Formal operational period

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Consider the following prompt: “If you hit a glass with a feather, the glass will break. Ann hit a glass with the feather. What will happen to the glass?” To answer correctly, one would have to first learn the rule about how the feather will affect the glass. The second step then is to apply the learned rule in a logical fashion. The mental activity needed to carry out these steps is known as *hypothetico-deductive reasoning*. It is required for counter-factual thinking, transitive inferences, and hypothesis testing. Jean Piaget postulated that this type of mental activity is characteristic of children who have reached the *formal operational period*. In the current entry, we describe Piaget’s argument and the effect of his insights on hypothetico-deductive reasoning on research in cognitive development.

According to Piaget, the formal operational period is the last of the four hypothesized stages of cognitive development. This stage is the culmination of an increasingly more abstract and rational form of reasoning: Unlike earlier stages (sensori-motor; pre-operational; concrete-operational), formal-operational thought relies exclusively on symbol manipulation and the application of logical rules. In fact, logical thought requires the reasoner to go entirely beyond concrete experiences and consider the information in amodal isolation. For example, in the

problem “If P then Q, P, therefore Q”, the details of what P or Q refer to are irrelevant (such as when P is a feather braking glass).

Experimental tasks that measure hypothetico-deductive reasoning follow the same observational protocol that Piaget has pioneered for the other cognitive-development stages. Children are presented with a conflict in which every-day experiences are pitted against formal logic. Consider again the example with the feather and the glass. Based on concrete experiences with feathers and glasses, one might conclude that a feather cannot break the glass. Yet, the logic of the problem is set up in such a way that the correct answer does not have tangible reality: In the world of logic, the feather is said to break the glass. Piaget argued that this kind of conflict is needed to reveal the true depth of formal-operational thought. It requires the reasoner to apply logical rules without reference to concrete imagery.

Findings with formal-operational tasks show that successful performance requires the cognitive maturity of an adolescent (12 years and older). They confirm Piaget’s claim that hypothetico-deductive reasoning is the most difficult form of human thought. However, Piaget’s claim that the formal-operational period is the culmination of cognitive development has been criticized, along with the more general theory that cognitive development progresses linearly from reasoning about concrete physical manipulatives to reasoning about abstract symbols. Thus, while the reliability of Piaget’s findings is not at issue, their validity is questionable.

One line of attack of the theory of a formal-operational stage comes from demonstrations of early hypothetico-deductive reasoning. Consider, for example, the following set-up: Two

brothers were said to argue about whether they have a big or a little mouse hiding in their home. They decided to find out about the size of the mouse by putting food into a house that has an opening of a certain size. Two opening were available to choose from: a big opening and a small opening. Children's task was to choose the opening that could help determine the size of the mouse. The correct choice is the house with the small opening. This is because only the small opening makes inferences about the size of the mouse possible: If the food is gone from the small house, the mouse must be small; if the food is still there, the mouse must be big. Findings show that even 6-year-olds could choose the correct opening, undermining Piaget's claim that formal operations appear only late in development.

A second challenge to the theory of a formal-operation stage comes from numerous demonstrations of context effects. For example, variations in task features proved strongly influential on performance, even when the underlying logical structure remained the same. Findings also show that socio-cultural differences and school curricula affect children's success in formal-operational tasks. For example, in cross-cultural comparisons with Chinese and American teens, American boys scored highest on formal-operation tasks, while Chinese girls scored the lowest. Similarly, children from rural areas were less likely to demonstrate formal-operational reasoning than their urban counterparts. Even educational experience matters: Children with more education were more likely to succeed on formal-operation tasks than children with less education.

There is yet a third line of research that casts doubt on the idea of a formal-operational stage: findings with adults. While Piaget focused on exclusively on children's cognition, his

theory assumed that the formal-operational period extends into adulthood. The idea was that, once the mind accomplishes the feat of symbolic formalism, it does not lose it again. Yet, results with adults prove otherwise: In many situations, adults appear to have difficulty following through with a formal deduction. Instead, adults' reasoning was shown to be driven by persistent biases, heuristics, stereotypes, prejudices, and a preference for cognitive shortcuts. If even adults struggle to apply formal thought, the theoretical relevance of the formal-operation stage is diminished.

Today, the idea that children eventually reach a formal-operational period has very little traction in the realm of cognitive development. Incidentally, Piaget's initial work on Binet's intelligence test has lost its luster for cognitive development too. What remains, instead, is the relevance of idiosyncratic details in the context in which children are asked to reason.

Further Readings:

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