Schema Theory

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Fall 2013

Basic Concepts

Definition: Schema theory is a branch of cognitive science concerned with how the brain structures knowledge.
A schema is an organized unit of knowledge for a subject or event. It is based on past experience and is accessed to guide current understanding or action.

Characteristics:

- Schemas are dynamic – they develop and change based on new information and experiences and thereby support the notion of plasticity in development.
- Schemas guide how we interpret new information and may be quite powerful in their influence (see work of Brewer and Treyens below).
- Schemas, or schemata, store both declarative ("what") and procedural ("how") information.

  > Declarative knowledge is knowing facts, knowing that something is the case; procedural knowledge is knowing how to do something – perhaps with no conscious ability to describe how it is done (Hampson & Morris, 1996).

- Declarative schemas may be thought to contain slots, or characteristics and values. For example, a house may be described in terms of its materials, such as wood and its parts, such as rooms. Materials and parts, are the house schema's slots and wood and rooms are the slot values. Slots may have default values (house purpose: to live in) though houses may also be places of worship or museums. Schemas may have parent and child relationships with other schemas which inherit or pass on characteristics (Anderson, 2000).
- A special slot in each schema is its isa slot, and points to the superset. Thus stored with the schema for building, the superset of house, we would have features such that it has a roof and walls and that it is found on the ground (Anderson, 2000).
- Schemas allow writers and speakers to make assumptions about what the reader or listener already knows.

People

Major Researchers

- F. C. Bartlett in *Remembering* (1932) – was the first to write extensively about schemas as they applied to procedural memory (though the distinction between declarative and procedural had not been made yet at that time).
    - Movement, e.g., driving a car or playing a sport, is not simply a matter of stimulus-response. We do not produce an exact copy of a previous movement, nor do we create something entirely new.
    - Past experiences help us make sense of new experiences by supplying us with expectations and frameworks for action.
    - Bartlett first wrote in the early 20th century when the prevailing theory was behaviorism, which was largely concerned with observable stimuli and behavior.
- Jean Piaget (1896-1980) – credited as first to create a cognitive development theory which included schemas.
    - New information is added or assimilated into current schemas.
    - Cognitive dissonance is caused by new information which cannot be easily integrated.
    - Schemas are forced to change or accommodate this new information.
    - Three factors cause cognitive development – biological development which progresses in stages, interaction with the world of nature and objects, and interaction with others.
- David Rumelhart (1975) – Posed that there is an underlying grammar of stories and that experience with this grammar would help in the understanding of new stories.
- Roger Schank and Abelson (1977) – Proposed that humans develop a grammar for procedural knowledge in the form of a script for all common events in our lives.
    - They wrote a computer program which was able to answer questions about events in a restaurant based on scripts for what typically takes place in restaurants.
    - In 1982 Schank proposed that there are deeper levels in how scripts are organized which account for scripts which share attributes, e.g., waiting on line at a restaurant and waiting on line at a Post Office.
- Brewer and Treyens (1981) conducted an experiment where subjects were asked to wait in an office for 30 seconds. When removed and asked what they saw in the office, many reported seeing things which were not present, for example, books. The presumption is that most people's schemas of "office" includes books.
- Alba and Hasher (1983) suggested four ways schema might affect memory:
    1. Guide attention to relevant information for encoding

2. Allow specific stimuli to be encoded as abstractions to be stored as meaning without details
3. Assist in interpreting new information by providing the relevant prior knowledge
4. Provide the means to integrate the previous three steps into a single memory and provide the framework for reconstruction of that memory when required.

- John R. Anderson (1983) formulated a model of cognition know as ACT-R (Adaptive Control of Thought-Rational) which describes the process of encoding and using schemas, particularly in mathematics and problem solving. He was the first to employ the use of both declarative and procedural schema in his theory. His work is based in neuroscience and computer artificial intelligence. ACT-R is actually published as computer code and is made available to researchers.

Perspectives

Historical Context and Schema Research

- In the latter half of 20th century psychologists began to focus more on human cognition and less on behaviorism.
- The widespread use of computers also had an effect on the theories of how we store and use information in our brain. Many models of cognition were based largely on how computers function.
- In the last 40 years, cognitive science has shifted its study from small-scale knowledge structures e.g., encoding words and simple concepts, to the study of large-scale knowledge structures and how they interact (Hampson & Morris, 1996).

Self-Schema and Adult Development

- **Self-schema** is a term used to describe knowledge we accumulate about ourselves by interacting with the natural world and with other human beings which in turn influences our behavior towards others and our motivations.
- The self-schema continues to develop throughout life, supporting the life-span developmental perspective.

  Because information about the self is continually coming into the system as a result of experience and social interaction, the self-schema will be constantly evolving over the life span (Lemme, 2006).

Schema and Adult Learning and Development

- Schema continue to develop over the course of adulthood as our microsystem, mesosystem, and exosystem change. Even as adults retire and age they are placed in new situations requiring the accommodation and assimilation of new knowledge and experience.

> Late-life in particular is full of many complex events, which require learning new or modifying old behaviors, particularly for health, compensation, and adaptability. For example, changing living arrangements from one's home to an assisted living facility is complex and stressful, and challenges existing coping strategies and requires adaptive compensation (Thornton, 2003).

- Schema theory reinforces the importance of prior knowledge to learning and the use of tools such as advance organizers and memory aids to bridge new knowledge to older knowledge stored in schema (Merriam, Caffarella & Baumgartner, 2007).
- In post-formal thought we are better able to balance two contradicting schema by preserving both separately, until the ability to maintain a relativistic outlook decreases with age.

Schema and Gender

- Gender schema theory states that children develop gender schema based on their experiences and the gender attributes of their culture. An individual's self-schema is merged with the culturally determined schema for their gender (Bern, 1983).

> …the phenomenon of sex typing, derives, in part, from gender-schematic processing. Specifically, the theory proposes that sex-typing results, in part, from the assimilation of the self-concept itself to the gender schema. As children learn the contents of their society's gender schema, they learn which attributes are to be linked with their own sex and, hence with themselves (Bern, 1983).

Schema and Culture

- There are two aspects to schema and culture. First, we develop schemas for our own and other cultures. We then may develop a schema for cultural understanding.
- Cultural information and experiences are stored in schemas and support cultural identity.
- The nature of schemas work to support one's own cultural identity. Once a schema is formed it focuses our attention on aspects of the culture as experienced and by assimilating, accommodating or rejecting aspects which don't conform.
- "A schema for understanding culture is culture-general – that is, it reflects knowledge that applies to all cultures" (Renstch, Mot & Abbe, 2009).
- A schema for cultural understanding contrasts with the rigid structure of a stereotype.

> A schema for cultural understanding is more than just a stereotype about the members of a culture. Whereas stereotypes tend to be rigid, a schema is dynamic and subject to revision. Whereas stereotypes tend to simplify and ignore group differences, a schema can be quite complex. (Renstch, Mot & Abbe, 2009).

References

Anderson, J. R. (2000). Cognitive Psychology and Its Implications (5th ed.). New York, NY. Worth Publishers

Bern, S. L. (1983) Gender Schema Theory and Its Implications for Child Development: Raising Gender-Aschematic Children in a Gender-Schematic Society. *Signs. 8*(4), 598-616.

Hampson, P. J. & Morris, P. E. (1996) Understanding Cognition. Cambridge, MA. Blackwell Publishers Inc.

Lemme, B. H. (2006) Development in Adulthood. Boston, MA. Pearson Education, Inc.

Merriam, S. B., Caffarella, R. S. & Baumgartner, L. M. (2007) Learning in Adulthood. San Francisco, CA. Jossey-Bass.

Rentsch, J. R., Mot, I. & Abbe, A. (2009). *Identifying the Core Content and Structure of a Schema for Cultural Understanding*. (Technical Report 1251). Arlington, VA: United States Army Research Institute.

Thornton, J. E. (2003). Life-span learning: A developmental perspective. *International Journal of Aging and Human Development, 57*(1), 55-76.