Assimilation theory and categorical perception: same story, different words

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Abstract
The similarities between an assimilation theory of geometric illusions as understood by perceptual psychologists and categorical perception as understood by cognitive scientists are detailed. It is concluded that assimilation theory may be able to provide a conceptual link between innate processes and those involving higher functions such as learning, memory and language.

Assimilation theory
Nearly a half-century has elapsed since a distinctive version of an assimilation theory of geometric illusions was first outlined (Pressey, 1967; 1970; 1971). The fundamental idea is that a perceptual feature that is embedded within a context of similar features will be phenomenally distorted. The percept will take on the properties of the context and regress to the average of the context. Thus, for example, in Figure 1A the shortest line (the standard) in the middle of the series of parallel lines appears elongated whereas, in Figure 1B, the same standard line in the middle of a series of shorter lines appears to shrink.

![Figure 1](image)

Figure 1. (A) Parallel lines illusion in which the center line is the shortest in the series and appears elongated and (B) parallel lines illusion in which the center line is the longest in the series appears to shrink

Much of the subsequent effort was designed to provide a quantitative analog of the verbal description of the theory. It was noted that many empirical functions were crudely predicted by calculating a simple average of the series (Pressey, 1972). However, this average had to be modified by (1) how close the contextual features were to the region that the observer was attending (Pressey, Butchard & Scrivner, 1971) and (2) how physically close the standard and contextual features were to each other (Pressey & Murray, 1976). Each of these concepts was operationally defined (e.g., Pressey & Pressey, 1992) which allowed patterns of both means and variances to be successfully predicted in a variety of experimental conditions (Pressey & Bross, 1973; Pressey & Murray, 1976; Pressey & Epp, 1992; Pressey, 2013a).
It was always recognized that a successful theory had to be bidirectional, i.e., it had to include not only assimilation but also contrast (Pressey, 1967). Our early investigations indicated that atypical groups such as schizophrenics and retardates exhibited smaller figural aftereffects, which are contrast phenomena but larger geometric illusions, which are assimilative phenomena (Kelm, 1962; Prysiazniuk & Kelm, 1963; Pressey, Bayer & Kelm, 1969). Clearly, a time delay between a standard and its context elicits contrast and this effect has been verified by several investigators (Pollack, 1964; Jordan & Uhlarik, 1986; Redding, Winson, and Temple, 1993). In addition, contrast does seem to occur when a standard and its context are presented simultaneously (Jordan & English, 1989; Pressey & Wilson, 1980).

In summary, Pressey’s assimilation theory proposes that a feature that is located within a context of similar features will be phenomenally distorted either by being assimilated to the context or contrasted with the context and that the assimilative process may well occur as the result of a cognitive calculation akin to an arithmetic calculation of an average.

Since it inception, assimilation theory has never presumed that it is solely restricted to what occurs in selected 2-dimensional geometric patterns. For example, in one of the earliest versions (Pressey, 1970) it was noted that assimilation had been shown to exist in memory (Figure 2) and that highly complex social phenomena such as acculturation could be described as assimilative. A second foundational assumption is that the illusions present in geometric patterns are not maladaptive “errors that deceive” (e.g., Coren, 1979). Yes, illusions do not conform to physical measurements¹ but they are deliberate errors that reflect how the mind levels out small differences and enhances large differences in order to deal with a world of objects and concepts rather with than a stream of unrelated stimuli (Pressey, 2013b; 2013c).

Categorical perception

A curious thing has happened in recent years.² With the development of a new approach called cognitive science, it is now clear that assimilation theory can be linked to a new area of research called “categorical perception” or CP. A summary of this revival was provided by Harnad (2003) who wrote: “CP turns out to be more general, and may be related to how the neural networks in our brains detect the features that allow us to sort the things in the world into their proper categories, “warping” perceived similarities and differences so as to compress some things into the same category and separate others into different categories.”

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¹Figure 2. Effects of assimilation in a memory task (Adapted from Carmichael, Hogan and Walter, 1932)
The similarity between assimilation theory and CP is most obvious by considering the words “warp” and “compress”.

One definition of the word warp is that it is a *distortion* of a shape or form. The words “illusion”, “error” and “distortion” are probably the most common words used to describe perceptual changes that are induced by geometric patterns. For example, we wrote: “This Kant-like category distorts information in order to extract the object character from the proximal stimulation (Pressey & Pressey, 1992, p. 211).”

The word “compress” is interesting for two reasons. First, it describes what an *average* does. An average *compresses* an array of items into a single item and, at least in the quantitative form, that is what assimilation theory does. A second way of considering the word “compress” is highlighted in Figures 1A and 1B. In both cases, the extreme lines phenomenally migrate toward the average thus leveling out the distinctiveness and “compressing” the features.

Finally, when Harnad states that similar entities are distorted in order to be sorted into one category and differences are accentuated in order to be sorted into different categories, his language mimics very much the ideas expressed by the words “assimilation” and “contrast”. Harnad emphasizes the fact that “Categorical perception (CP) can be inborn or can be induced by learning.” Assimilation theory, as it applies to geometric illusions, has not been consistent in its position on whether such distortions are learned or innate. In early writings, the theory selected examples of the central tendency effect as it develops during repeated judgments (e.g., Hollingworth, 1909) and many writers claimed that the theory was a “judgmental theory” (e.g., Restle & Decker, 1977). However, by 1974, I had opted to think of assimilation as an inherent “program”. As an example, a hypothetical scenario of a prehistoric bird foraging for einkorn on the shores of the Mediterranean Sea was concocted. I came to believe, more firmly, that illusions are not inappropriate instances of an adaptive function as Gregory (1963) would have use believe. Rather, it became clear that both geometric illusions and constancy were instances of assimilation (the leveling out of differences) and therefore one cannot explain illusions as being *caused by* constancy. In other words, constancy is an “illusion” in the same sense that a geometric illusion is an “illusion.” Or, in the words of CP, constancy and illusions belong to the same category of processes and it is no more possible to explain one as the cause of the other than to say, for example, that the greenness of leaves causes grass to be green.

A link between primitive sensory processes and more complex perceptual ones has been demonstrated recently (Pressey, 2013c). A new “bedroom lamp” illusion that is a hybrid a Müller-Lyer and a Ponzo illusion was derived from the recipe used to demonstrate the Craik-O’Brien-Cornsweet effect. However, I have been unable to come up with a similar recipe-like link between geometric illusions and acquired cognitive functions.
References


Notes

1 Often I puzzle over a curious inconsistency in what is deemed to be an illusion. For example, if two equal lines appear to be unequal we call it an illusion but if two unequal lines appear equal we don’t call it an illusion.

2 I left academia in 1996 and did not become aware of the similarity between assimilation theory and categorical perception until I began writing “Assimilation theory: a pretty tale.” Because I needed to refresh my memory about William James’ famous phrase about a “blooming buzzing confusion”, I searched online and found the link to Professor Harnad’s little essay. Scientists will understand the feeling of elation that accompanies the discovery of a new insight and in my case the word is a precise description of my reaction.

3 Perhaps there is no better example of how language structures the way we think than the use of the word “error” to describe the difference between a subjective experience and a physical measurement. The word “error” connotes “wrongness”, a “mistake” or “falseness” and philosophers especially love to use the term “illusion” to mean a false belief when in fact they ought to use the word “delusion.” Thus the word itself drives the speaker to believe such phenomena are maladaptive flaws of the mind.


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