

論文

Why are some concepts lost after brain damage whilst others are preserved?*

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Abstract:

This essay attempts to answer the question as in the title by reviewing previous literature on category-specific semantic impairments among brain-damaged patients, describing what kind of concepts are lost and preserved, and shows models accounting for the loss and preservation of certain concepts.

Keywords: concepts, brain, semantic models, semantic deficits, concrete and abstract ideas

1. Review of category-specific semantic impairment

Concepts are ways in which people categorise the world in order to understand it and communicate with it (Baddeley, 1998, p. 231). Therefore, a concept like *DOG* is used to refer to what poodles and borzois and bull terriers and great danes have all in common. A concept like *DOG* is undoubtedly linked with superordinate concepts such as *ANIMAL* and *PET*, and subordinate concepts such as *GREAT DANE* (*ibid.*).

Research on the effects of brain damage on patients has revealed that knowledge about particular semantic categories is damaged, whilst leaving that of other related ones intact (Harley, 2008, p. 346). Category-specific semantic deficits have provided insights into how semantic knowledge may be organised in the human brain (Pilrgim et al., 2005). Warrington and McCarthy (1983) reported a case of an aphasic patient with a semantic impairment, who was able to name and recognise the relevant semantic attributes of animate objects such as foods and flowers, but unable to do so when shown inanimate objects. An opposite case was found a year later by Warrington and Shallice (1984), where one of their patients, JBR performed much better at naming inanimate objects. He also had a relative comprehension deficit for living things. At first glance, this suggests that semantic memory is divided into animate - inanimate categories, however, the fact is that JBR has been reported to be good at naming parts of the body, even though these are parts of living things. On the other hand, he was also poor at naming musical instruments, foodstuffs, types of cloth, and precious stones, even though these are obviously inanimate objects. JBR seemed to be impaired with his semantic concept of animate objects after brain damage due to the loss of the animate category in the brain, but maintained his concept of inanimate things.

Since their work (e.g., Warrington & McCarthy, 1983), various category-specific dissociations have been reported, for example, between concrete and abstract words (Tyler et al., 1995; Warrington, 1981) and between nouns

and verbs (e.g., Damasio & Tranel, 1993; Daniele et al., 1994). Relatively recently, consensus regarding the basic facts of category-specific semantic deficits has emerged: the categories that can be disproportionately impaired or spared are “animals,” “fruit/vegetables,” and “artefacts” (Caramazza & Mahon, 2003). However, the most commonly reported category-specific semantic deficit, is the double dissociation between living and non-living things.

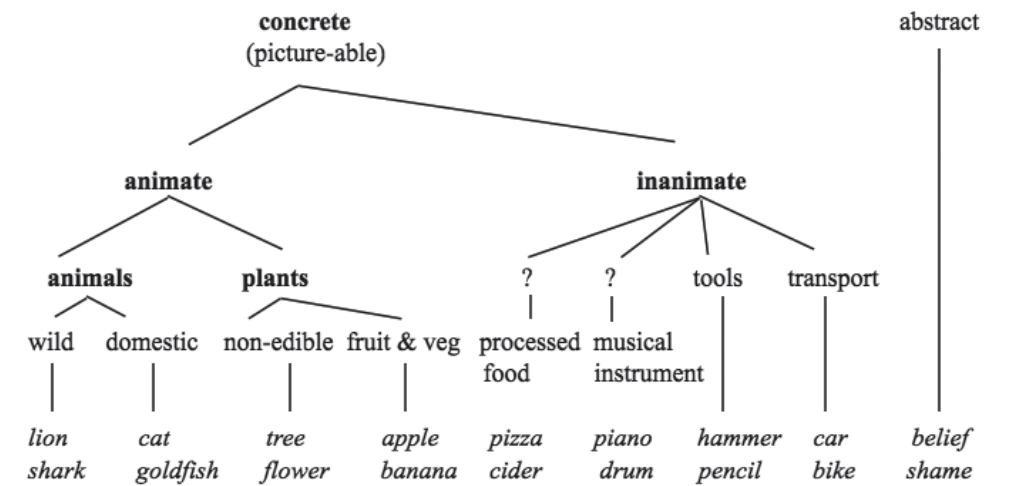
Patients with more specific semantic impairments have been observed and described by Harley (2008, p. 346); Hart, Berndt, and Caramazza (1985) had a patient, MD, who had specific difficulties in naming fruits and vegetables; PC (Semenza & Zettin, 1988) had selective difficulty with proper names; BC (Crosson et al., 1997) only had difficulty with medical instruments. Crosson et al. (1997) explain that although the stimulus words (medical item lists) were found to differ from non-medical item lists in imageability and abstractness, their patients’, category-specific deficit did not seem to be caused by word frequency, concept familiarity, imageability, or abstractness. Nor could BC’s performance be explained in terms of deficits in broader semantic categories such as animate vs inanimate or man-made vs natural. He was unable to retrieve medical items even when he was given phonemic cues for those he could not name. Their findings indicate that the damage in the dominant pulvinar, which is the largest nucleus of the thalamus and strongly connected with the visual cortex (Benarroch, 2015, p. 738), may create category-specific deficits. Damage to the temporal pole has been shown to cause a loss of distinctions between items that are very similar semantically, whereas distinctions between highly dissimilar area concepts are maintained (Rogers et al. 2004).

Ingram (2007, p. 233) constructed a tree diagram which represents a taxonomy of terms frequently used to describe different semantic deficits based on Capitani et al’s review (2003). The figure shows hierarchically arranged terms into superordinate-subordinate categories with their

feasible affiliations. The categories written in bold are the ones more frequently mentioned. According to the figure, the word *apple* is, first of all, categorised as a concrete object. It is then judged whether it is *animate* or *inanimate*, and put into the *animate* category. The *animate* category has two subordinate categories, which are *animals* and *plants*. After being put into the *plants* category without any doubt, *apple* reaches the bottom of the taxonomy; *fruit & vegetable*.

The more usual pattern is that knowledge of living things is found to be disproportionately impaired in relation to non-living things (e.g., Warrington & Shallice, 1984). On the other hand, a few patients have also been reported to become unable to recognise non-living things contrary to their relatively preserved knowledge of living things (e.g., Damasio et al., 2004; Warrington & McCarthy, 1983). There have been several models which have attempted to explain category-specific deficits, which will be explained below.

Figure: Types and relative incidence of category-specific semantic disorders
(a reproduction based on Ingram, 2007, p. 233)



2. Models accounting for category-specific semantic deficits

One of the models which has attempted to account for the above-mentioned pattern of preserved and impaired knowledge is the sensory-functional model (e.g., Warrington & McCarthy, 1983, 1994; Warrington & Shallice, 1984). This model argues that the dissociation between living and non-living concepts can be explained in terms of their properties, e.g., visual, functional, tactile, etc. Hence, living concepts are more reliably distinguished by their sensory properties, while making a distinction among non-living concepts depends more on their functional properties. Here again, there have been some contradictory findings that some patients have difficulty processing sensory information but do not show a specific deficit for living objects (e.g., Lambon-Ralph et al., 1998). Moreover, patients with living objects deficits should have more difficulty with sensory compared to functional properties. Nevertheless, this prediction has not always been supported (e.g., Caramazza & Shelton, 1998) and some patients have shown a contradictory pattern, with greater difficulties with the functional properties of living objects (e.g., Lambon-Ralph et al., 1998).

A category-specific account has been proposed partly in response to the limitations of the sensory-functional account, combining a prototype theory of semantic structure with an evolutionary perspective on brain organisation. Caramazza and Shelton's (1998) hypothesis denotes that evolutionary pressures have resulted in specialised mechanisms for animals, plants, and probably some non-living concepts (e.g., tools) and that this has led to such knowledge being categorically organised in the brain. Category-specific semantic deficits, such as an impairment for fruit and vegetables, would be linked to prototype identification systems that serve specific biological functions (e.g., recognition of edible natural plants) (Ingram, 2007, p. 235). Caramazza and Shelton (1998) argue that semantic knowledge is organised into broad categories reflecting evolutionarily salient distinctions in semantic knowledge, supported by distinct neural structures that may be damaged

independently of one another.

Conceptual structure account (e.g., Tyler & Moss, 2001) is the final model that has attempted to specify the reason why there are some patients whose living objects concepts are spared, whereas, non-living concepts are lost. It argues that it is the distribution of distinctive and shared properties, and the correlations between them, that are the key to the pattern of spared and impaired knowledge across domains. Correlated properties occur frequently and are more resilient to damage because they support each other with mutual activation. Living and non-living domains have differently correlated properties. The former tend to have shared properties which are strongly correlated, while their distinctive properties are relatively weakly correlated. The latter tend to have fewer shared properties which are generally not highly correlated and strong form-function correlations among distinctive properties (e.g., Randall et al., 2004; Tyler & Moss, 2001).

3. Conclusion

This essay has demonstrated what kind of concepts are maintained and impaired by describing previous studies on category-specific semantic disorders. Some concepts have been found to be maintained and lost among particular patients (e.g., animate-inanimate and verbs-nouns). Caramazza (1998) mentions that theories developed to explain category-specific semantic deficits fall into two groups. Theories in the first group, based on the neural structure principle, assume dissociable neural substrates and are differentially (or exclusively) involved in representing different semantic categories. Theories in the second group, based on the correlated structure principle, assume that conceptual knowledge of items from different semantic categories is not represented in functionally dissociable regions of the brain.

Theories based on the neural structure principle illustrate that category-specific semantic deficits are due to differential or selective damage to the

neural substrate upon which the impaired category of items depends (e.g., Warrington & McCarthy, 1983, 1994; Warrington & Shallice, 1984; Mahon & Caramazza, 2009). In addition, although the models mentioned above have not been reliably verified and remain within the bounds of hypothesis, the reasons why some concepts are spared and some are lost are due to the evolutionary pressures on semantic knowledge which have led it to categorically organise in the brain, and the degree of correlation between shared and distinctive properties and their frequency.

Ingram (2007, p. 233) points out, however, that care must be exercised when construing classifications of semantic deficit. There are also a number of methodological issues in studying category-specific semantic disorders; for instance, if frequency is important in brain-damaged naming, an artefactual effect will show up unless care is taken to control for frequency across the categories (Harley, 2008, p. 347). Individual interests, and patterns of habitual exposure to particular knowledge domains, are clearly relevant for interpreting profiles of test performance. In a few cases where conservation of abstract objects but impaired identification of concrete objects has been found, subjects are in most cases professionals with a high level of education, experienced in practicing high levels of abstract verbal expressions in their daily work (Crutch & Warrington, 2003). Hence, these issues might have caused difference in results of the previous studies on which concepts are kept and which ones are not. There need to be more thorough investigations into the control for the features of the subjects and tasks given to them so as to obtain more reliable results about which concepts are kept and which ones are not, and why.

From a practical point of view, it is considerably easier to talk about concrete concepts than abstract ones (e.g., Taylor, 1969). It has been interestingly found that abstract words such as “*prayer*” activates related concrete words such as “*candle*,” but concrete words such as “*candle*” do not seem to activate closely related abstract words such as “*solace*” (e.g.,

Field, 2004, p. 159; Kiran et al., 2009, p. 837). Indeed, when my students are given a picture taboo task, they find it easy to explain concrete ideas such as “*lights*,” but particularly demanding to describe abstract ideas such as “*education*.” Nonetheless, as abstract reasoning (e.g., Carbonneau et al., 2013; Thorndike, 1920), one of many mental abilities, is a crucial capacity to function in a socially ideal manner, it would be beneficial for our students to perform tasks involving reasoning, planning, problem-solving, abstract thinking, comprehension of complex ideas (e.g., Goswami, 2019) in order for them to maintain their neurocognitive capacity to process abstract meaning which is subserved by the right hemisphere (e.g., Yang, 2014), since there is no guarantee that no one will suffer brain damage of any form as they age.

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