The purpose of the present study is to test the hypothesis that a fifth stage of intellectual development characterized by the ability to test alternative explanations involving unseen theoretical entities exists. This fifth-stage hypothesis will be tested in the context of a nonmajors, college-level biology course in which the assumption is made that some, but by no means all, students have acquired stage-five reasoning skills.

Jean Piaget's well-known developmental theory proposes that the development of thinking skills, which most would characterize as “scientific,” takes place in a stage-like fashion. Stage one, the sensory-motor stage, lasts from birth to about 18 months. As the name suggests, the stage involves the development of sensory-motor knowledge and acquisition of practical knowledge such as the fact that objects continue to exist even when out of sight. Stage two, the pre-operational stage, lasts until seven years of age. This stage primarily involves development of the ability to speak and understand the spoken word. Stage three, concrete operations, which begins at age seven, involves the development of descriptive thinking skills in which the child acquires an understanding of class subclass relationships and begins to understand the world in terms of specific variables such as weight, length, area and volume (e.g. Flavell 1963; Inhelder & Piaget 1958; Lawson & Renner 1975; Piaget & Inhelder 1969; Trifone 1991). Potential for moving into Piaget’s fourth and highest stage of thinking, called formal operational, generally occurs between 11 and 12 years of age. Inhelder and Piaget (1958) invented several widely used tasks to find out whether or not students have developed formal thinking patterns. A prototype task is the pendulum task. The pendulum task asks students to identify variables that may cause differences in the rate at which pendulums swing. If a student conducts controlled experiments to test the possible effects of variables such as pendulum weight, string length, and release angle on swing speed, s/he is classified as formal operational.

An important point in terms of the present study is that the pendulum task characterizes stage-four thinking by the presence of a hypothetico-deductive thinking pattern. In other words, to test the hypothesis that weight differences cause differences in swing speed, one generates the following argument:

If ... differences in swing speeds are caused by differences in the amount of weight hanging on pendulums (hypothesized cause) and ... the weights are varied, while holding other possible causes constant (proposed experimental test), then ... the speed of pendulum swing should vary (deduced expected result). But ... when the proposed experiment is actually carried out, we find the swing speed does not vary (observed result).

Therefore ... changes in swing speeds are probably not caused by weight differences (conclusion).

Piaget’s theory implies that all formal stage tasks with the same “logical” form should be of equal difficulty. Note that the stage is called “formal” because the thinker presumably is able to separate form from context in reasoning (Piaget 1957). Thus, the well-documented phenomenon that not all logically identical tasks are equally difficult (referred to as horizontal decalage or separation) contradicts the theory. In hopes of eliminating this contradiction, the present view proposes the existence of a fifth stage characterized by the use of a similar reasoning pattern, but applied to situations in which the possible causes are no longer seen, hence are theoretical, more complex, and more difficult.

The idea of fifth stage is not new among psychologists (Arlin 1975; Commons, Richards & Armon 1982; Kramer 1983; Riegel 1973, 1975). However, psychological evidence for a fifth stage is hard to come by. Nevertheless, evidence suggestive of a fifth stage can be found in the neurophysiological literature. Perhaps the most compelling comes from a study reported in Science by Thatcher, Walker & Giudice (1987).