PSYC 3013 – Perceptual Systems

Lecture 1

- 'Umwelt'
    - Provides a sense of what exists & the significance it has: defines our understanding of time (defined relatively) – not on a scale
- Functional roles of perception
    - Control of behaviour/action
        - E.g. optical flow (overrides vestibular system in balance & coordination)
    - Recognition & awareness of the 'world'
- 2 visual pathways

1. Magnocellular - where/how, projects up (projects to areas - reach, walk etc): DORSAL
2. Pavocellular- what projects along side (optic recognition, what is in the world): VENTRAL

- Mediated by senses: what's real and what exists?
    - Realist View
        - Von Uexkull: Sense of what the world is, is based on what our experience is (phenomenal world/self-world of animal)
            - Perception based action - different for each species, in order for us to survive/reproduce. Our perception is informed by the actions that we CAN perform.
            - We see USEFUL representations of the world relative to our behaviours. What its SIGNIFICANCE is, see what behaviours it affords you.
            - Our understanding/concept of time - is not absolute, defined relative to species/relative to you. E.g. Fever vs. sense of time, as fever goes down, time goes down.
            - Allometric scaling (relationship of body size to shape perceptions)
- Why does the world appear the way it does?
    - Problem: brains have to guess what's in the world from light that reaches our eye - images are 2D but our experience of the world is 3D
        - Complexity of a single image
- Different factors of light structure
    - Reflectance & transmittance properties (e.g. colour, lightness, transparency)
    - 3D shape – Changing orientation of surface depending on light source
        - e.g. shading = variations in pigment
        - Point on surface that will be brightest (straight at light source). Eyes- light reflection, brain takes pattern of light for info
    - Illumination (intensity, spectral content, shadow e.g. blue sky, don't attribute to shadow but to the reflectance of the sky)
    - Occlusion: blocking
        - Partial occlusion: brain connects pieces of things together
        - Border ownership: brain distinguishes between occluding edges, that 'own' the contour & side of edge that is occluded which seems to continue behind occluder
        - Camouflage - parts of contourance that are missing; Movement = enemy
        - Illusory contours: e.g. can see triangle instead of 3 pacman looking things

Opaque Materials - Reflectance

- Bidirectional reflectance distribution function

- Any given direction & position of the eye etc. can measure the amount of light from any given direction
- Need to make measurements, what portion of light comes our from a particular vantage point, behaviour changes depending on the angle

- Everything we see is determined by how light reflects off it (reflectance) and the way that light is reflected (the different reflectance properties e.g. lightness, colour, material) → can tell us about materials as these reflect light differently

- Reflectance

- When we see the surface of objects, all of the structure and light (except for translucency and the transparency) is created by the way the light strikes the object and is reflected back into our eyes
    - Objects omit light and is referred to as a **secondary light source** (can have **'inter reflections'** = additional bounces between things)
- Surface normal: Generalization of a perpendicular, or 90 degree angle
- **Dichromatic reflectance Model:** Two types/models sufficient to capture most things in the world
    - **Diffuse**, or '*matte',* or *'Lambertian reflectance'*: when we talk about the colour or lightness (subset of colour) of an object, we are referring to our perception of what we think it's diffuse reflectance is
        - Light hits the surface and is scattered uniformly in all directions (because of its interaction with colorant particles)
        - Light = absorbed by material
    - **Specular**: *angle of incidence* = *angle of reflectance* relative to the surface normal
        - Mirror is a perfectly specular surface
        - Light = reflects the structure of the world around it (e.g. mirror)
- Objects can have a combination of diffuse and specular, in which some light is scattered uniformly and some light is reflected according to the angle of incidence
    - **Diffuse + Specular** – Light = Part of the light is reflected & parts are absorbed
    - **Diffuse + Specular blur** - The specular model can also have a blur component = how spread out or scattered the specular reflectance is, or 'micro roughness'
        - Light = Absorbed, and reflected in a few different ways (few arrows coming off of surface normal)
        - E.g. Surface irregularities, semi gloss
- Example one: What would happen in the diagram if the teapot changed colour from white to black/dark grey?
    - Answer: the arrows (representing light reflectance) would be smaller/thinner, the proportion of light reflected would be less as more light would be absorbed, shorter arrows = less reflectance
- Example two: What would happen in the diagram if the light source becomes weaker?
    - Answer: the same thing --- the arrows (representing light reflectance) would be smaller/thinner
    - I.e. we can create the exact same effect by changing the colour of and object vs. turning the lights down

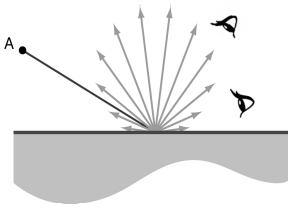
Colour & Lightness

- Light colours reflect light, dark absorbs
- Colour isn't just what's in the image → e.g. blue strawberries pic – brain is adaptive, does this all the time
- Transparency - Viewing portions of scene through transparent layer, 'thin' the fog by manipulating contrast
- Not just the amount/proportion of light that is reflected (lightness), but its spectral content (proportion of each wave length, its relevant power – brain turns into colour)
    - **Lightness (albedo):** the proportion of light a surface reflects (it's about the object – we talk about things having 'lightness', not 'brightness')
    - **Brightness**: amount of total light (luminance) projected to the eye from something (surface or light source)

- It can refer to the intensities of the retinal images or any image
- Contrast Effect: Context matters – things surrounded by darker things look lighter & surrounded by lighter things look darker e.g. 2 tone squares
- We can usually distinguish different sources of image structure even when they're locally identical
  - Checkerboard example: Sources A & B have the same amount of light but they appear to differ in **lightness** (due to shadow) The reflectance image tells us what the intrinsic pigments are (light grey & dark grey)
  - The luminance image tells us which sides are being illuminated by the light source (change in surface pose relative to the light source → shading)
  - In the picture, the shading edge is the exact same as the reflection edge, however our brain is able to tell that these edges mean different things → has to somehow take context into account

Lambertian Reflectance ('matte')

- **Lambert's law:** The brightness of a surface patch is independent of viewing direction; it only depends on the position(s) of the light source(s) – the brightness will look the same independent of where you view it from
  - The brightest portion of the surface tells you what the main illumination point is – this is the surface normal (is pointing directly toward the illuminant)
  - Example: If this tea pot was viewed from some other position, the brightness of visible patches would not change
  - But why doesn't the brightness change? The arrows are all different sizes, so if they are viewed from different directions, it suggests that the brightness should change
    - At the surface normal – becomes an elipse (it disappears)



- If we hold surface orientation fixed (i.e. 2D), the following equation holds:
  - The total amount of reflected light (arrows - lumination) depends on both the amount of light striking the surface (illumination) and the proportion of light the surface reflects (its lightness) → **luminance = reflectance x illumination**
    - The amount of light striking a surface varies with surface orientation & gives rise to shading
    - If the direction of the light source is know → a 3D shape of a surface can be computed from patterns of shading
    - What proportion of light the object reflects (e.g. shirt is black) → rest of light is absorbed
    - We can't tell what the proportions are by looking at them
  - Brightness level (illumination) changes at the exact same rate as the size of that surface patch area you are viewing – so the relative amount of light (lumination) per area stays the same