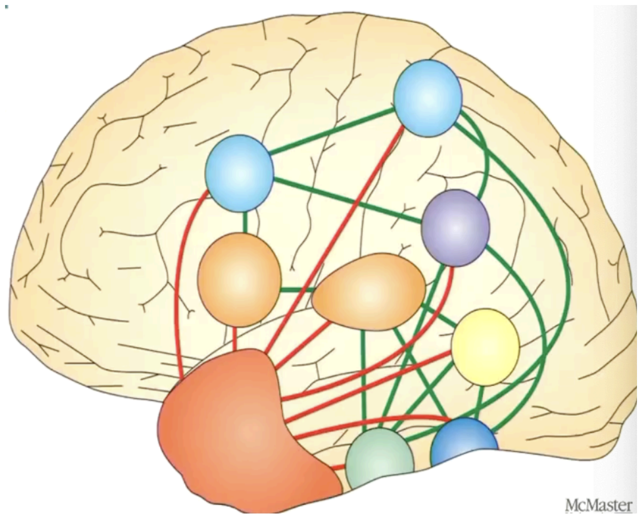
<u>Chapter 9 - Categories & Concepts</u>

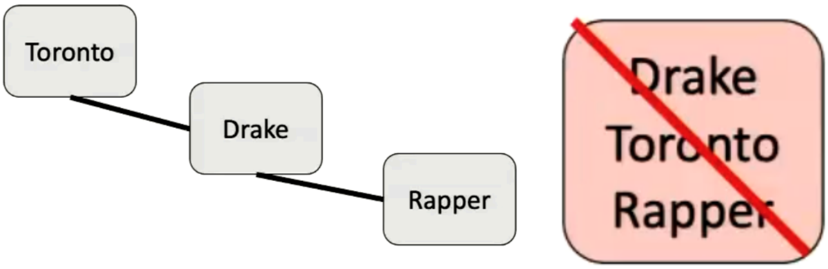
- **Concepts** allow us to:
    - Apply general knowledge to new cases.
    - Draw broad conclusions from previous experiences.
    - E.g. the concept "dog"
        - Allows us to know what a dog is.
        - Allows us to have certain expectations of what characteristics a dog has.
- How do we think about concepts?
    - **Definitional Approach**
        - Membership in a category is defined by fitting definitional characteristics.
        - Always possible to find exceptions, so not necessarily the best approach.
            - E.g. "Tables are flat surfaces with 4 legs" works in most cases, but isn't sufficient to define all tables.
    - **Family Resemblance**
        - Membership in a category is defined as possessing enough characteristic features.
        - In this approach, the idea of "defining features" is replaced with "characteristic features", aka features that family members *usually* possess.
        - E.g. A basenji can't bark, but is still a dog according to the family resemblance model.
    - **Prototype Theory**
        - In this approach, a category is characterized by a central member that possesses all the characteristic features (the **prototype**).
        - Category membership is judged based on **typicality** (Closeness in terms of shared observable features between member and prototype).
        - Members are given a **graded membership** (More typical objects are considered better members of the category)
        - **Evidence for prototype theory:**
            - **Sentence verification tasks:**
                - Participants were asked to verify the truthiness of a sentence.
                    - E.g. "Birds are birds", "Robins are birds", "Penguins are birds"
                - The closer the potential member was to the prototype, the faster the participants responded.
                    - E.g. Things like "Birds are birds", "Robins are birds" had very fast reaction times, while things like "Penguins are birds" had very slow reaction times, since penguins are less "birdy".
            - **Production tasks:**
                - Participants were asked to name as many members of a category as possible.
                - More typical members, such as "Apples in Fruits" were produced more often, whereas less typical members such as "Avocados in Fruits" were produced less often.
            - **Rating tasks:**
                - Participants were asked to rate members/non-members of a category.
                - More prototypical members tended to get rated higher than non-prototypical members.
- **Basic-level categories**

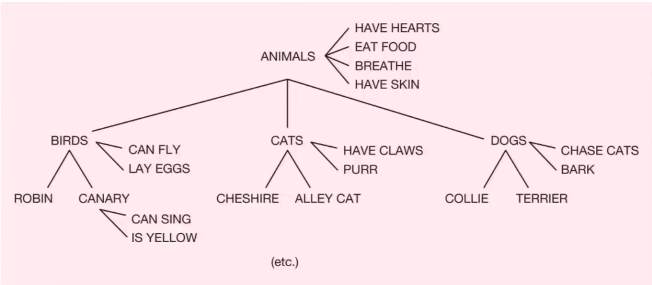
    - Categories also have different levels of specificity. We tend to choose the relevant **basic-level category** (The most informative and easily-learned category amongst possible categories) when trying to determine the category membership of an object.
        - E.g. When seeing a metal bench outside of the student center, we wouldn't categorize the bench as "furniture" (too general, aka **superordinate**) or "the bench 20m from the student centre" (too specific, aka **subordinate**), but simply as "bench".
    - Basic level categories are usually represented by single words, and are the default for naming objects.
    - This allows us to easily explain things to people - too general, and not enough information is given for the context, too specific and people get lost in the details.
    - The theory behind why we learn basic level categories is that this is how we categorize the world as infants, and that we extend this categorization throughout adulthood.
- **Exemplar theory**
    - The idea that we categorized based on knowledge about specific category members as opposed to prototypes.
- **Exemplar vs Prototype theory**
    - Both are used to categorize things. We tend to use exemplar theory to categorize extreme or niche members, and prototype theory for the rest.
    - We tend to build our prototypes of a category through encounters with examples.
        - It is for this reason that young children and those inexperienced with stimuli tend to have a hard time categorizing novel stimuli - they simply haven't had enough examples yet to form prototypes of categories.
    - Prototypes are economical summaries of a category, bottled into one ideal member. Exemplars on the other hand provide information about category variability and make categories easier to adjust, but are less economical.
    - Economical in this context means the amount of time and effort it takes to describe the category representation. So exemplars tend not to be economical because if you wanted to exhaustively describe a category this way, it would take forever.
- **Formation of conceptual knowledge via exemplar and prototype theory:**
    - Conceptual knowledge is a mix between examples and the prototype.
    - Early learning involves exemplars, and as experience accumulates, exemplars are averaged to get prototypes. Eventually, we use both of them to ascertain category membership.
- **The role of typicality in categorization**
    - Typicality aids judgement of category membership, but is not the only determining factor.
    - Atypicality doesn't exclude category membership:
        - E.g. painted, squished, chopped, poisoned lemon, is still a lemon.
    - Presence of all typical features doesn't guarantee category membership:
        - E.g. perfectly counterfeit money still isn't money.
    - Category membership often depends on the observer's pre-existing knowledge:
        - E.g. Children understand that skunks can't be turned into raccoons, but understand that toasters can be turned into coffee pots.
            - This is actually evidence that we categorize living things differently from unliving things, natural things different from artifacts (man-made things), etc.

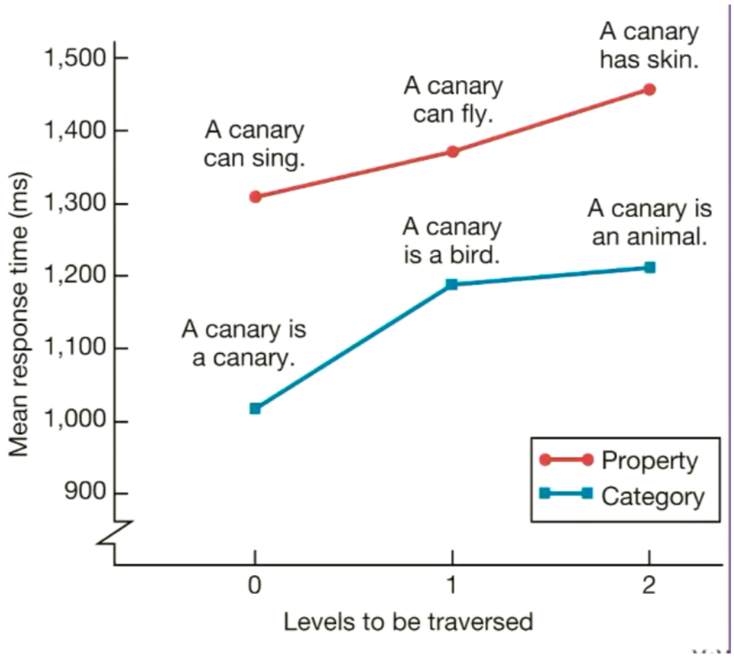
- **The role of beliefs/prior knowledge in categorization**
    - Belief in what is typical and required for category membership is fairly important. Belief is developed through previous experience.
        - E.g. A person dressed like Santa is still a person to most adults due to our pre-existing beliefs about the existence of Santa. But maybe not to kids.
    - Judgements about whether something fits in a category based on resemblance (without discrimination for which resembling features matter) can be uninformative.
        - E.g. I weigh under 10 tons, and so does an elephant. We don't belong in the same category though.
    - Beliefs/prior knowledge help us determine what the essential characteristics of a category are.
        - E.g. I don't have a trunk, weigh over 600 pounds and my parents aren't elephants. These characteristics are essential to judge whether or not I belong in the elephant category.
- **The categorization/conceptual knowledge process**
    1. Typicality influences category judgement - this is revealed by the substantial roles of prototypes and exemplars.
    2. Judgements of resemblance on a member to a prototype/exemplar is then made.
        a. This judgement depends on beliefs/prior knowledge.
        b. Beliefs/prior knowledge tell us which attributes are relevant and which to ignore.
- **Making inferences**
    - **Category based inferences** are inferences about the member of a category made based on typicality and theories/broader beliefs related to a category.
        - We tend to be willing to make inferences from typical members down to atypical members, but not the other way around.
            - E.g. Knowing that robins lay eggs makes us infer that penguins do too, but knowing that penguins dive in the ocean doesn't make us infer that robins do too.
        - E.g. Knowing that grass contains chemical A allows us to assume that Betsy the cow contains chemical A, since Betsy is a cow and cows eat grass.
- **Defining Categories & Concepts**
    - Concepts can be characterized by:
        - **Category type**
            - Features (e.g. dog vs chair features)
            - Goal-driven categorization
                - E.g. We can put an elliptical in the "exercise equipment" category because we know its function/goal is to facilitate exercise.
            - Relational categorization, aka categories that are defined by the relationship.
                - E.g. gifts (defined by the relationship between giver/receiver/object), bridge (defined by its ability to connect 2+ entities), predator (defined by its relationship to its prey)
            - Event categorization
                - E.g. interviews, romantic dates, etc.
        - Natural vs artifacts (man-made)
            - Actually activates different areas in the brain. E.g. The superior temporal sulcus is related specifically to the processing of *biological* motion.
        - Living vs non-living

        - Living categorization often depends on perceptual properties.
        - Nonliving categorization often depends on functional properties.
- **Concepts and the Brain**
    - **Embodied cognition**
        - The idea that our cognition is shaped by one's bodily state and its interaction with the environment.
        - E.g. I perceive the world differently than someone taller than me due to our height difference. What is "close" to them is inherently different from what is "close" to me.
        - "Evidence": Sensory and motor areas are active when we think about concepts like kicking or punching. The same motor areas that light up when you actually kick someone and the same visual areas that light up if you were to see yourself kicking light up.
            - The idea here is that thinking about an action causes you to actually run the hypothetical sequence in your head and imagine the outcomes (how it feels, where you would be in space, etc.)
    - **Hub and Spoke Model**:
        - The idea that a "hub" connects and integrates more specialized information from other brain areas (the "spokes").
        - Damage to the "hub" leads to loss of general knowledge related to its specific network of processing.
            - E.g. Impaired semantic memory and recognition.
        - Damage to a "spoke" leads to loss of specific knowledge related to its specific. network of processing.
        - 

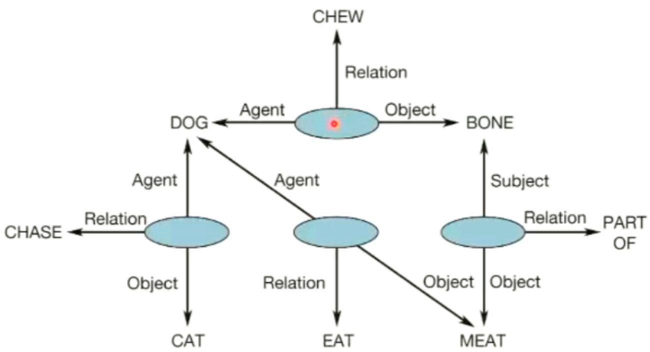
        - In the image above, the anterior temporal lobe is the "hub". This is the proposed site of the hub for embodied cognition.
- **The representation of knowledge as links between concepts**
    - A link between concepts *is knowledge*

- 

- In the figure above, the knowledge bit "Drake is a rapper from Toronto" is represented by the link between the 3 nodes, not the singular node "Drake Toronto Rapper"
- 

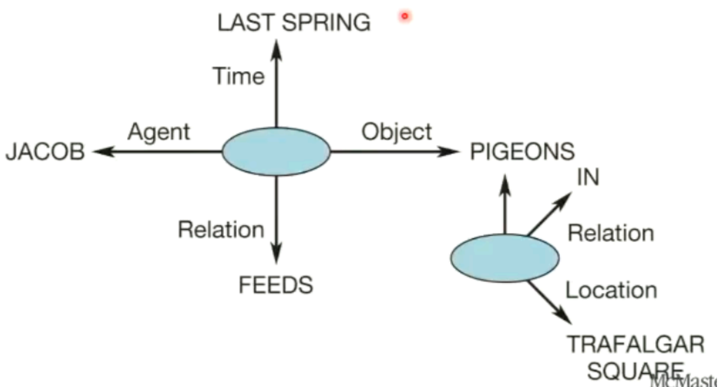
- To travel the **knowledge network** (an example is shown above) for a concept like "Do cats have hearts", we start at "cats" and travel up the tree, looking for "have hearts".
- This representation of the knowledge network is similar to the idea of a prototype chain in computer science, or semantic inheritance in hierarchical networks - we avoid having redundant information like "Have hearts" twice - in this example, "CATS" doesn't need "HAVE HEARTS" directly, since this is present in its ancestor "ANIMALS".
  - When exceptions occur, like "JELLYFISH", we would have an exception branch like "DON'T HAVE HEARTS" to override the ancestral feature.
- **Evidence:** Concepts that require less travel between nodes are more quickly recognized. See image below:
- 

            - Problems with this “evidence” of travelling across the network:
                - Sentence verifications are faster if sentences are about more prototypical stimuli. For example, “Do peacocks have feathers” is processed faster than “Do sparrows have feathers”, even though technically they traverse the same number of nodes.
                    - This is amended by the idea that when key characteristics occur, such as “FEATHERS” for peacocks, we have a branch that might say “FEATHERS”, for faster association.
                    - But this amendment therefore means that the **principle of non-redundancy** does not always hold.
- **Propositional Networks**
    - **Propositions** are the smallest unit of knowledge that can either be true or false.
        - E.g. “Children love Candy” is a proposition, “Children” is not
        - **Nodes** represent concepts, and link to form complex concepts.



Our understanding of dogs is represented by interconnected network of propositions.

        - E.g. in the image above, ellipses are the propositions, and their outward arrows are the parameters. In this case, we would read bits of information like “dogs chase cats”, “dogs eat meat”, etc.
        - This allows us to represent complex concepts by linking isolated concepts, such as the one below, which reads “Last spring, Jacob fed pigeons in Trafalgar Square”.



Our representation of previous events/episodes includes propositional networks that include time, location nodes

- **Different types of networks**
    - Propositional networks
        - As above - each node represent one proposition or idea
    - **Connectionist networks**

- Each idea is represented by a pattern of activation across the network via parallel distributed processing.
  - E.g. The 2 nodes in the figure above activate simultaneously to form the idea about Jacob feeding the pigeons last spring.