit our concern to the relations between physical objects or the accuracy of their interpretation, but allows for an investigation of the underlying, mainly psychological conditions necessary for object understanding.

The process of physical object conception can be explained as sensible recognition followed by identification through memory. The object identities are then stored in an abstract semantic memory structure where the object model and its associated significance is developed. This thesis will set off to explore these different cognitive functions in order to discern how physical objects are conceived and understood. The journey will take us from a solid stone to the elementary particles, through Kant's theories of noumena and phenomena and also examine the development of episodic and semantic memory with help from the psychologist Endel Tulving. Hume and Stuart Chase, a social theorist concerned with general semantics finally provide useful insight in order to explain how semantic memory is structured and how semantic meaning is derived through various associative connections.

1.1 Purpose and Question Formulation

The purpose of this thesis is to explore the process of physical object conception and investigate how physical objects are identified and understood through the development of memory.

How do we recognize and identify a physical object? How is it stored in memory? And how is our physical object understanding developed through abstraction and association?

1.2 Method

The underlying idea behind this thesis has been to bring about a deeper understanding of physical objects through a synthesis of different research perspectives. This has lead to a more diverse study that indulges in both philosophical, physical as well as psychological theory. Key aspects are presented with the help of literature from distinguished researchers in their respective fields, while a few explanations of physical phenomena are supported by scientific articles. The disposition has mainly been organized according to the developmental order of the physical object conception process. But it also reflects the author's own inquiry, where problematic questions set the direction of the investigation.

1.3 Disposition

Recognizing Physical Objects (Section 2) This section attempts to illustrate the arbitrary nature of physical object delineation by scrutinizing a stone through orders of magnification. The delineation of a human being is also briefly problematized. In subsection 2.1, Kant's philosophies are applied as it is explained how an abstracted object identity is necessary for object conception and the functioning of our understanding. With further help from Kant the final subsection (2.2) explains how the identity and its ascribed sensations develop an abstracted model of an object, as distinguished from 'the object in itself'.

Memory and Models (Section 3) In this section the distinction between episodic and semantic memory is presented with assistance from the neuroscientist Endel Tulving. The relation between the two is illustrated and object models are understood as cognitive referents in semantic memory, ultimately developed through the continuity of appearances.

The Structure of Semantic Memory (Section 4) Here the structure of semantic memory is examined. Chase's orders of abstraction and Hume's associative connections are presented to understand how the semantic significance of an object is derived from its associative context.

Summary (Section 5) The main points of the thesis are summarized.

Concluding Discussion (Section 6) Finally, a concluding discussion puts some perspective on our findings.

2 Recognizing Physical Objects

Figure 1: A stone in the grass

When we recognize an object in the physical world we do so by recognizing a delineation through sensory differentiation. Take for example the stone in figure 1, an object with a relatively clear border. It is delineated by its ragged surface which is recognized through its relation to its environment. The stone and its environment show differences in their reflection of light; the stone is of different color than the grass in which it rests. If we go on to examine our stone we can feel the different strengths of structure (material), the gravitational impact (weight) and atomic vibrations (temperature) against our skin and so on. In this manner it can be said that the recognition of an object is a sensory recognition of difference between two opposing sides. By common logic nothing can be both stone and non-stone (its environment) simultaneously. So in this sense we have separated the world into distinct parts. This behavior can however lead to a certain confusion as these borders are not absolute in nature. For example, if we bring our stone inside a laboratory and magnify it through an advanced microscope in atomic or even quantum detail, the object appearance and the delineation we recognize will be completely different if at all distinguishable.

[1] David Shiga, *Microscope discerns atoms of different elements* (2007)

At first we would find several different types of vibrating atoms (similar to figure 2) and adjust our object delineation according to the atomic structures we think should be contained in the concept of our stone. Afterwards we may try to draw an arbitrary line between stone and non-stone, through a landscape that at this scale perhaps more resembles the complex, vibrant surface of our earth than that of a small stone. But as we keep enhancing our magnification, the once believed indivisible atomic particles dissolve once again, this time into even more elusive subatomic particles; protons, neutrons and electrons (similar to figure 3).

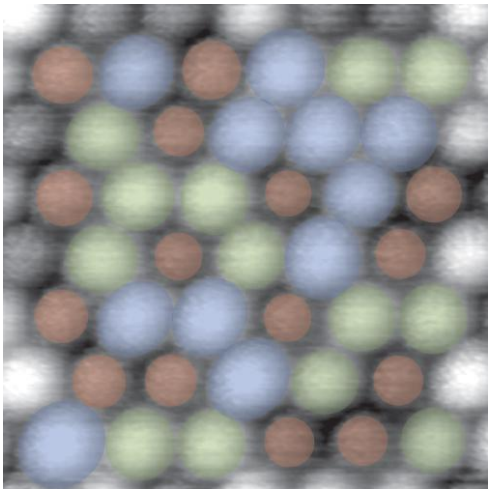

Figure 2: Individual atoms observed through an atomic force microscope.[1]

Finally, according to quantum physics, the subatomic particles in turn dissolve into the tiniest elementary particles; fermions ("matter particles") such as the quark, and bosons (“force particles”) such as the photon and Higgs boson, which mediate interactions between the fermions. In superstring theory particles are understood as different energy states of vibrating strings. The theory states that there is an infinite number of potential particles, but that only a finite number are accessible to experimental detection at available energy levels. And so it is believed that the elementary particles constitute the tiniest particle expression in the energy levels available in our universe.[3]

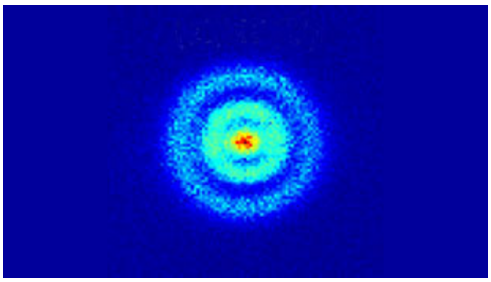

Figure 3: A hydrogen atom observed through a quantum microscope.[2]

To further clarify the arbitrary nature of object delineation we could try to delineate a human body. We may start drawing our line along the skin and perhaps even as fine grained as around every wiggling piece of hair as well. But no matter how precise we are in our effort, the problem of interaction and transformation will remain. For example the oxygen running through our bloodstream was once part of the environment, incorporated

[2] Tushna Commissariat, *'Quantum microscope' peers into the hydrogen atom* (2013)

[3] Murray Gell-Mann, *The Quark and the Jaguar* (1995), p. 198.

into our concept of the human body through breathing. The energy we use and the cells we consist of were once food we ingested and light from our sun and so on. Even our stone, as solid and timeless as it may seem, is also an expression of an inert pattern of movement, similar to a whirlpool in water. The electrons are still dancing on the subatomic level, slowly scattered by sunlight, wind and falling rain, until the pattern changes and structure finally dissolves.

2.1 Object Identity

So we have found that physical objects can change content and appear completely different if at all distinguishable depending on our perspective. Yet we still consider these appearances to be expressions of the same object. Hence we do not only perceive of an object, but also abstract a corresponding identity to which we ascribe the recognized sensations. To understand how an object identity is created, we have to consider the different functions at work in the object conception process.

Kant distinguishes between two different stems of human cognition, namely sensibility and understanding. Through sensibility objects are given to us and through understanding they are thought.[4] All thought however, whether direct or indirect, must ultimately be related to sensibility, because there is no other way objects can be given to us in the first place. Sensibility in this sense is the capacity of the observer to receive a sensation of the object, what Kant calls an empirical intuition. The undetermined object that appears to us through this empirical intuition, before any interpretation through understanding, he calls an appearance.[5] However, Kant argues that the intuitions of time and space are already necessary for us to apprehend such an appearance and should be considered pure, a priori intuitions. These pure intuitions are not rooted in sensation or understanding, but lie in the sensibility of the mind itself.[6] The pure intuitions are therefore to be regarded as the conditions of the possibility of appearances, not as determinations dependent on them.[7]

The object identity is closely related to these pure intuitions. Without intuitions of time and space there is no spatial-temporal context from which the object appearance can be given to us. And without abstracted object identities, the information received from such appearances would have nothing to refer or attach to and so no memorizing about

[4] Immanuel Kant, *Critique of Pure Reason* (1781), p. 135, A15.

[5] Ibid., p. 155, A19/B33.

[6] Ibid., p. 155-156, A20-21/B34-35.

[7] Ibid., p. 158, A24/B38-39.

anything would be possible. Hence identities are a prerequisite for the functioning of our understanding that allows for the differentiation of sensation and the mapping of spatial-temporal relations. For different sensations to be understood as expressions of the same physical object they are to be understood as following a continuous trajectory through space-time. Even though our stone changes appearance beyond recognition through the orders of magnification, we still consider it to be the same object because we are examining the same space-time trajectory. And even though the vibrant subatomic content that constitutes our object may change over time, we still consider it to be the same object if the sensation is sufficiently similar.

2.2 Object Model

When a space-time trajectory is identified we can also start learning about its development. If we for example consider the appearance of our stone in the first section, before any understanding is applied, we find no direct expansion of three dimensional space or substance, nor any material attributes or borders given in the appearance alone. Hence most of the object as we understand it is derived from memory of previous experience; information about the object trajectory and perhaps primarily its interaction with other object trajectories. Following this information we can then predict future developments as well. In this way we create models to orient us in the physical world from memory. This behavior is a fundamental attribute of what the renowned elementary particle physisist Gell-Mann calls complex adaptive systems; a class in which we humans are part. The process can generally be described as the system (the person) gathering information, then identifying rules and consistency in that information and compressing it into an abstract schema or model.[8] The compression Gell-Mann mentions implies a certain loss of information that will be more thoroughly discussed in the coming section.

To clarify the constructed nature of our models we can continue exploring Kantian philosophy. Kant distinguishes between what he calls noumena and phenomena; the world as it is 'in itself' and the world as it appears to us. As we can only experience the world as it appears to us through our senses we cannot actually directly observe anything that lies beyond this appearance; anything as it is 'in itself' (noumena).[9] Noumena he explains as something that isn't of anything, but signifies the thought of something, abstracted through our sensible intuitions.[10] He continues explaining that because we are limited to

[8] Gell-Mann, *The Quark and the Jaguar*, p. 17.

[9] Kant, *Critique of Pure Reason*, p. 347-348, A249-250.

[10] Ibid., p. 348-349, A252.

observe through our own sensibility, we can only infer the existence of objects through interpretation of appearances. The appearances in phenomena are then considered the effect of something which we consider its cause.[11] Because the same effect can have more than one cause the projection is however always uncertain. Hence our models of physical objects aren't constructed from things as they are 'in themselves' (noumena), but evolve from a series of sensible appearances (phenomena) that through memory allow for space-time trajectory identification and storage of developmental information (models). As we have found the significance of memory in our conception of physical objects it will now be examined further.

[11]Kant, *Critique of Pure Reason*, p. 535-537, A538-541/B566-567.

3 Memory and Models

When trying to understand memory some nuancing has been necessary to delineate between different types of memory functions. Although there are a great number of categories such as short and long term memory, working and auditory memory and so on, there are two categories that will be covered in this section, namely episodic and semantic memory. Endel Tulving, the psychologist and cognitive neuroscientist who first made the distinction between these two concepts, helps us understand how our physical object models are constructed, and how they function as 'cognitive referents'.[12]

3.1 Episodic and semantic memory

To understand how a model is created we have to examine the relation between episodic and semantic memory. Episodic memory receives and stores information regarding temporally dated episodes or events, and temporal-spatial relations among these events. For example that one remembers seeing a flash of light a short while ago, followed by a loud sound moments later (lightning and thunder), or that one remembers having an appointment tomorrow. In this way the appearances (phenomena) are always stored in terms of their autobiographical reference to the already existing contents of the episodic memory store.[13] As the episodic memory store follows spatial-temporal logic it is a fundamental manifestation of what Kant called pure space-time intuitions, as mentioned in the previous section. Retrieval of information from the episodic memory store also serves as an input to episodic memory and thus changes the contents of the store. And as the detail of most episodic memories also fades over time the system can be considered quite susceptible to transformation and loss of information.[14]

Semantic memory on the other hand is necessary for the use of language and can be understood as a mental thesaurus. Information stored in the semantic memory system represents objects; general and specific, living and dead, past and present, simple and complex; concepts, relations, quantities, events, facts, propositions and so on, detached from autobiographical reference.[15] For example that one remembers that grass is green and stones are hard, that July is the month following June and that the association between "table" and "chair" is stronger than that of "table" and "nose". Any input to the

[12]Endel Tulving and Wayne Donaldson, *Organization of Memory* (1972), p. 382.
[13]Ibid., p. 385-386.
[14]Ibid.
[15]Ibid., p. 389.

semantic memory system is always referred to an existing cognitive structure and so contain information regarding the referent they signify rather than the input signal as such.[16] For example if one observes a stone in the grass, the information that might be stored in semantic memory refers to the abstracted concept of our stone (the cognitive referent) that resides in semantic memory, not the sensible intuition that appears before our eyes. If a person possesses semantic memory information, he obviously must have learned it, directly or indirectly, at an earlier time, but he need not possess the episodic information of that learning in order to retain and use the semantic information.[17] Because semantic memory can outlast the episodic information underlying its development, information regarding a physical object's space-time trajectory (model) can be retained without any explicit empirical foundation. Information in episodic memory of necessity must be recorded into the store directly, while semantic memory information can, although it need not, be recorded indirectly or in a piecemeal fashion. As items in episodic memory are connected through spatial-temporal relations, items in the semantic memory store often associate each other in this manner as well. Yet there are many relations between concepts in semantic memory that do not follow this logic.[18]

The relation between episodic and semantic memory can be illustrated according to figure 4. When appearances are stored in episodic memory they form an autobiographical timeline of events. Our visual sensibility allows us to differentiate between colors and shape in two dimensions with the added benefits of binocular vision. So in this sense the items in episodic memory contain discrete frames that retain information regarding the spatial relation between different visual sensations. As episodic memory discretizes the continuous flow of visual appearances, the translation leaves out a certain amount of detail; that which happens between the frames. The reader may try to evoke a continuous video sequence from memory, at least to the author it appears impossible. However, when it comes to less information intensive non-visual sensations, a higher amount of detail can usually be recalled. For example we can easily recollect entire melodies. But as we don't remember it all at once we often have to start over and follow the melody in order to figure out how it develops. Hence it appears we are still working with fragments and their interrelations.

[16] Tulving and Donaldson, *Organization of Memory*, p. 389.

[17] Ibid.

[18] Ibid., p. 388-389.

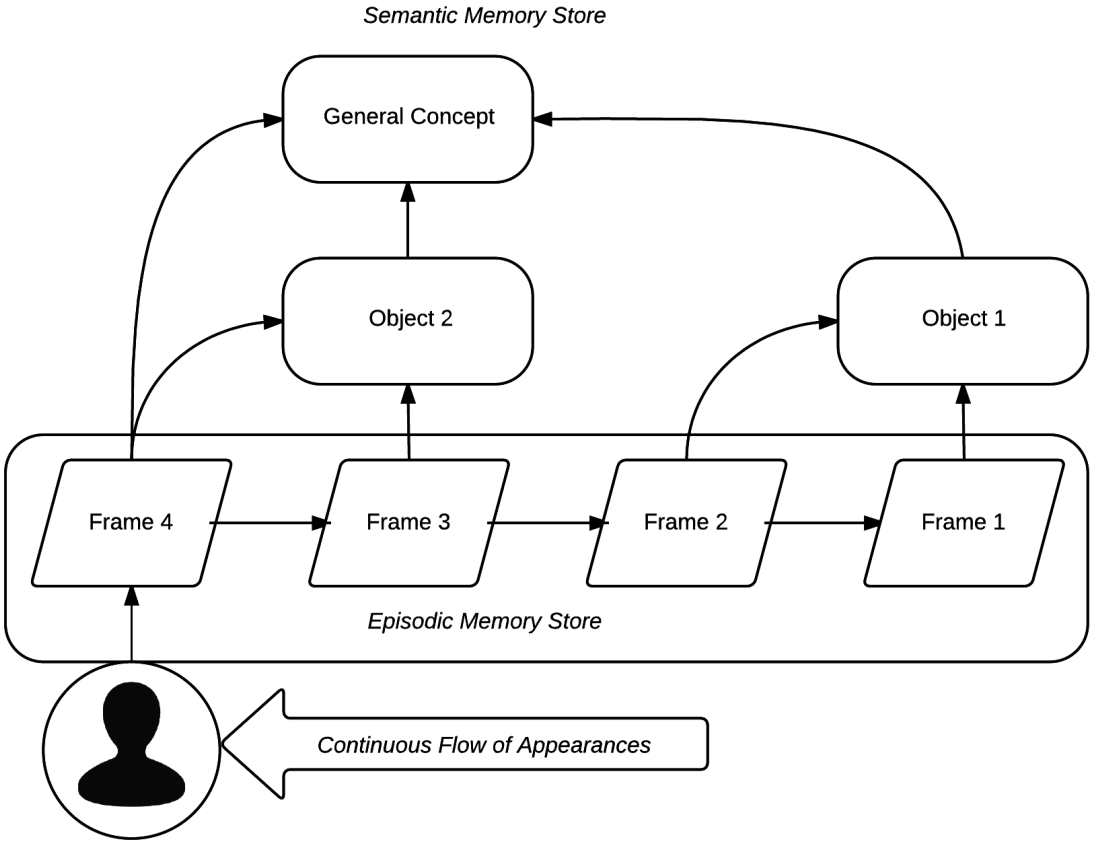

Figure 4: The relation between episodic and semantic memory

As a frame is never understood outside of the context of other frames, any storage or recollection of a specific event is influenced by its temporal relations to the others. When the frames are then put together they form a slideshow from which we can identify temporal-spatial relations between different sensations. From a bundle of episodic memory we can now identify a physical object space-time trajectory and store it as a cognitive referent in semantic memory. As we continue examining the yet undetermined object, we learn about its inertia, how its shape persists over time from different points of view, about the sensation of resistance upon touch, weight, the possibility of moving it around and so on. All this information is associated to our object in semantic memory, effectively developing the object model.

So far we have only stored information about one specific object. But as we find another that behaves in accordance to the first object model, we realize that they are similar. Hence we combine the two into a general concept that describes these similarities. As shown in figure 4 the following appearances can now be interpreted in relation to an

increasingly complex semantic structure. As the episodic timeline develops, the semantic structure is populated with a multitude of cognitive referents and so each observation can associate to a vast amounts of increasingly abstract concepts. In this way semantic memory can also influence what is perceived and stored in episodic memory; the phenomenon is called encoding.[19] For example a toy may associate the entirety of childhood for an adult observer, while for a child it merely associates playing and other toys. In this sense we find that the understanding of physical objects isn't limited to the episodic spatial-temporal development of the object trajectory, but also involves various abstract associations in the semantic memory structure. As these items also influence our understanding of physical objects, abstract concepts and their associative connections will be further examined in the coming section.

[19]Tulving and Donaldson, *Organization of Memory*, p. 386.

4 The Structure of Semantic Memory

To understand how physical objects and concepts relate to each other, Chase differentiates between different orders of abstraction. The first order of abstraction he calls the referent which is the yet undetermined object as we conceive of it through our sensible intuitions. These referents are then developed into an interconnected semantic structure through several orders of abstraction as presented below.[20]

4.1 Orders of abstraction

0. **The space-time event**

   To the best of our knowledge it is continuous, unique and can be ascribed an indefinite number of characteristics.[21]

   According to Chase we cannot observe this event. In this sense Chase's space-time event resembles Kant's idea of noumena, things as they are 'in themselves' prior to sensible reception. At least they both emphasize the important limitation in that we cannot observe outside of our own sensibility. Hence the event can be considered a representation of the unknown that lies beyond this border.

1. **Referent, object**

   In the first order of abstraction the physical object is apprehended by the senses, it is of finite size and has a limited amount of characteristics.[22]

   As Chase's referent is directly perceived through sensible intuitions it can be considered an appearance as explained by Kant in section `2.1`.

2. **Word or label**

   The object is given a symbolic representation, a name.[23]

   As the continuity of the appearance develops episodic memory, the physical object space-time trajectory can then be identified. Although it isn't necessary to give

[20] Stuart Chase, *The Tyranny of Words* (1938), p. 84.
[21] Ibid.
[22] Ibid.
[23] Ibid.

the object a linguistic representation (a name) in order to identify it, the object model cannot be developed without an abstracted symbolic representation or identity. Hence we at least have to construct some sort of mental representation or image that can function as cognitive referent.

3. **Description of object**

   We now begin to describe the particular object or symbol and ascribe attributes to it.[24]

   Through experience of the object's spatial-temporal development, we start the construction of our object model by adding attributes to it. Hardness implies an experience of resistance upon touch and grey implies a color upon watching it and so on. In this sense attributes are developed through observation of episodic memory from a perspective that spans both time and space.

4. **Inferences from description**

   In the fourth order of abstraction we refer to whole classes and object types in general.[25]

   As we find other objects that have the same attributes or fit into the same model, we can now give the model itself a name. Stones are things that are three dimensional, hard and grey and so on.

5. **Other inferences and abstractions**

   From here abstractions can break out in all directions.[26]

   We can expect a person to express form and shape, but can we really fathom her intentions, dreams and beliefs?

[24]Chase, *The Tyranny of Words*, p. 84.
[25]Ibid.
[26]Ibid.

Chase gives an example of how a pencil can develop through the orders of abstraction:[27]

0. The [unobservable 'actual'] event.
1. The referent, non-verbal [unidentified appearance].
2. The word, label or symbol "pencil" [cognitive referent or identity].
3. Descriptions of this pencil [object model development].
4. Pencils as a class.
5. Pencils as household equipment along with chairs and tables.
6. Pencils as part of the term "shelter", as distinguished from clothing.
7. Pencils as part of the term "standard of living".
8. Pencils as part of the term "economic goods".
9. Pencils as part of the term "production".
10. Pencils as part of the term "capitalism".
11. Pencils as part of the term "western civilization".
12. Pencils as part of the term "human culture"... and so on.

So a stone does not only associate substance, hardness and color, but also 'primitive tool', 'building material' and 'dead'. Although many of these more abstract concepts can be considered outside of the object definition, they still influence our object understanding through encoding and association. In the object definition we try to differentiate between which of these connections that always go together. For example a stone isn't always used as a primitive tool or building material, but it is indeed always dead. A brick on the other hand is a building material by definition, because it is always expected to be used in construction. Finally, if we find a stack of finely shaped stones on a building site (a more abstract concept), our object interpretation is influenced by encoding from the higher order abstraction. Hence most people would agree that the stones can now appropriately be interpreted as building materials. As the order of abstraction increases, the models disconnect from physical reference altogether, through manipulation and imagination. This is how for example the stones that make up pyramids can associate such abstract concepts as mythical realms.

[27] Chase, *The Tyranny of Words*, p. 85.

4.2 Associative Connections

So our understanding of physical objects and the interpretation of their episodic spatial-temporal development is highly influenced by abstract concepts and their associative context in semantic memory. As we have found that our association patterns don't necessarily follow episodic logic, the associative connections between semantic items will be examined further. Hume attempts to explain the associative connections between different thoughts and ideas. He distinguishes between three main components of this process, and adds a fourth for more vague connections:

1. *Resemblance. "A picture naturally leads our thoughts to the original."* [28]

   As the "original" is an item in semantic memory, it functions as a cognitive referent for the observation. As any input to the semantic memory system is always referred to the existing cognitive structure, the picture is interpreted in terms of the original. This is the encoding process at work.

2. *Contiguity. "The mention of one apartment in a building naturally introduces an inquiry or discourse concerning the others."* [29]

   As episodic memory stores information regarding spatial-temporal relations, many of the semantic memory items are also organized in this way. However, as a semantic memory item can also be constructed from disjointed frames in the episodic memory store, imagination or other abstracted semantic items, they aren't necessarily related according to this logic. For example an apartment could also associate city life or the ghosts of previous residents depending on which cognitive referent that gets priority in the encoding process. This type of association can be called contiguity through orders of abstraction.

3. *Cause and effect. "If we think of a wound, we can scarcely forbear reflecting on the pain which follows it."* [30]

   Hume argues that the third connection 'cause and effect' can really be explained as something similar to the second connection, 'contiguity'. As what is cause and effect is a result of an experience of conjoinment, they are only linked together through a

[28] David Hume, *An Enquiry Concerning Human Understanding* (1777), p. 101-102, sec. III.
[29] Ibid.
[30] Ibid.

sort of temporal contiguity and our habit of interpreting such relations as cause and effect.[31] Because a frame is always understood from its spatial-temporal connection in episodic memory, associations naturally follow temporal succession.

4. *"For instance, Contrast or Contrariety is also a connexion among Ideas: but it may perhaps, be considered as a mixture of Causation and Resemblance. Where two objects are contrary, the one destroys the other; that is, the cause of its annihilation, and the idea of the annihilation of an object, implies the idea of its former existence."* [32]

   Perhaps this fourth associative connection can be explained in terms of cognitive referents and encoding. As an appearance can exhibit behavior that fits into several different models through several orders of abstraction, there is a contradiction between the models. Depending on which model we choose to interpret the appearance, we arrive at different conclusions. These conclusions are then considered contrary. So the association between contrary ideas can be considered an association between alternative models or associative 'clusters' that function as cognitive referents for same the input signal. For example, if you perceive of a box and consider opening it, you would expect it to either contain something or be empty. If you open a newly bought ice cream box however, you no longer doubt there is a content, instead you might be concerned with what type of ice cream it contains. But the alternatives are really unlimited as the box-like appearance may just be an illusion that suddenly disappears upon opening and so on.

   So objects and concepts are not only connected through resemblance and episodic spatial-temporal contiguity, but also through contiguity in the orders of abstraction and through the habit of comparison in the encoding process. As an event can have strong connections to different cognitive referents, their relation is reinforced through the frequency of their contradiction. Similar to how opposing political parties are related through debate, or conflicting nations are related through war, models also relate through opposition.

[31] Hume, *An Enquiry Concerning Human Understanding*, p. 109, sec. IV.

[32] Ibid., p. 106, sec. III.

5 Summary

A physical object is not something we directly perceive in an external world, but an understanding that develops through several different cognitive functions. As Kant points out to us, we can only observe the world as it appears to us through our senses (phenomena), not how it is 'in itself' (noumena). Depending on the object's relation to its environment and the capacity of the observer, we may find anything between elementary particles, waves, fields and solid substance upon observation. And as there is always movement over and around the object border, its delineation is never absolute.

Due to our sensibility and pure space-time intuitions we are capable of receiving appearances in a spatial-temporal context, but only through identification are we able to retain information about them. Hence the abstraction of identities is a prerequisite for the functioning of our understanding. In what Chase calls the first level of abstraction (comparable to Kant's phenomena), a continuous flow of appearances or referents are perceived and thus develop episodic memory; a discretized autobiographical timeline storing spatial-temporal relations between recognized sensations. As we can now begin to observe appearances in a temporal perspective, we start to recognize patterns of space-time continuation. From a bundle of episodic memory we then identify a differentiable space-time trajectory and abstract its cognitive referent, which is then stored in semantic memory. This is what Chase calls the second level of abstraction and it is here the object model is initially conceived, through memory and identification.

As we continue to examine the yet unknown object and add more frames into episodic memory, we experience its attributes, weight, substance and temperature. In the third level of abstraction these descriptions are then added to the cognitive referent in semantic memory. When we then find another object that subscribes to these attributes or behaves according to the same cognitive referent, we realize that they are similar. Hence, in the fourth order of abstraction, we combine the two objects into a general concept that describes these similarities. Stones are things that are visually differentiable as grey and three dimensional, give a sensation of resistance upon touch and so on. In this sense attributes are abstracted from episodic memory according to the development of the identified object space-time trajectories.

As the episodic timeline develops, the semantic structure is populated with a multitude of cognitive referents and so each object can associate to a larger semantic structure and more abstract concepts through encoding and association. Similar to how an object appearance changes form depending on the perspective of observation, object models also change form

through the different levels of abstraction, from pencils to human culture. But as the semantic memory store isn't limited to episodic events, but also develops through thought and imagination, concepts may disconnect from physical reference altogether. This is how pyramids can associate spiritual ideas.

To understand the relation between items in semantic memory we examined Hume's explanation of the associative connections between ideas. He mainly considered them to be connected through resemblance and contiguity, in spatial as well as temporal space. But as we also associate through the orders of abstraction that aren't necessarily connected through spatial-temporal relations, contiguity in abstraction was also added as an associative connection. Hume also discussed associations that follow a different type of logic, for example contrast or contrariety. These associations can be said to signify alternative 'possibilities' of spatial-temporal pattern development depending on which cognitive referents, models, rules or theories we compare it to. For example if you perceive of a box and open it, you would expect it to either contain something or be empty, depending on which spatial-temporal context we apply. As an appearance can associate several cognitive referents in semantic memory which project different contexts, the resulting differences between them are then described as contrary. So different objects and concepts are not only connected through resemblance and episodic spatial-temporal contiguity, but also through contiguity in the orders of abstraction and through the habit of comparison. As an event can have strong connections to different cognitive referents, their relation is reinforced through the frequency of their contradiction.

6 Concluding Discussion

So we have found that a physical object cannot be understood outside the context of environment; in sensible appearances, episodic memory or in the abstractions of semantic structure. And although some of the object-environment relations are more inert or stable than others, they all appear to be caught in a state of perpetual transformation. Hence our object understanding, as derived from memory of past experience, will always be rooted in a lost context. When it comes to more inert relations such as the relation between celestial bodies, we can often accurately predict their development or expected position within a certain time frame. But in the case of more volatile affairs, such as the development of human beings, it is clear that there is no experience or rules applicable to confidently predict our coming future; or for that matter, deduce detailed circumstances in our forgotten past. Here an important limitation of our object understanding is exposed; we cannot extrapolate the development of an event that is no longer behaving according to the abstracted rules of our limited experience. After all it is not our rules that generate development, but rather the development that generated the rules in the first place. And as perpetual change slowly transforms the equivalent context for whatever our reasoning involves, object understanding will disconnect from the reality in which it was conceived. Hence vast amounts of information regarding more volatile physical circumstances inevitably becomes outdated on a daily basis. As it has been naturally difficult to abstract useful theories concerning such elusive behavior, traditional science has primarily been focused on more inert relations in nature, such as the 'natural laws'.

The common object interpretation mentioned in the introduction; that objects are made out of indivisible atoms, is also part of this narrow category of 'certain' understanding. It merely states that when you magnify an object, you can expect to find atoms (and that for some reason we believed there was nothing smaller). Although such knowledge has proven useful in many ways, it is far from comprehensive with regard to physical object understanding as a whole. The statement does however also imply a certain notion of causality; that the behavior of the smallest things can somehow explain the behavior of the macroscopic. But the significance of atomic interactions can only be understood in comparison to the corresponding macroscopic circumstances. In this sense all knowledge regarding physical behavior is complementary, not explanatory. No matter how much we divide or how deep we look into the constituents of physical objects, we will never capture their 'nature', or some kind of root cause for their development. We mustn't forget that the appearances we observe are as much objects as they are environment. The driving forces cannot be observed within either one alone, as they only emerge in relation. And so, it becomes difficult to discuss what is 'responsible' for an object's behavior; the object, the

environment or perhaps the observer himself. As nothing exists in isolation, the nature of objects or the fundamental cause of behavior can never be isolated. And if we think that further specialization in the narrow departments of 'certain' or inert knowledge will bring about a complete understanding of our physical world, we are indeed in trouble.

Several concerns have now been raised regarding the validity and significance of our physical understanding. Especially when concerned with more volatile relations, it is often difficult to trust the knowledge we've accumulated. But since contextualization through association is necessary for the functioning of our understanding, it seems we cannot escape the expansion of a spatial-temporal and abstracted semantic context; regardless of its validity. However, as we are often aware of this predicament, a multi-dimensional context is often applied, where alternative or contrary associative 'clusters' are juxtaposed and compared. In this sense, physical object understanding is often spanning several contradictory semantic contexts which makes it difficult to reach a satisfying interpretation. Hence it can be said that the object understanding itself has become volatile. Perhaps, if we learn to recognize this limited, living nature of our physical understanding, we could develop a more sensible relation to it.

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