

## **Building Semantic Knowledge Base for the Visual Perception- Cognitive Ability of Neuropsychology Using Web Ontology Language**

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**Abstract:** — Cognitive Science deals with the study of the human mind and brain. It focuses on the mechanisms involved in representing and manipulating knowledge and how intellectual graphics and processes are realized in the human brain. A cognitive scientist considers the brain an abstract computing device in which neural tissue carries out mental computations to support cognition. They aim to understand the mental computations that underlie cognitive functioning and how these computations are realized. Several disciplines have converged to form the field of cognitive science, which is composed of various disciplines. Several important factors contribute to the study of cognitive psychology, linguistics, and a portion of computer science and artificial intelligence. However, there are also essential components that can be drawn from neurosciences, philosophy, and anthropology that are useful for understanding these areas. Developing a theoretical framework can be achieved in many ways, one of which is by constructing and testing computational models analogous to mental operations to establish theoretical frameworks. Researchers have developed computational models that simulate aspects of human performance, such as deductive reasoning, concept formation, mental imagery, and similar problem-solving, to complement psychological experiments on these topics. In this Paper, various Concepts of Psychological issues, theories, Visual perception and Sense organs are discussed. Object properties are defined for the different aspects of psychology, using protégé editor, Web Ontology language is used to build Knowledge base.

**Keywords:** *Visual Perception, Psychology, Brain, eye, Mid-brain, CogniFit*

### **I. Introduction**

In cognitive science, the mind and intelligence are studied interdisciplinary. An integrated approach incorporates ideas and methods from psychology, linguistics, philosophy, computer science, artificial intelligence (AI), neuroscience (neurology), and anthropology. According to cognitive scientists, cognition includes thinking processes relating to perception, problem-solving, learning, decision-making, language use, and emotion. Reading this text seems straightforward, and the words arrange letters in a way we can understand.

#### **Relevance and nature**

Early modern philosophical theories claimed that minds and spirits were immaterial or supernatural, so they couldn't be studied scientifically. To develop theories of mind, cognitive processes and phenomena based on empirical evidence, which can come from many disciplines. [1][2][3]

Previously, scientists have compared the mind to mechanical devices like clocks and switchboards in a clumsy and unproductive way. Using computer programs, one can analyze how an

algorithmic procedure (computation) can be used to manipulate symbols to solve complex problems, generating productive analogies about how minds might work.

The "IF...THEN..." instructions in standard programming languages suggest a model of how people make plans. In addition, computers have helped test scientific hypotheses about how the mind functions and is organized. A given idea can be modeled in a computer program by building algorithms to mimic the entities and processes that the hypothesis proposes. To test the theory, the program is run on a computer, and if the computer's output resembles actual human performance appropriately, the assumption is considered valid. [4]

Your senses receive information from your surroundings that you interpret. Using your cognitive abilities and prior knowledge, you can analyze data. Our ability to perceive visual communication is a function of how our eyes interpret what they see. Visual perception, vision, or sight results from the brain interpreting and receiving this information. Our eyes are the starting point for visual perception:

Retinal photoreceptor cells are activated when light rays reach our pupils. Through the optic nerve, these cells transmit signals to the brain. As information from the right field of vision travels to the left hemisphere, it travels to the right via the optic chiasma (where the optic nerves cross). [5]

A variety of characteristics influences insights into visual perception. If you look at a soccer ball, you can get an idea of how

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complex this cognitive function is. How should you identify the factors? Objects around and behind it have a different parameter than the lines that are illuminated more or less. This circular object measures about 27 inches in circumference. It has a round shape. It is about ten feet away to my right, in front of me. It was easy for me to touch it. The pentagons are black and white, and black and white would still be visible even if the light suddenly went out. Spheres are three-dimensional, so it's three-dimensional. There is no movement now, but it is susceptible to moving in the future. The ground and the units are different. It is used for playing soccer. Foot kicks it It is similar to the soccer ball you use at practice. Soccer ball: that's what it is. It is called naming that last process. [6]

Think about how your brain performs those tasks continuously and extremely fast throughout the day. When you look at anything, your brain processes all the information it receives and makes sense of it. Additionally, the brain contributes to completing whatever it sees rather than passively receiving it (e.g., a ball looks flat even when it appears round in the picture). Several brain areas occupy the occipital lobe and the adjoining lobes (temporal lobe and parietal lobe) that specialize in the above processes. The sites must work together for good perception. You can quickly respond to something on your desk by looking at it, as your brain identifies everything on it with just a glance. Understanding how vital it is to have a good visual perception to function effectively daily is essential.

#### ***A few examples of visual perception***

Many people do complex daily tasks like driving every day. There are many complex processes involved, including visual perception. If one of the processes in visual perception fails, you could be in danger of harming yourself or others. You need to determine quickly how close two cars are, how fast they are moving, etc., which is impossible if you have poor visual perception. A child with developed visual perception will be able to take better notes in class and understand the material more deeply. Academic performance may be impaired if these skills are altered or deficient. Visual perception is crucial in the visual arts, such as painting or graphic design. Choosing every color and drawing every line ideally is essential to drawing a square that appears lifelike. In any activity requiring supervision or care, visual perception is essential. Poor visual perception makes it difficult for security guards to see the cameras well, making their jobs more difficult. How do we perceive visual information? The ability of the brain to interpret what the eyes see is called visual perception. A person's visual acuity (for instance, "20/20 vision") is not the same as this. Visual perceptual processing problems can occur even when a person has 20/20 vision.

#### ***1.1 Importance of visual perception***

It is essential to have good visual perception skills to read, write, solve puzzles, cut, draw, solve math problems. [7]

#### ***To develop visual perception***

Processing sensory information in the environment and inside the child: Accurately registering, interpreting, and responding to stimuli from the environment and inside the child.

- a) The ability to filter out unimportant background information and focus on crucial visual information.
- b) Memory for visual traits of objects and forms.
- c) Relationships between objects in space: Understanding the relationships among things.

- d) Memory for the order in which objects appear in a sequence.
- e) Finding something in a busy background using visual figure-ground.
- f) Constancy in Form: Being able to tell if a form or shape remains the same regardless of its size or shape.
- g) Close-up vision: Recognizing forms or objects without seeing all of them.

## **II Related works:**

Understanding the concepts of Visual Perception

### ***2.1 The Perception of Sensation***

We perceive sensations we receive from the environment by recognizing, organizing, and making sense of them. There is a difference between what our eyes see and what we perceive. Instead, our brain actively tries to process the multitude of stimuli that enter our eyes and hit our retinas. See Figure 1. A high-rise building and a low-rise building can be seen in Boston. In the right picture, the right tower appears substantially higher than the left. On the left, however, you can see that the buildings are the same height. Objects can appear quite different from different vantage points, revealing further details. Hence, perception is more than just seeing what you are presented with; it is a much more complex process. To interpret visual stimuli, the brain processes them, giving them meaning. Since researchers have tried to teach computers to see, it has become clear how difficult it is to interpret what we see; however, computers are still lagging behind humans when recognizing objects.[7][8][9]

Objects in the outer world (e.g., falling trees) are distal (far) objects. When a tree falls, it creates a pattern on a medium of information. As in the case of the falling tree, sound waves could be the medium of communication. Alternatively, data can be conveyed through reflected light, chemical molecules, or tactile sensations. An example of proximal (near) stimulation occurs when light waves are absorbed by your eyes' sensory receptors (the retina absorbs, i.e., the light waves).

Each sense perceives things differently.[10][11] Perceptual Continuum Perception occurs when information about a distal object is transmitted to a person through an informational medium. Upon receiving the report, the person's sense receptors respond by causing proximal stimulation, which leads to object perception.

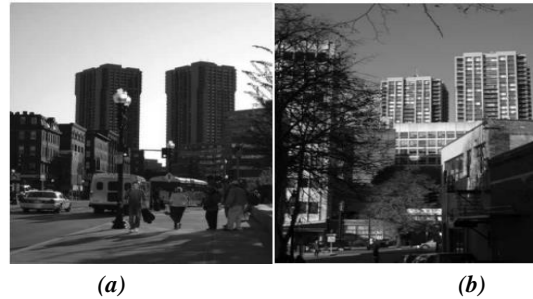
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**Figure 1:** shows two images of the same high-rise building in Boston taken from two different perspectives. The two look alike in (a), as they are, in reality, the same size. We can only determine their size by further processing (b) since their image on the retina appears to be of different heights.

Mode of operation	Object at the distal end	Medium of information	Stimulation at a Distance	Objects perceived by the senses
The vision	The face of Grandma	EM waves reflecting off Grandma's face	The rod absorbs photons in the retina, there are cone cells and rod cells an eye's back surface contains receptors	The face of Grandma
Aural impressions	Tree falling from a height	As a result of the tree's fall, sound waves were generated	Conduction of sound waves to the basilar membrane, a receptor Cochlear surface Aural innervation	Trees falling
Olfaction—smell	Frying bacon	By frying bacon, molecules are released	Absorption of molecules in Olfactory epithelial cells, In the nasal cavity, there is a receptor surface Vacuum	Bacon
Gustation—taste	Sweetened condensed milk-The ice cream	Both ice cream molecules Dissolved in water and released into the air	Taste is a chemical reaction a receptor cell is located on the Combined with olfactory stimulation, tongue and soft palate	Ice cream
Touch	The keyboard of a computer	A point of contact is subjected to mechanical pressure and vibration located on the surface of the skin keyboards and mice	Dermis, the innermost layer of the skin, is stimulated by a variety of receptor cells	Using computer keys

**Table 1:** Illustrates the Modes of Operations of the Sensory Organs Nerves

### III. Methodology

Methods for measuring and assessing visual perception: An incredible number of activities can be done with visual perception. Adapting to the environment and interacting with your surroundings depends on visual perception. As a result, even academics, medicine, or professional fields can benefit from knowing how developed your visual perception is. Identifying children who have difficulty seeing the board or writing notes is essential in the academic world. Suppose a patient's visual perception level is low. In that case, it will be necessary to determine whether they will miss the instructions regarding their medication or if they will have difficulty surviving and thriving independently. When reading or working in a potentially dangerous environment, visual perception in a professional environment will be helpful. Knowing which workers should not handle heavy equipment or need assistance in a specific meeting can make a big difference for employers. In addition to measuring cognitive skills, including visual perception, a complete neuropsychological assessment can help determine a person's overall mental health. An adaptation of Korkman, Kirk, and Kemp's classic NEPSY test is used for assessing visual inspection. [12][13][14] Through this exercise, it is possible to measure the cognitive resources that the user has to comprehend and perform the task effectively and decode and decipher the different elements within the exercise. The test also measures naming, response time, and processing speed in addition to visual perception. An image of various objects will appear briefly on the screen before disappearing. There will then be four letters, but only one corresponds to the thing's name. The user must choose the correct answer as quickly as possible. Visual perception can be improved or rehabilitated.

CogniFit may assist in training visual perception, as it can be trained like all of our cognitive abilities. Neuroplasticity is the basis of visual perception rehabilitation. As your visual perception improves, you can send information from your eyes to your brain more quickly and efficiently. CogniFit was developed by a team of professionals specializing in neurogenesis and synaptic plasticity, which allows us to create personalized cognitive stimulation programs tailored to each user's needs. Each user receives a customized brain training program based on their results from an evaluation of their visual, auditory, and other cognitive domains. With sophisticated algorithms, the program uses the data from this initial cognitive assessment to develop a program that improves the user's mental weaknesses and trains their cognitive strengths. Consistently practicing challenging exercises is the key to successful brain training. [14][15][16] This cognitive function can be evaluated and optimized using CogniFit's evaluation tools and rehabilitation program. Two or three times a week, the program only takes 15 minutes. During each training session, the user receives a detailed graph showing their cognitive progress based on fun, interactive brain games.

*If a child has vision problems, Signs are:*

The following difficulties may be experienced by children who have problems with visual perception:

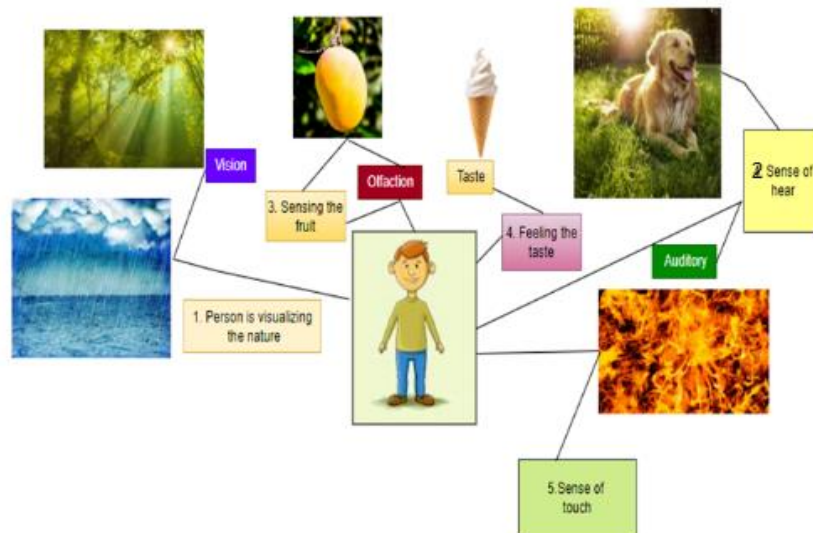
- a) Playing dot-to-dot games or completing puzzles.
- b) Considering objects around them when planning actions.

- c) Spatial concepts include "in, out, on, under, next to, up, down, in front of."
- d) Understanding the differences between "b, d, p, and q."
- e) They are writing letters or numbers backward.
- f) When reading or writing, losing a place on a page.
- g) Left and right are important to remember.
- h) I was reading without knowing where to begin.
- i) In words or math problems, sequence letters or numbers.
- j) Keeping track of the alphabet in sequence,
- k) Dressing (socks or shoes that match).
- l) Identifying letters and objects by their size.
- m) Sight word memory.

*Performance in academics:* How well they can complete tasks academically. Achieving, maintaining, and changing one's emotion, behavior, and activity level appropriate for a particular scenario that requires sustained effort, doing activities without distraction, and self-regulation. Visual-perceptual activities may be avoided or refused by them. The ability to perform precise hand and eye tasks causes frustration, and their avoidance may cause them to prefer to get others to do their jobs instead of doing them themselves. For example, they may ask their father to draw a house for them or to build them a rocket.

*Way to improve visual perception*

- a) Using visual cues: Use colored dots or stickers to indicate and identify which side of the page the child should start writing on or reading
- b) Directional arrows: To assist in determining direction or position (e.g., for forming letters).
- c) Word spacing and sizing can be improved with graph paper.
- d) To encourage correct line alignment, highlight the line.
- e) Instead of asking the child to copy work from the board, provide them with a piece of paper to place on their desk.
- f) Placing an alphabet strip at the child's table is a great way to ensure that the letters are formed correctly.
- g) Keep distractions and clutter off the child's desk:
- h) Removing visually stimulating classroom decorations, especially near the child's desk, will help to eliminate visual distractions.
- i) It is essential to keep worksheets straightforward to avoid unnecessary decorations (such as placing only one activity on a page and removing pretty borders).
- j) If you're coloring, mazing, or cutting, outline boundaries with a red marker.
- k) If you are working on a puzzle, present one piece at a time and cover unneeded components.



**Figure 2:** Response of Sensory Organs from the environment

When a child has difficulties with visual perception, therapy to g) seek

- When a child has difficulty with visual perception, therapeutic intervention is crucial to: Improve your ability to perform visual tasks and your persistence.
- Engage and complete academic studies with the child.
- Put the child's shoes on the right feet and help them to complete self-care tasks.
- Parent, teacher, and child frustration can be avoided when a child struggles academically.
- Positively affect your well-being and maintain it.
- Handwriting, spelling, and math skills should not fall behind the child's peers.

*Consequences of untreated visual perception difficulties:*

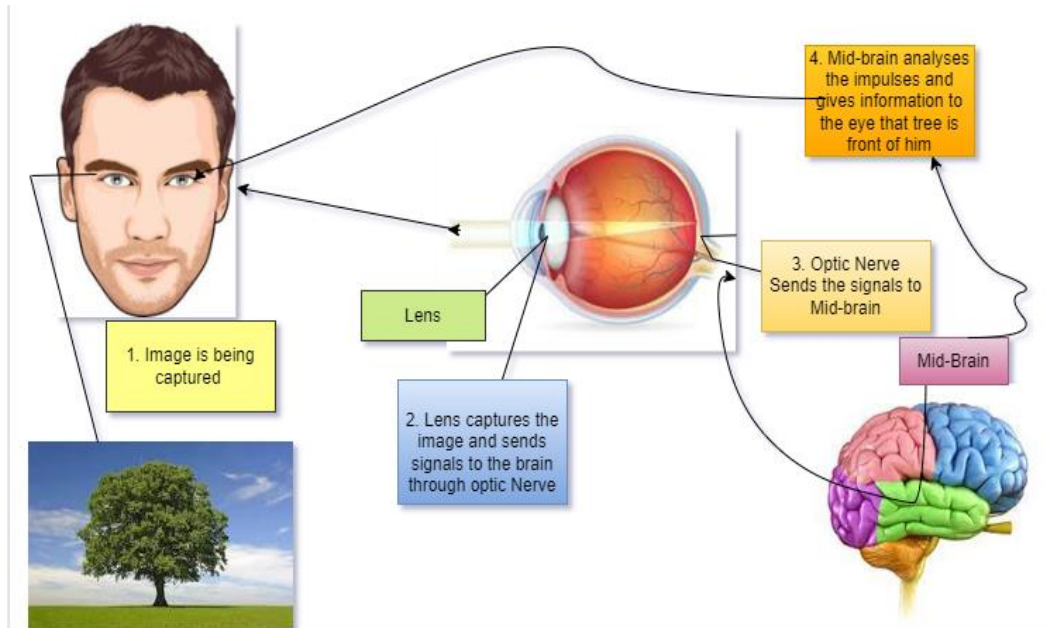
Visual perception difficulties can also cause a child to have problems with:

- In various situations, anxiety and stress result in difficulty meeting academic goals.
- Worksheets that are too busy or visual instructions are difficult to complete.
- A lack of visual information makes it difficult to access the curriculum.
- A child who compares their abilities with their peers has low self-esteem.
- The ability to write well is poor

**VISUAL PERCEPTION – THE EYE**

- In the brain, data is interpreted and interpreted in a way that gives the organized data require from the input we receive, starting with the eye receiving the inputs in the form of light. Light is focused on to the retina by the eye. Light is converted into electrical signals by photoreceptors (light receiving) in the retina, so that they transmit to the brain. Rods and cones are the two types of photoreceptors.

Low levels of light are detected by rods that are located in the peripheral regions of the retina. Due to their location on the retina, they work to improve night vision by allowing the light to reach the rod cells more efficiently by focusing slightly to the side of whatever you're looking at. It is in the fovea of the retina where cones cells are located; the cone cells are responsible for processing high acuity visual tasks such as reading as well as color perception. Using cone cells, we can perceive a full range of colors by combining signals from the three red, green, and blue receptors on the surface of our retinas. A network of neurons transfer electrochemical signals from the photoreceptors to the retinal ganglion cells after the light has been processed by the photoreceptors. Through the optic nerve, the neurons transmit an amended electrochemical signal to the brain that detects contrasts within an image (such as shadows or edges).



**Figure 3:** Pictorial Representation of Visual Perception

As a result of the optic nerve and the thalamus (another brain area) the electrochemical signal travels to the cerebral cortex to take part in visual perception. Two additional areas of the brain receive data from the optic nerve to the main signal sent to the cerebral cortex. We can adjust our pupil size based on the intensity of light we see with the pretectum, which controls our pupils. In bright sunlight, your pupil contracts, while in darkness, it expands.

**The Eye - PERCEPTION OF VISUAL INFORMATION**

As light enters the eye, it is interpreted by the brain, which provides the information we need from the data we receive. Below is a diagram of the eye's components. Light is focused on the retina by the eye. In the retina, photoreceptor cells (light-receiving cells) convert sunlight into a series of electrochemical signals for transmission to the brain.

**Visual Perception Challenges Associated with Cultural Disciplines**

Although both long-sightedness and short-sightedness are commonly referred to as health problems that can affect vision, both of these conditions can be corrected by wearing glasses, by designers. Designers face a variety of challenges, including colour blindness and visual stress.

**Psychological Principles of Gestalt**

According to Gestalt psychology, human perception goes beyond simply seeing what's actually present in the world around us. Motives and expectations also play a significant role in it. Wertheimer created the Gestalt perception principles to explain how it works.

Gestalt theory consists of the following principles:

- a) **Pregnanz:** According to this principle, things are perceived in their simplest form or organization.
- b) According to Gestalt theory, similar items' color, size, and orientation naturally lead them to be grouped.
- c) Objects near each other are usually viewed as a group based on the principle of proximity.

- d) An object with a closed surface is perceived as a group of elements. An object can be made sense of by filling in the missing information.
- e) Objects in the same bounded region tend to be grouped according to Gestalt psychology principles.

**Perception According to Gestalt Laws**

Therapy based on Gestalt principles

- a) Gestalt therapy is based on the theory that perception is influenced by various factors that interact with each other. In addition to our past experiences, current environment, thoughts, feelings, and needs, many other factors play a role.
- b) In Gestalt therapy, the present is the focus. You will be encouraged to keep your focus on your present experience by a Gestalt therapist, even though the previous context is essential for viewing yourself as a whole.
- c) Currently, research suggests Gestalt therapy can be effective at treating depression and anxiety symptoms, as well as increasing feelings of self-efficacy and self-kindness. It can also be helpful for structuring group therapy sessions.
- d) The client and therapist must have a good relationship during the therapeutic process. You must feel comfortable with your therapist to develop a close relationship, and your therapist must allow you to discuss your thoughts and experiences in an unbiased environment.

**Proposed Methodology**

An online knowledge base provides self-service access to information about products, services, departments, or topics. Any data can be incorporated into your knowledge base. A knowledge base is typically expanded and enhanced by contributors with expertise in the relevant subject matter. An explanation of how a product works to the ins and outs of your HR department or legal



department can be included in the content. FAQs, manuals, troubleshooting guides, runbooks, and other information your team may need may be found in the knowledge base. [17][18]

Many knowledge bases incorporate artificial intelligence that responds to input from users. Some encyclopaedias are indexed. A machine-readable knowledge base stores content in a form that can be machine-read by a computer. Automated deductive reasoning is used to come up with solutions. The software helps narrow down a user's query when entering a question.

Data organization is the process of gathering and organizing information from various sources, capturing information about entities of interest (such as people, places, or events), and connecting those entities.

The combined descriptions of concepts, entities, relationships, and events make knowledge graphs. It is possible to integrate, unify, analyze, and share data using knowledge graphs because they allow for the linking and presenting of data in context. Known entities, relationships, and events are described in the knowledge model, the heart of a knowledge graph. Formal semantics can provide computers and people with an efficient and accurate way to process reports. Based on the knowledge model, diverse data is connected and described using semantic metadata, with each entity representing a part of the description of the entities related to it.

*Key characteristics include the following:*

By applying formal semantics, knowledge graphs can interpret and infer meaning from the data in various ways. Databases can be explored through structured queries.

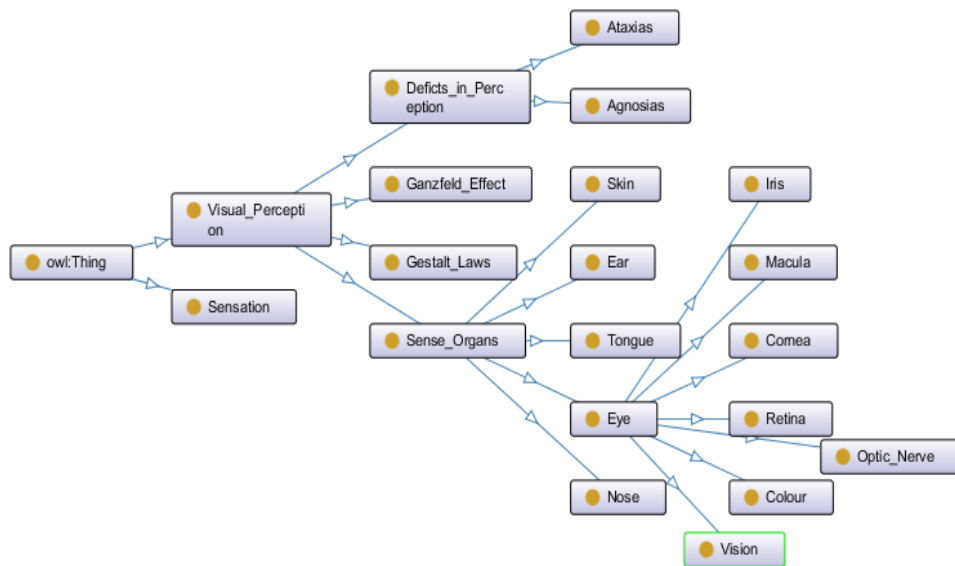
**Visual Perception – THE BRAIN**  
**IV. Results and discussions**

The ability to integrate, unify, link, and reuse data is best achieved using knowledge graphs expressed in RDF.

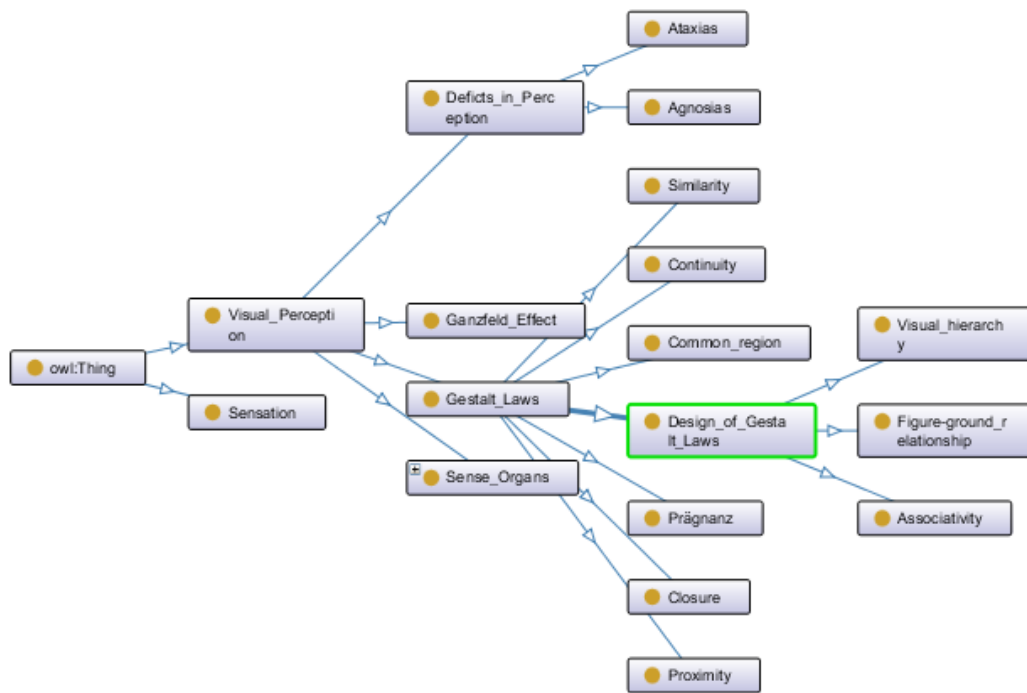
A wide selection of standards in the Semantic Web stack can be used to express data schemas, taxonomies, vocabularies, metadata, reference data, and master data. These standards include RDF(S) and OWL, and RDF is an extension that can model provenance and other structured metadata easily. A high level of performance has been ensured through careful consideration and testing of each specification to be able to manage graphs with billions of facts and properties in an efficient manner. It is now possible for data to be serialized, accessible (SPARQL protocol for endpoints), managed, and federated through several specifications. By using globally unique identifiers, it is made more accessible for data integration and publishing to be done. It is the W3C community

process that is responsible for standardizing the above information so that all of its requirements are met - whether they are of interest to logicians, business data managers, or system operators.

It is based on ontologies that knowledge graphs have their formal semantics. There is a difference between the data schema and the data structure of a graph. Through these contracts, the developers and users of the knowledge graph define the meaning of the data contained within it. As a user, you could be either a human being or a software application looking for a reliable and precise manner of interpreting data. An ontology ensures that everyone, in the same way, understands the meaning of data.



**Figure 4:** Knowledge base for the visual perception of Neuro-Psychology



**Figure 5:** Semantic Approach for Gestalt Psychology

## V. CONCLUSION AND FUTURE WORK

Initially, the concepts of Psychology, Cognitive Neuropsychology are discussed after a deep study, and psychological theories of Gestalt are explained in the literature. The process of sending and receiving signals from the sensory nerves to the brain is represented pictorially. Based on these concepts, Knowledge graphs are built on understanding the images in a semantic approach. In the future, we can extend the knowledge brain to generate the inference Engine rules and apply Deep learning and data mining techniques for the Gestalt theories and visual perception, treating the problems of the Visually impaired people optimally.

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