BEHAVIOUR OF HUMAN EYES IN IDENTIFYING CARS

MVDSPL -25

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1.0 Why this Topic?

Automotive styling plays important role in selling of a car or vehicle. How a car looks has always affected its purchase and perception of the brand. Its Visual Perception of an object that creates a desire and makes one opt for 'whether *to have the object or* not?' *situation. Automotive visual elements and styling intent is always kept in a way that people can recognize the car, the brand, the model etc. from a distance.*

Thus studying how eyes see and perceive cars and what are the features that communicate barely enough info to identify a car becomes an important topic. The study may reveal some of the interesting facts about how people see and perceive cars and thus can help in styling.

2.0 How Do We Recognize Objects?

Look around and you will see a lot of day to day objects. You recognize them almost instantaneously and involuntarily. You don't *have to wait for a few minutes after looking at a table to understand that it is in fact a table. Machines, on the other hand, find it very difficult to do this task. People have been working for decades to find a solution to this problem, but they have only been able to achieve an accuracy of around 65%. Why is it so hard for machines to recognize and categorize objects like humans?* What's *so difficult here? We do it everyday and we get it right almost every single time.* What's *the missing link? This is actually the holy grail of computer vision!*

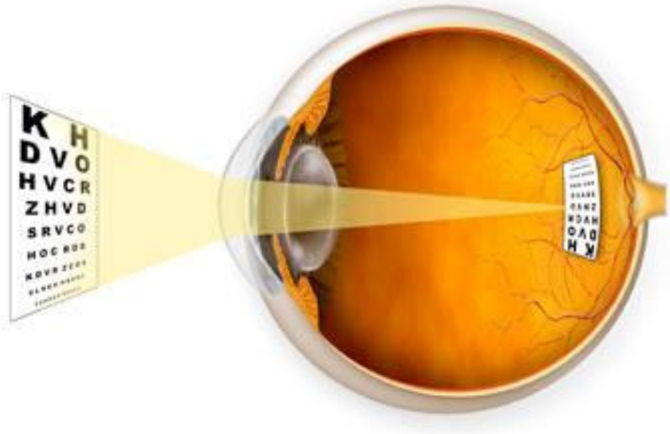
2.1 How do humans do it?

Let's *take a look at how humans recognize and categorize objects. The processing of visual data happens in the ventral visual stream. It is a hierarchy of areas in the brain which helps in object recognition. Humans can easily recognize different sized objects and put them in the same category. This happens because of the invariances we develop. Whenever we look at any object, our brain extracts the features and in such a way that the size, orientation, illumination, perspective etc* don't *matter. You remember an object by its shape and inherent features. It* doesn't *matter how the object is placed, how big or small it is or what side is visible to you. There is a hierarchical build-up of invariances first to position and scale and then to viewpoint and more complex transformations requiring the interpolation between several different object views. We have cells in our visual cortex that respond to simple shapes like lines and curves. As we move -*

along the ventral stream, we get more complex cells which respond to more complex objects like faces, cars etc. Neurons along the ventral stream show an increase in receptive field size as well as in the complexity of their preferred stimuli. Humans take remarkably little time to recognize and categorize objects. This suggests that there is some form of feed forward processing of information going on. This means that the information processed by the cells in the current level in the ventral stream hierarchy is used by the next level. This helps speed up the process by a huge factor.

2.2 Why is it hard for machines?

We know the mechanism by which the visual data enters the human visual system and how it’s *processed. But the problem is that we are still not exactly sure how our brain categorizes and organizes the data. So we try to extract features from an image and ask our machines to learn from it. There are variations like size, angle, perspective, occlusion, illumination etc. The same object looks very different to a machine when it is presented with a different perspective. Humans, on the other hand, will immediately recognize an object from anywhere. One way to go would be to store all possible sizes, angles, perspectives etc, but this would be infeasible. It would take an enormous amount of space and time to recognize an object. If a chair is partially blocked, we will still identify it. Machines will fail in this situation because it is now a new object according to them.*

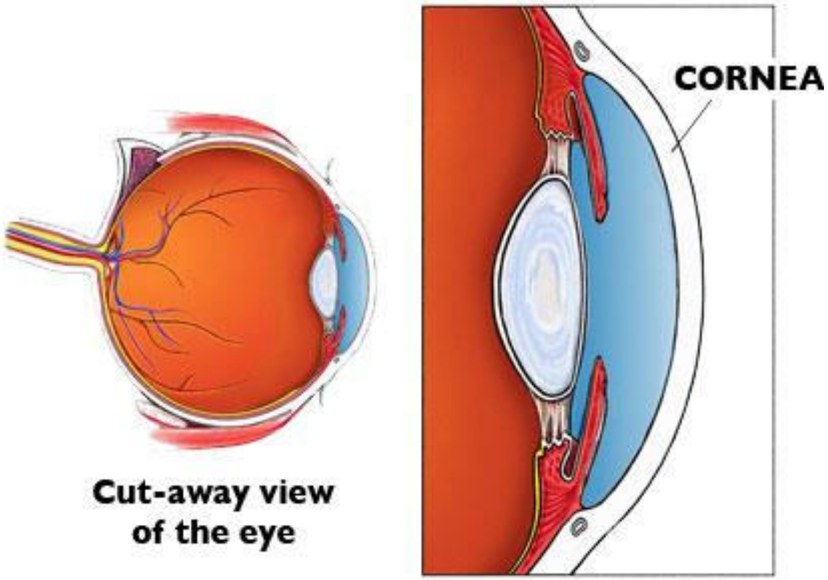


2.3 Human Eye

Light rays enter the eye through the cornea, the clear front “window” *of the eye. The* cornea’s *refractive power bends the light rays in such a way that they pass freely through the pupil the opening in the centre of the iris through which light enters the eye. The iris works like a shutter in a camera. It has the ability to enlarge and shrink, depending on how much light is entering the eye.*

After passing through the iris, the light rays pass thru the eye’s *natural crystalline lens. This clear, flexible structure works like the lens in a camera, shortening and lengthening its width in order to focus light rays properly. Light rays pass through a dense, transparent gel-like substance, called the vitreous that fills the globe of the eyeball and helps the eye hold its spherical shape. In a normal eye, the light rays come to a sharp focusing point on the retina. The retina functions much like the film in a camera. It is responsible for capturing all of the light rays, processing them into light impulses through millions of tiny nerve endings, then sending these light impulses through over a million nerve fibbers to the optic nerve.*

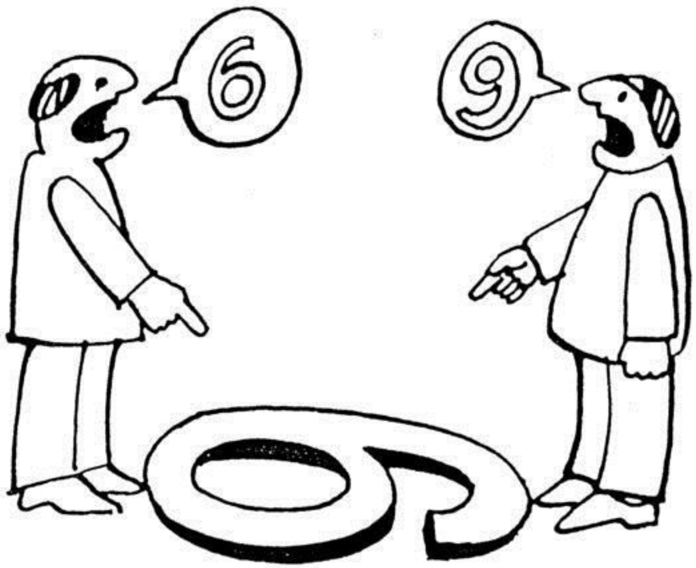
Because the keratoconus cornea is irregular and cone shaped, light rays enter the eye at different angles, and do not focus on one point the retina, but on many different points causing a blurred, distorted image.



In summary, the cornea is the clear, transparent front covering which admits light and begins the refractive process. It also keeps foreign particles from entering the eye.

The pupil is an adjustable opening that controls the intensity of light permitted to strike the lens. The lens focuses light through the vitreous humor, a clear gel-like substance that fills the back of the eye and supports the retina.

The retina receives the image that the cornea focuses through the eye's *internal lens and transforms this image into electrical impulses that are carried by the optic nerve to the brain. We can tolerate very large scars on our bodies with no concern except for our vanity. This is not so in the cornea. Even a minor scar or irregularity in the shape can impair vision. No matter how well the rest of the eye is functioning, if the cornea is scarred, clouded or distorted, vision will be affected.*
In keratoconus, the irregular shape of the cornea does not allow it to do its job correctly, leading to distortion of the image it passed to the retina and transmitted to the brain.



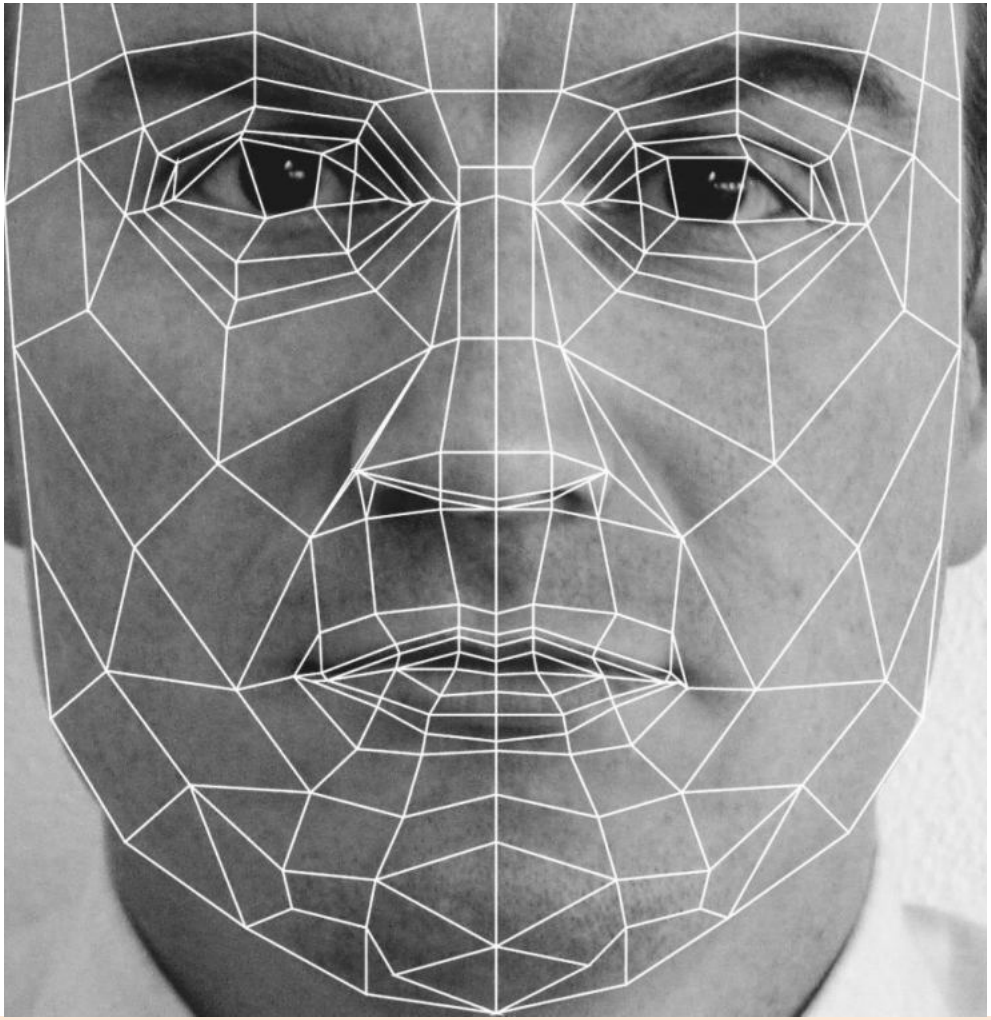
2.4 Perception

Perception (from the Latin perceptio, percipio) is the organization, identification, and interpretation of sensory information in order to represent and understand the environment. All perception involves signals in the nervous system, which in turn result from physical or chemical stimulation of the sense organs. For example, vision involves light striking the retina of the eye, smell is mediated by odor molecules, and hearing involves pressure waves. Perception is not the passive receipt of these signals, but is shaped by learning, memory, expectation, and attention.

Perception can be split into two processes. Firstly, processing sensory input, which transforms these low-level information to higher-level information (e.g., extracts shapes for object recognition). Secondly, processing which is connected with a person's concepts and expectations (knowledge) and selective *mechanisms (attention) that influence perception.*

Perception depends on complex functions of the nervous system, but subjectively seems mostly effortless because this processing happens outside conscious awareness. Since the rise of experimental psychology in the 19th Century, psychology's understanding of perception has progressed by combining a variety of techniques. Psychophysics quantitatively describes the relationships between the physical qualities of the sensory input and perception. Sensory neuroscience studies the brain mechanisms underlying perception. Perceptual systems can also be studied computationally, in terms of the information they process. Perceptual issues in philosophy include the extent to which sensory qualities such as sound, smell or color exist in objective reality rather than in the mind of the perceiver.

Although the senses were traditionally viewed as passive receptors, the study of illusions and ambiguous images has demonstrated that the brain's perceptual systems actively and pre-consciously attempt to make sense of their input. There is still active debate about the extent to which perception is an active process of hypothesis testing, analogous to science, or whether realistic sensory information is rich enough to make this process unnecessary.



2.4.1 Face perception

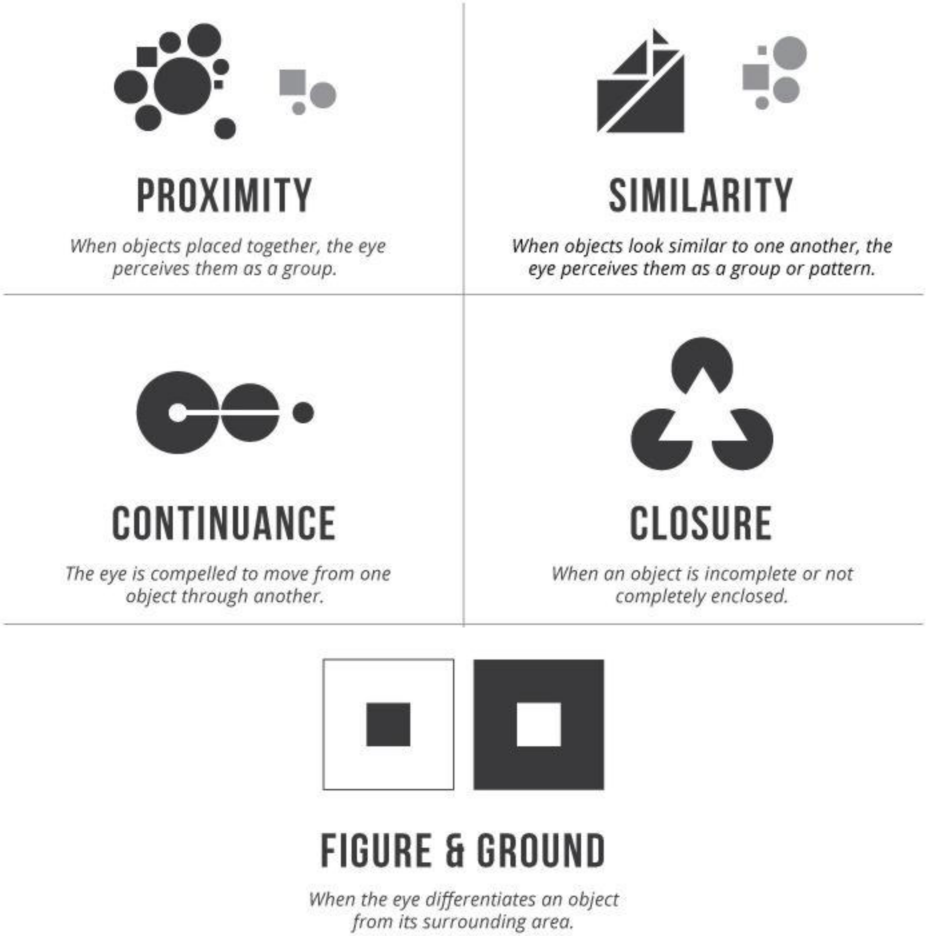
For the psychological phenomena of seeing faces in inanimate objects, see Pareidolia. For computer-based facial perception, see Facial recognition system. Face perception refers to an individual's understanding and interpretation of the face, particularly the human face, especially in relation to the associated information processing in the brain.

The proportions and expressions of the human face are important to identify origin, emotional tendencies, health qualities, and some social information. From birth, faces are important in the individual's social interaction. Face perceptions are very complex as the recognition of facial expressions involves extensive and diverse areas in the brain. Sometimes, damaged parts of the brain can cause specific impairments in understanding faces or prosopagnosia.

2.4.2 Features

Constancy

Perceptual constancy is the ability of perceptual systems to recognise the same object from widely varying sensory inputs.For example, individual people can be recognised from views, such as frontal and profile, which form very different shapes on the retina. A coin looked at face-on makes a circular image on the retina, but when held at angle it makes an elliptical image. In normal perception these are recognised as a single three-dimensional object. Without this correction process, an animal approaching from the distance would appear to gain in size. One kind of perceptual constancy is color constancy: for example, a white piece of paper can be recognised as such under different colors and intensities of light. Another example is roughness constancy: when a hand is drawn quickly across a surface, the touch nerves are stimulated more intensely. The brain compensates for this, so the speed of contact does not affect the perceived roughness. Other constancies include melody, odor, brightness and words. These constancies are not always total, but the variation in the percept is much less than the variation in the physical stimulus. The perceptual systems of the brain achieve perceptual constancy in a variety of ways, each specialized for the kind of information being processed.



Grouping

Law of Closure. The human brain tends to perceive complete shapes even if those forms are incomplete. The principles of grouping (or Gestalt laws of grouping) are a set of principles in psychology, first proposed by Gestalt psychologists to explain how humans naturally perceive objects as organized patterns and objects. Gestalt psychologists argued that these principles exist because the mind has an innate disposition to perceive patterns in the stimulus based on certain rules. These principles are organized into six categories, namely proximity, similarity, closure, good continuation, common fate and good form. The principle of proximity states that, all else being equal, perception tends to group stimuli that are close together as part of the same object, and stimuli that are far apart as two separate objects. The principle of similarity states that, all else being equal, perception lends itself to seeing stimuli that physically resemble each other as part of the *same object, and stimuli that are different as part of a different object. This allows for people to distinguish between adjacent and overlapping objects based on their visual texture and resemblance. The principle of closure refers to the* mind's *tendency to see complete figures or forms even if a picture is incomplete, partially hidden by other objects, or if part of the information needed to make a complete picture in our minds is missing. For example, if part of a* shape's *border is missing people still tend to see the shape as completely enclosed by the border and ignore the gaps. The principle of good continuation makes sense of stimuli that overlap: when there is an intersection between two or more objects, people tend to perceive each as a single uninterrupted object. The principle of common fate groups stimuli together on the basis of their movement. When visual elements are seen moving in the same direction at the same rate, perception associates the movement as part of the same stimulus. This allows people to make out moving objects even when other details, such as color or outline, are obscured. The principle of good form refers to the tendency to group together forms of similar shape, pattern, color, etc. Later research has identified additional grouping principles.*

Objects that are close together
wil be grouped together visually.

PROXIMITY

SIMILARITY

Two items that share attributes will be visually grouped together.

CLOSURE

The Brain is good at filling in gaps to create a whole.

CONTINUATION

A line will always appear to continue travelling in the same way.

FIGURE & GROUND

Sometimes, the blank space is just as important as the filled space.

PRINCIPALS OF VISUAL PERCEPTION

3.0 Automotive design

Automotive design is the profession involved in the development of the appearance, and to some extent the ergonomics, of motor vehicles or more specifically road vehicles.

This most commonly refers to automobiles but also refers to motorcycles, trucks, buses, coaches, and vans. The functional design and development of a modern motor vehicle is typically done by a large team from many different disciplines included within automotive engineering. Automotive design in this context is primarily concerned with developing the visual appearance or aesthetics of the vehicle, though it is also involved in the creation of the product concept. Automotive design is practiced by designers who usually have an art background and a degree in industrial design or transportation design.

4.0 Study

Things to be taken care of-

- *The common cars should be chosen to make sure that people know the car and have seen the ample of times and has an ability to recognize it.*
- *Selected cars should belong to common brand and subject should be familiar with the brand and the design language of the brand*
- *Side view, and perspective are the commonly seen observation angles in real world, thus selected car views for identification has to be side view and front perspective.*
- *From just silhouette to details, there must me more than 5 stages of renders to differentiate between features to know what feature makes a person identify the car.*

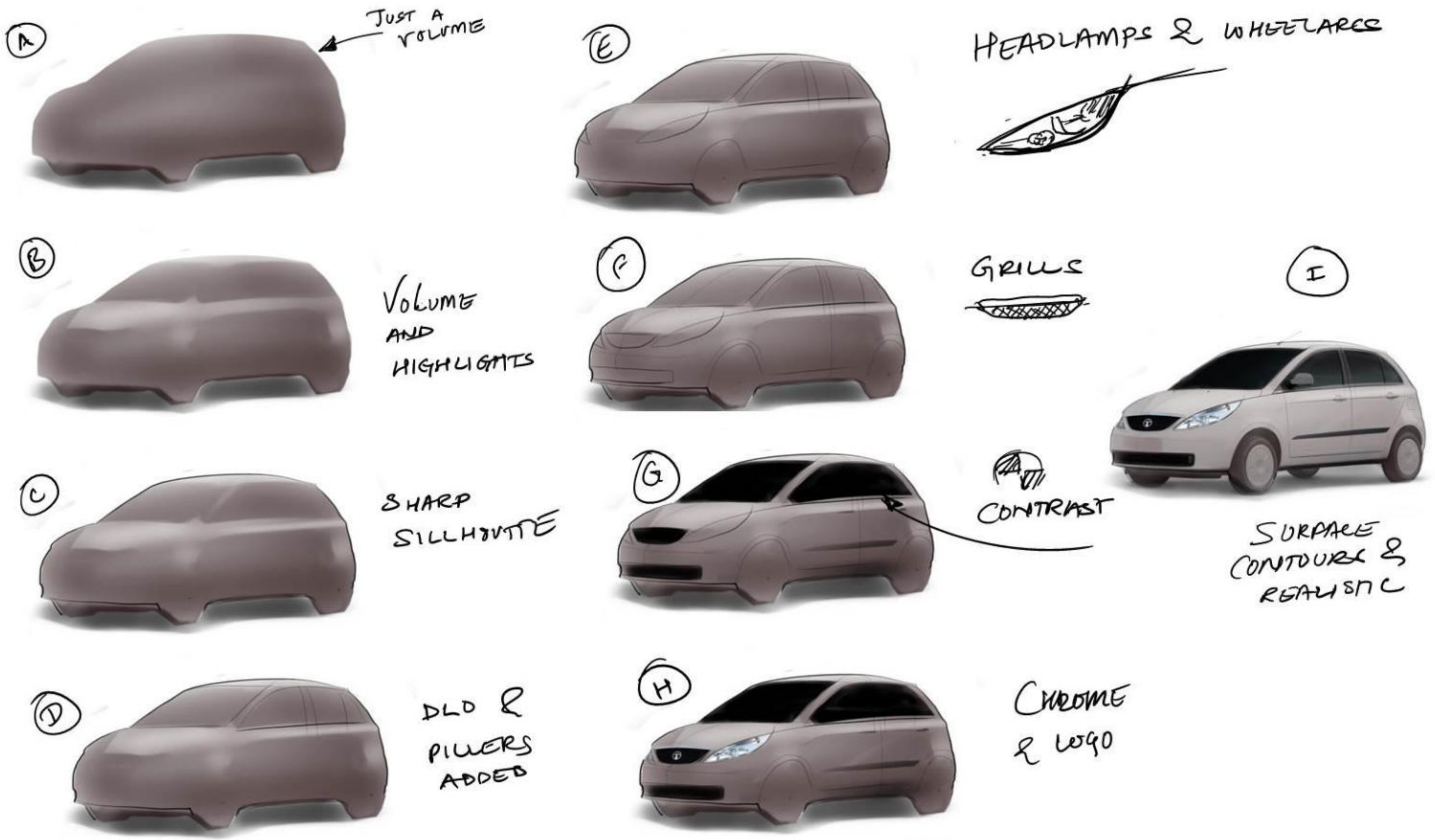
4.1 Strategy

1. *To know which are the bare minimal details required to identify a vehicle, we have to cut down features and thus rendering only silhouette. One by one going on increasing the details the renders are made.*
2. *The renders will be arranged in order of increasing details.*
3. *Subject person will be chosen randomly assuming the car is commonly seen and thus must have been seen by the subject person.*
4. *Subject person will be told to have a look at renders one by one [rest are hidden] till he identify the car.*
5. *The person name, age, gender and the stage at which he identified the car will be noted down.*
6. *Process will be repeated for many subject*
7. *Conclusion will be made from more occurring stage that, that level of minimum details are required to identify a car.*

4.2 Indica Vista

The **Indica Vista** *was unveiled at the 9th Auto Expo in New Delhi. The Indica Vista is not a facelift of the Indica. It is built on a completely new platform and shares nothing with the existing Indica.*

Also called	*Tata Indica V3* *Tata Vista Ego (South Africa)*
Production	*2008–2015*
Assembly	*Pune, Maharashtra, India*
Body and chassis	
Body style	*5-door hatchback*
Related	*Tata Indigo*
Powertrain	
Engine	*1.2 L Safire I4 (petrol)* *1.4 L Safire I4 (petrol)* *1.4 L TDI I4 (diesel)* *1.3 L Multijet I4 (diesel)*
Transmission	*5-speed manual*
Dimensions	
Wheelbase	*2,470 mm (97.2 in)*
Length	*3,795 mm (149.4 in)*
Width	*1,695 mm (66.7 in)*
Height	*1,550 mm (61.0 in)*
Chronology	
Successor	*Tata Bolt*


A
JUST A VOLUME
B
VOLUME AND HIGHLIGHTS
C
SHARP SILLHOUTTE
D
DLO & PILLERS ADDED
E
HEADLAMPS & WHEELARCS
F
GRILLS
G
CONTRAST
H
CHROME & LOGO
I
SURFACE CONTOURS & REALISTIC

Identify The Car

Animation [2 sec Delay]

A B C D E F G H

	Name	Age	Stage Where He/She Recognize Car
1	*PANKAJ*	*25*	*C*
2	*ALICE*	*26*	*D*
3	*SHREYAS*	*28*	*D*
4	*AJAY*	*28*	*E*
5	*KARTIK*	*32*	*G*
6	*SHREYA*	*34*	*E*
7	*ANANT*	*41*	*E*
8	*ROOPALI*	*24*	*B*
9	*MAYURI*	*23*	*E*
10	*ROHIT*	*24*	*F*
11	*CHETAN*	*36*	*D*
12	*PATRIC*	*24*	*E*
13	*NEIL*	*28*	*F*
14	*TAPAN*	*27*	*F*
15	*SNEHA*	*24*	*G*

	Name	Age	Stage Where He/She Recognize Car
1	*PANKAJ*	*25*	*C*
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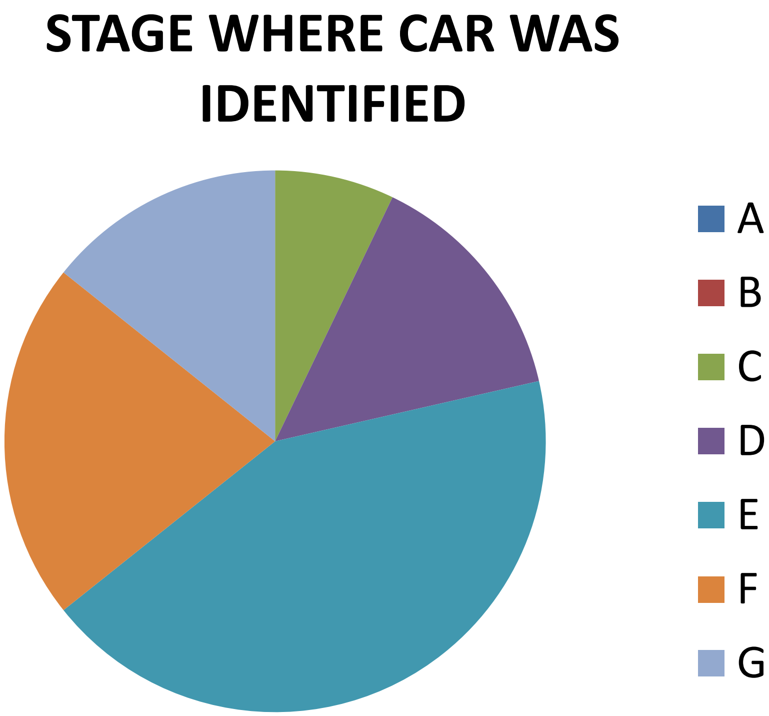
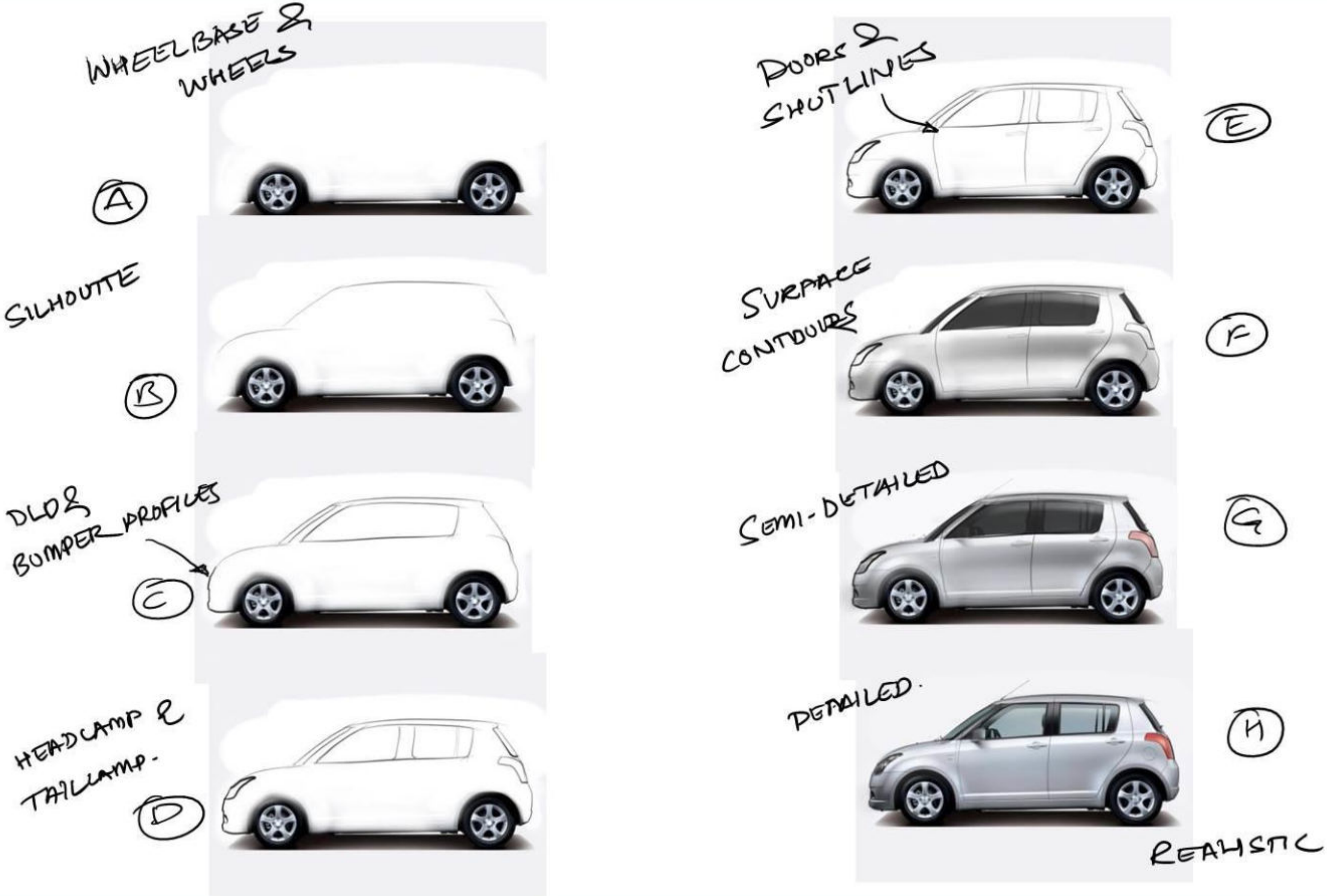
10	*ROHIT*	*24*	*F*
11	*CHETAN*	*36*	*E*
12	*PATRIC*	*24*	*E*
13	*NEIL*	*28*	*F*
14	*TAPAN*	*27*	*F*
15	*SNEHA*	*24*	*G*



4.3 Suzuki Swift

The **Suzuki Swift** *is a subcompact car produced by Suzuki in Japan since 2000. Prior to this, the "Swift" nameplate had been applied to the Suzuki Cultus in numerous export markets.*

Maker	*Suzuki*
production	*2004 - 2011*
Classe	*Citadine polyvalente*
Moteur et transmission	
motor	*- 1248 cm³ - 55 kW / 75 ch* *- 1328 cm³ - 68 kW / 92 ch* *- 1490 cm³ - 75 kW / 102 ch* *- 1586 cm³ - 92 kW / 125 ch*
max	*70 à 125 ch*
Couple maximal	*116 à 190 Nm*
Transmission	*Traction*
Poids et performances	
Velocity	*165 à 200 km/h*
	4.5 à 7.2 L/100 km
Emission de CO2	*119- 171 g/km*
Chassis	
Capacity	*3 - 5*
Dimensions	
Long	*3 695 – 3 760 mm*
width	*1 690 mm*
Height	*1 500 – 1 535 mm*


WHEELBASE &
WHEELS
A
SILHOUTTE
B
DLO &
BUMPER PROFILES
C
HEADLAMP &
TAILLAMP.
D
DOORS &
SHUTLINES
E
SURFACE
CONTOURS
F
SEMI-DETAILED
G
DETAILED.
H
REALISTIC

Identify The Car

Animation [2 sec Delay]

A B C D E F G H

	Name	Age	Stage Where He/She Recognize Car
1	PANKAJ	25	A
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6	SHREYA	34	D
7	ANANT	41	D
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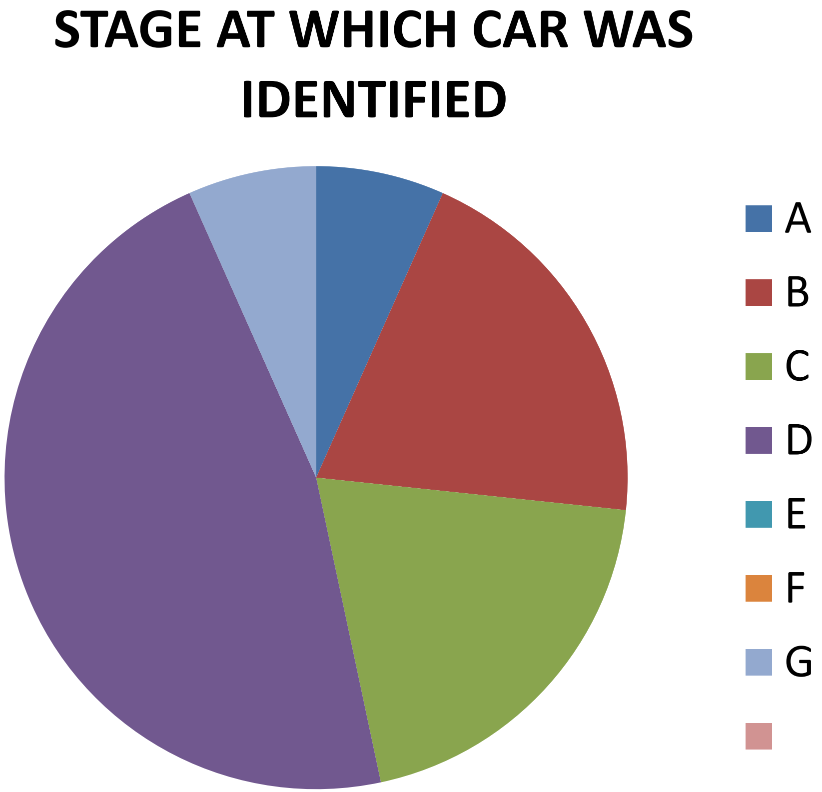
9	MAYURI	23	C
10	ROHIT	24	D
11	CHETAN	36	D
12	PATRIC	24	C
13	NEIL	28	B
14	TAPAN	27	B
15	SNEHA	24	D

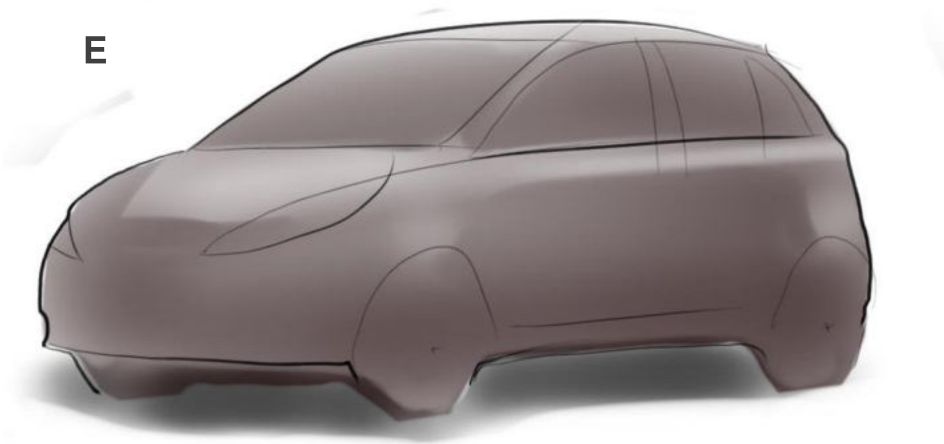


5.0 Conclusion

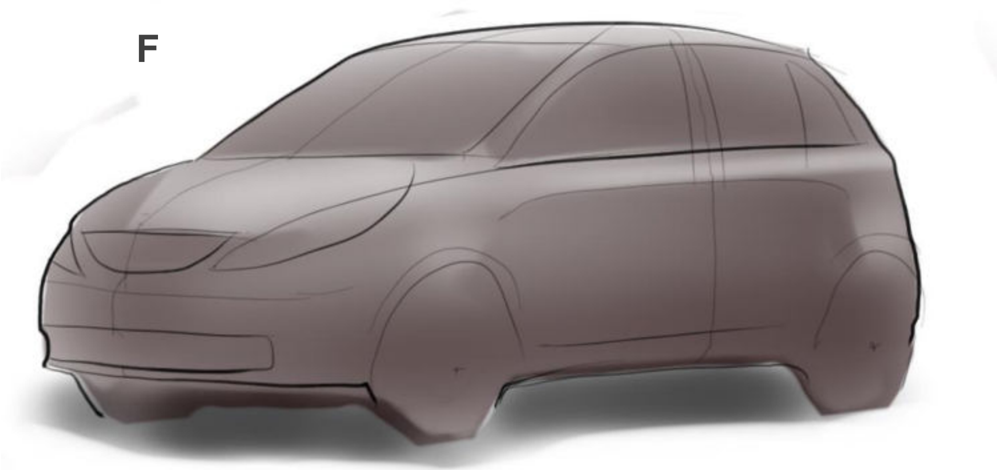
Both the cars were well known to people whom we did experiment on. Thus there was no difficulty in identifying them. The tables and pie chart have shown which stage communicates enough details for someone when its good enough data to identify that car.

Thus looking at those stages we can conclude what are bare minimal details required to identify a car.

E



F



Tata Indica Vista

E stage was most occurring stage where people identified the car

Here the silhouette in perspective is visible, surface highlight and headlamps are shown

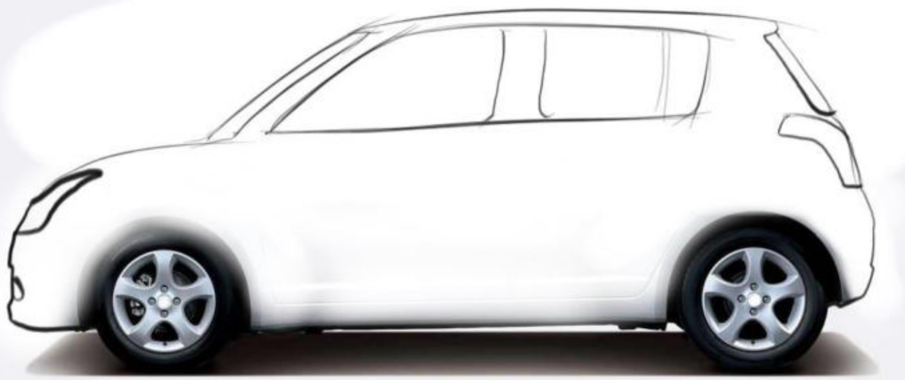
Thus one gets a big clue by looking at headlamps to help identify the car.

F stage was second most occurring stage where people identified the car

Here in addition to previous details, the grills are shown and contour lines are visible [center section]

Thus when headlamps don't *communicate enough information, headlamp with grills gives a clear idea to help recognize the car.*

D



Suzuki Swift

At stage D, most of people recognized the car.

At stage C, some people were little confused between 1-2 cars. As soon as headlamp and tail lamp details are added, people can identify the car.

Thus silhouette gives rough idea of volume. But it’s *the headlamp and tail lamp here that plays important role to differentiate one car from other.*

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