- Classical conditioning enables human and nonhuman animals to take advantage of the orderly sequence of events in environment to take appropriate actions in anticipation of what is about to happen
- **The early years of classical conditioning**
    - Classical conditioning began by Pavlov
    - Also independently discovered by Edwin Twitmyer submitted in 1902
        - Repeatedly tested knee-jerk response by sounding a bell 0.5 seconds before hitting knee
            - Bell was sufficient to elicit the knee-jerk reflex
    - Pavlov's research was extension of research on process of digestion
        - Made major advances in study of digestion by developing stomach fistulae that collects various digestive juices
        - Secretions could be used to study the mechanisms of association learning and functions of the nervous system
    - **The discoveries of Vul-fson and Snarskii**
        - First systematic studies of classical conditioning performed by Vol'fson and Snarskii in Pavlov's laboratory
            - Focused on salivary glands
        - After dogs were exposed to food in the mouth enough times, the sight of the drugs was enough to make them salivate
        - Substances produce distinctive texture and taste sensations in the mouth
            - Orosensory stimuli
            - Dog learns to associated visual feature of substance with its orosensory features
            - Object learning – association of one feature of an object with another
        - To study associative learning – stimuli have to be manipulated independently of one another
    - **Classical conditioning paradigm**
        - Pavlov's basic study involved two stimuli
            - Tone or light
            - Food or sour solution
        - Conditioned Stimulus – tone or light
        - Conditioned response – salivation that was elicited by the light
        - Unconditioned stimulus – the food substances
        - Unconditional response – salivation elicited by food
- **Experimental situations**
    - **Fear conditioning**
        - Watson and Rayner investigated the conditioning of emotional reactions
            - Assumed there was a simple method by means of which range of stimuli which can induce emotions
        - Conditioned fear response in Albert to the presence of a white lab rat
            - Presenting rat to Albert and then associating that with the sound of a metal bar being hit by a hammer
                - After 2 – Albert did not want to touch the rat
                - By 7 – showed strong fear response
            - Conditioned fear generalized to all furry things
        - Fear and anxiety sources of considerable human discomfort and can lead to serious psychological and behavioural problems
        - Rats show their fear by freezing, animals that aren't moving are not easily seen by predators
            - Immobility of body and absence of movement of whiskers
        - Conditioned suppression
            - Suppression of ongoing behaviour
        - Two more measures of immobility
            - Lick-suppression procedure

- Animals are slightly water deprived and lick readily when put into an experimental chamber with a drinking spout
- If fear CS presented, licking behaviour is suppressed and takes longer to make specified number of licks

- Conditioned emotional response
  - Rats first trained to press response lever for food reward
  - Lever press provides behavioural baseline for fear measurement
    - Once rats are pressing at a steady rate, fear conditioning is introduced
      - Tone or light paired with a brief shock
  - To measure suppression of lever pressing, suppression ratio is calculated
    - Compares number of lever presses that occur during the CS with number that occur during a comparable baseline period before CS is presented
    - Suppression ratio of zero if rat suppresses lever pressing during CS
  - $Suppression\ ratio = \frac{CS\ responding}{CS\ responding + pre{-}CS\ responding}$
    - Example: if rat presses lever 30 times pre-CS and 30 times after CS, then suppression ratio will be 0.5

$$0.5 = \frac{30}{30 + 30}$$

  - No suppression on first day, but gradual suppression as CS was exposed to rats
  - Smaller the suppression ratio, the more motionless the animal

- **Eyeblink conditioning**
  - Eye blink reflex early component of startle response and occurs in many species
  - Eye blink conditioning extensively investigated in studies with human participants early in development of learning theory
    - Provides tool for studying problems in development, aging and Alzheimer's
    - Used extensively in studies of neurobiology of learning
  - Ivkovich et all
    - Eye-blink conditioning in five month old infants
    - Found increased response to CS in group where CS was paired with US compared to when CS paired with US randomly
    - Important points about learning
      - Showed that classical conditioning requires pairing of CS to US
        - Responding to CS did not develop in the unpaired control group
      - Learning was not observable at first
  - Also conducted on domesticated rabbits
    - Rabbits rarely blink, ideal for eye-blink research
    - Rabbit eye blink conditioning relatively slow, requires several hundred trials for substantial levels of conditioned responses
- **Sign tracking**
  - Moving toward and possibly contact with stimulus that signals the availability of a positive reinforce
  - Tend to approach contact stimuli that signal availability of food
    - Availability of food can be predicted by some key aspects, such as its appearance at a distance
  - Investigated in lab by presenting discrete visual stimulus just before each delivery of a small amount of food

- Brown and Jenkins
  - Pigeons placed in experimental chamber that had illuminated circular key that illuminated so pigeons could peck
    - Illuminated for 8 seconds before food was delivered
  - Started pecking the light hoping to get food
    - Not required to gain access to food
  - Presenting key light at random or unpaired with food does not lead to pecking
- Tracking of signals for food dramatically illustrated by instances when signal far from food source
  - Pigeons
    - Pigeons went to key light when CS was presented before approaching the food
  - Quails
    - Birds approached CS before approaching location of female (8 ft)
    - CS elicited strong enough appeal that it attracted male quails more than the female
- Only occurs in situations where Cs is localized and can be approached and tracked

- **Learning what tastes good and what tastes bad**
  - Taste aversion theory
    - Learned if ingestion of a novel flavour followed by an aversive consequence such as indigestion or food poisoning
  - Taste preference theory
    - May be learned if followed by nutritional repletion or other positive consequence
  - Human taste aversions result of Pavlovian conditioning
    - Typically involves eating a distinctively flavoured food and then getting sick
      - May contribute to lack of appetite which is linked to chemotherapy
  - Conditioned food aversions also contribute to suppression of food intake or anorexia
    - People suffering from anorexia nervosa experience digestive disorders that may increase likelihood of learning food aversions
  - Taste aversion learning is a result of the pairing of a CS and US
  - Has some special features
    - Aversions can be learned with one pairing of the flavour and illness
      - Such rapid learning is rarely observed in other forms of conditioning
    - Long-delay learning
      - Evolved to enable human and other animals to avoid poisonous foods that delayed ill effects
      - Learning can still occur even if the illness does not occur until several hours after exposure
      - Smith and Roll
        - Rats adapted to water deprivation schedule so they'll readily drink when water placed on cage
        - Exposed rats to saccharin solution and then fake x-ray machine (sickness was induced)
        - Showed aversion to the solution
        - 6 hours – 20% less of total fluid intake
        - 12 hours – hardly any aversion
        - 24 hours – little to no aversion
  - Can be made unpalatable by pairing it with another taste that is disliked
    - Vice versa is true
  - Evaluative conditioning

- Evaluation of stimulus changes by virtue of having that stimulus associated with a liked/disliked stimulus

- **Excitatory Pavlovian conditioning procedures**
  - Excitatory conditioning
    - Organisms learn association between conditioned and unconditioned stimuli
  - **Common Pavlovian conditioning procedures**
    - Major factor is the relative timing of CS and US
    - Small and trivial variations in how CS – US is paired can have profound effects on how vigorously CR occurs and when it occurs
    - Conditioning trial – presentation of CS and US
    - Interstimulus interval / CS - US interval – time from start of CS to start of US
    - Five common classical conditioning procedures
      - Short-delayed conditioning
        - Most frequently used procedure
        - Delaying start of the US slightly after the start of CS, US presented before CS ends
      - Trace conditioning
        - US starts after CS ends
      - Long-delayed conditioning
        - CS starts before US, but US delayed much longer
      - Simultaneous conditioning
        - CS presented at the same time as US
      - Backward conditioning
        - US presented before CS
  - **Measuring conditioned responses**
    - To make comparisons, they are compared to a test trial
    - CS can be introduced to track progress of learning
    - Magnitude – how much of the conditioned behaviour occurs
    - Probability – vigor of responding can be measured by how often CS elicits a CR
    - Latency – amount of time that elapses between the start of the CS and occurrence of the CR
  - **Control procedures for classical conditioning**
    - Association between CS and US implies two events have become connect in some way
    - After an association
      - CS is able to activate processes related to US
        - Requires more than familiarity with CS and US
    - To conclude association has been established, must have observable change in behaviour not produced by separate presentations of CS or US
    - Pseudo-conditioning – exposure to just US produces increase response to previously ineffective stimulus
      - Control processes required to determine whether responses that develop to CS represents a genuine CS-US association or pseudo conditioning
    - Random control procedure – present US periodically during both CS and inter-trial interval, making sure probability of US the same during CS and inter-trial
    - Explicitly unpaired control – CS and US presented far enough apart to prevent their association
  - **Effectiveness of common conditioning procedures**
    - Most effective when CS is a good signal for impending delivery of the US
    - Simultaneous and trace procedures poor predictors
    - Trace interval – CS best predictor of US

        - Temporal coding hypothesis – classical conditioning involves not only learning what to expect but when to expect it
- **Inhibitory Pavlovian conditioning**
    - Learning to predict the absence of the US
    - Ability to predict bad things is helpful because it also enables you to predict when bad things will not happen
    - Conditioned inhibitor is a signal for the absence of the US
    - **Procedures for inhibitory conditioning**
        - Conditioned inhibition has an important prerequisite
        - For absence of US to be significant, US has to occur periodically in the situation
        - Inhibitory conditioning and inhibitory control of behaviour occur only if there is an excitatory context for US in question
        - **Pavlov's Procedure for Conditioned inhibition**
            - 2 types of trials
                - Excitatory conditioning trials
                    - CS+ signals US
                - Inhibitory conditioning trials
                    - CS+ presented together with second stimulus called the CS- and US does not occur
        - **Negative CS-US contingency or correlation**
            - Negative correlation or contingency means that US less likely to occur after CS than at other times
            - CS signals reduction in probability that US will occur
            - Aversive US may occur shortly after CS occasionally but much more likely to occur in absence of CS
    - **Measuring conditioned inhibition**
        - Conditioned excitatory stimuli come to elicit new responses such as salivation, approach or eye blinking, depends on what US is
        - **Bi-directional response systems**
            - Certain behavioural responses bi-directional
            - Conditioned excitation results in change in behaviour in one direction and conditioned inhibition results in change in behaviour in opposite direction
            - Many responses not bi-directional
            - Conditioned inhibition measured indirectly using compound stimulus test and retardation of acquisition test
        - **Compound-stimulus or summation test**
            - Compound-stimulus/summation test popular with Pavlov and remains one of the most widely accepted procedures for measurement of conditioned inhibition
            - Based on simple idea that conditioned inhibition counteracts or inhibits conditioned excitation
            - To observe conditioned inhibition, must measure how presentation of CS- disrupts or suppresses responding normally elicited by a CS+
            - Compound-stimulus test for conditioned inhibition indicates that presentation of conditioned inhibitor or safety signal can reduce stressful effects of an aversive experience
        - **Retardation of acquisition test**
            - If stimulus actively inhibits particular response, should be especially difficult to condition that stimulus to elicit the behaviour
                - Rate of excitatory conditioning should be retarded if CS is a conditioned inhibitor

- **Prevalence of classical conditioning**
  - Investigated in laboratory situations
  - Occurs in wide range of situations outside the lab
  - Stimuli in environment occur in orderly temporal sequence