Modularity of Information, not Processing

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The framework of a Fuzzy Logical Model of Perception (FLMP) has guided our research and also helps clarify the modularity issue. The results from a wide variety of experiments have been described within the framework of the FLMP. Within this framework, pattern recognition is guided by multiple sources of information that the perceiver evaluates and integrates to achieve perceptual recognition. According to the FLMP, well-learned patterns are recognized in accordance with a general algorithm, regardless of the modality or particular nature of the patterns. It is assumed that patterns are processed through a sequence of processing stages: evaluation, integration, and decision. Continuously-valued features are evaluated, integrated, and matched against prototype descriptions in memory, and an identification decision is made on the basis of the relative goodness of match of the stimulus information with the relevant prototype descriptions.

The model allows an important distinction to be made between information and information processing. Information refers to interface between the attributes and characteristics of the stimulus world and the participant's memory, serving as functional inputs to the evaluation operation in the FLMP. Information processing refers to the algorithm describing how this information is processed. Information processing corresponds to the algorithmic nature of the evaluation, integration, and decision operations rather than the actual information that is being operated on. Information is clearly different across different domains such as object recognition and speech perception, but the information processing might follow the same algorithm across these different domains. If we must use the term modularity, there is no question of modularity of information across different domains. On the other hand, there is convincing evidence that information processing is highly similar, if not identical, across the different domains.

Pattern recognition is usually studied in an expanded factorial design. This design has been used to study both speech perception by ear and by eye and affect perception as conveyed by both the face and the voice. As an example, an animated talking head was used to combine each of the four auditory syllables with each of the four visible syllables in a speech identification task (Cohen & Massaro, 1993). In addition, each of the syllables is presented unimodally. Most importantly, we are able to control and manipulate the audible and visible speech independently of one another. This is important because a necessary ingredient of scientific inquiry is to pull apart several variables that are normally confounded in the natural world. The goal of this type of study is to determine how the separate sources of information are processed together to achieve perception. The expanded factorial design also provides a strong test of quantitative models because each candidate model must describe the relationship between unimodal and bimodal performance. More generally, the goal is to determine a theoretical description that can describe or explain the performance on the bimodal conditions as a function of performance on the unimodal conditions.

Our studies of facial affect are exactly parallel to our speech perception studies. In face-to-face communication, perceiving speech does not necessarily correspond to just the sound, but somehow emerges from the sound and sight of the face, respectively. We ask whether the same is true of judgments of affect. In some experiments, our talking head was programmed to say the word "please" under happy, angry, surprise, and fear affects. Using an expanded factorial design, the four affects were presented auditorily, visually, and bimodally.

Fodor's original claim of modularity was that the nature of the information processing would necessarily differ across these different input systems. (Massaro & Cowan, 1993). In contrast, the results of these experiments and a variety of others indicate that speech perception and affect recognition follow the same algorithm. The quantitative judgments are well-described by the FLMP. We take this result as support for the general framework of the FLMP and as evidence against modularity.

In an analogous line of research, we have studied the influence of bottom-up and top-down sources of information in language processing (Massaro, 1994; Massaro & Oden, 1995). Once again, experiments independently manipulating these two sources of information are highly informative. The model tests have established that perceivers integrate top-down and bottom-up information in language processing. This result means that sensory information and context are integrated in the same manner as several sources of bottom-up information.

The nature of this integration process is also accurately described by the FLMP. Many investigators operate as if interactive activation is the only viable alternative to modular or autonomous models. However, the FLMP allows integration while maintaining independence among the sources (at the evaluation stage). Thus, the FLMP and its corresponding theoretical framework offers a viable solution that combines important features of both the modular and interactive activation frameworks.

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