Perception perception by breaking down sensory stimuli

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Perception of everything around us is based upon the fundamentalprinciples of pattern recognition, which involves simplifying complex sensorystimuli into patterns that are easier to interpret and distinguish between. Pattern recognition is a cognitive process which involves matching informationof a stimulus with information previously stored in our memory (DiCarlo et al., 2012). The recognition of patterns allows us to differentiate between a sliceof pizza and an apple because of the different parts that make up each object, which are known as geons.

A geon is defined as a 3-D object such as spheres, blocksand arcs among many more that correspond to the simple components used to make upa complex object (Biederman, 1987). An example of this is viewing an ice creamcone into its basic geons: a sphere on top of a cone. A geon can be arranged toform virtually an unlimited number of different types of objects. The concept of breaking down objects into simpler parts forrecognition was proposed by Irving Biederman in 1987 through therecognition-by-components (RBC) theory, which was structured around the conceptsof bottom-up processing and feature analysis model of pattern recognition(Biederman, 1987). Bottom-up processing involves the process of interpretingsensory information the moment it is presented and then later processing it inthe brain to understand what was perceived (Ochsner et al., 2009). Featureanalysis model is a type of pattern recognition focused around an analyticalapproach towards perception by breaking down sensory stimuli into its basicfundamental parts (Nothdurft, 1992).

Similarly, the RBC theory shows that perception is an analytical process which is heavilyreliant on the ability to detect patterns allowing us to

perceive compleximages by breaking them down to a simple arrangement of geons. It is believed that there are 36 geons or less thatcan be arranged in a variety of different ways in order to create any of theobjects we see on a daily basis (Biederman, 1987). Biederman stated that ifspeech can be broken down to a number of phonemes, which are units of sound, thensimilarly the perception of objects can be broken down to a number of geons(Biederman, 1987). If 55 phonemes are required to create every word in alllanguages then similarly, 36 geons can be used to create all the differenttypes of objects in the world (Biederman, 1987). An object is defined by two criteria's, edges and concavity. Edges allows an individual to maintain the perception ofan image regardless of the orientation the object is being viewed from Recognition-by-componentstheory, 2018). Concavities of an object refers to the area where two or moreedges meet, this allows for the distinguishing of two or more geons presentwithin an object (Recognition-by-components theory, 2018).

A study was conducted to determine the importance of vertices, created by two or more edges, compared to midsegments of an image in terms ofthe RBC theory by asking participants to identify images with missing verticescompared to missing midsegments (Koch & Abbey, 1999). It was found thatthere were no significant differences between either the missing vertices ormidsegments, illustrating that one is no more important than the other (Koch& Abbey, 1999). Therefore, it was concluded that vertices are important butnot necessary for object recognition. This study proved that object recognitionis not reliant on just one of the properties of geons, being edges, but ratherit is reliant on both properties, edges and concavity (Koch &

Abbey, 1999). The RBC theory was largely accepted due to the factthat it allowed recognition of an object regardless of the viewing angle due tothe invariant edge properties of geons such as curvature, symmetry, parallellines, co-termination and co-linearity (Biederman, 1987).

These propertiessimply allowed for the perception and recognition of an object from any angle, allowing the theory to be more robust and widely accepted. Irving also statedthat the geons used to make up an object are essentially formed by the five invariantproperties of edges (Biederman, 1987). Irving Biederman conducted an experiment to test the RBC theory bypresenting participants with objects drawn with only two or more of theircomponents and asked participants to indicate what the object was after a 100millisecond exposure to it (Biederman, 1987). The results showed that as thenumber of components increased the percent error started decreasing, however90% of participants were able to correctly identify an object with only 3 to 4components present, when the actual objects originally consisted of six to ninecomponents (Biederman, 1987).

This experiment proved that humans naturallybreak down complex objects into distinct geons which can be used to identifyand differentiate between different objects, even when the image is notcomplete with all of its geons. Despitehow promising the RBC theory seems to be, it is still limited in part due tospecific aspects of perception, specifically regarding the identification ofreal objects. It was said that when comparing an apple and an orange, althoughit is easily distinguishable by humans, it lacks the edges required for the RBCtheory to recognize the objects as two different objects. Irving Biedermanargued the RBC theory explained a certain extent of perception

whereas theperception of objects that appear similar but are different was due to anothermode of perception (Biederman, 1987). Overall, the RBC theory proposed byIrving Biederman has provided great insight as to how human beings perceive andbreak down complex images into simple geons for perception.

This theory has notonly further increased our understanding of perception but it has also allowedfor advancements in technology, specifically related to security and artificialintelligence.