A survey of students’ notions of body function as teleologic or mechanistic

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Richardson, Daniel R. A survey of students’ notions of body function as teleologic or mechanistic. Am. J. Physiol. 258 (Adv. Physiol. Educ. 3): S8–S10, 1990.—The objectives of this study were to determine 1) the relative degrees to which students’ notions of physiological functions are teleologic or mechanistic in nature, 2) whether these notions differ between students in elementary and advanced level physiology courses, and 3) whether the degree of teleologic vs. mechanistic thinking can be modified by direct discussion of this topic. A questionnaire that determined whether students thought about body functions in a teleologic (why) or mechanistic (how) manner was administered to the following categories of students: 1) a class of high school biology students, 2) classes of students taking elementary college-level physiology courses, and 3) college students in advanced physiology courses. Overall, there was an average 61% teleologic response among the various classes, and differences between the classes were not statistically significant (P > 0.05). To address objective 3, one of the classes was presented the questionnaire after being given a lecture on teleology vs. mechanistic approaches to body function. The average teleological response of this class was only 12%, a value significantly lower in comparison, by a one-way analysis of variance, to any of the other groups (P < 0.0001). These results indicate that the students have a strong tendency to think of body functions in teleological terms and that this tendency can be modified on a short-term basis by a direct discussion (by an instructor) of teleologic vs. mechanistic thinking.

preconceptual notions: teleology

As pointed out by Vander et al. (8), body functions can be thought of in terms of either their teleologic purpose (why they happen) or their mechanism of action (how they happen). While physiology as a scientific discipline deals primarily with the latter, some consideration of teleology can be beneficial in orienting a student as to the integrative, or homeostatic, role of a particular function carried out by a tissue, organ, or organ system. Such orientation, albeit subjective on the part of an instructor, may assist a student in comprehending the mechanisms by which the various functions of the body are carried out. However, since it is the operation of mechanisms that determines whether a given function will be performed, not the necessity of the function itself, it is important for students not to confuse teleologic purpose with mechanisms of action in considering body functions. In this regard, the perception that the teleologic purpose of a body function is of itself sufficient to elicit that function could lead a student, or health care professional, into the trap of “perceptual seduction” (3). As an example consider the relationship between bacterial infection and hyperthermia. From a teleological point of view, the elevated body temperature associated with a bacterial infection occurs as part of the immune response designed to protect the host against the invading organism. However, the mechanism of an increase in body temperature is a central nervous system (CNS)-elicited increase in heat conservation activities, such as shivering, not the presence of bacteria per se. Thus a student who approaches this subject from a teleologic point of view may overlook the fact that hyperthermia can be elicited by conditions other than bacterial infection and that not all bacterial infections result in an elevated body temperature. Furthermore, if before any formal instruction students’ “preconceptual notions” (1) of body function were heavily slanted toward teleology, this could form the basis of a “preconceptual block” (1) toward the learning of physical mechanisms.

The above discussion points out that while both teleologic and mechanistic approaches to body function have merit, it is important that a course in biology or physiology clearly distinguishes between the two. This objective could be facilitated if physiology instructors knew in advance whether students in general tended to think of body functions in teleologic or mechanistic terms, i.e., what are students’ preconceptual notions of body function. However, there is no information presently available on this point. Furthermore, there is no information available as to whether specific instruction on teleology vs. mechanisms would modify the way students thought about body functions, although educational studies that have utilized the physical sciences (1, 4) suggest that it would. Accordingly, the objectives of the present study were to determine 1) whether students’ notions of physiological functions were mainly teleologic or mechanistic in nature; 2) whether the relative degrees of teleologic and mechanistic thinking differ between students in elementary and advanced-level physiology courses; and 3) whether the relative degrees of teleologic and mechanistic thinking of a particular class are modified after a lecture on these two different approaches to body function.

METHODS

Students. The subjects for this study were students in one of the following didactic courses: 1) three sections of
a high school (HS) biology class, all taught by one instructor at Bryan Station High School in Lexington, KY (n = 68); 2) two different classes of an undergraduate level elementary physiology course (PGY 206) taught by the Department of Physiology and Biophysics at the University of Kentucky to students in a variety of academic programs, one taught in 1987 (n = 30) and one in 1988 (n = 45); 3) two different classes of an undergraduate advanced physiology course (PGY 412) also taught by the Department of Physiology and Biophysics but restricted to students in allied health programs, one in 1987 (n = 75) and one in 1988 (n = 87); 4) a course in health education taught to native Africans [African health education (AHE)] at the University of Transkei in the Republic of South Africa (n = 16); and 5) a medical school course also taught to native Africans [African medical (AM)] at the University of Transkei (n = 22).

For the HS students this was their first exposure to a biological science, whereas the PGY 206 students and the AHE students had taken biology as a prerequisite. The PGY 412 students had taken either PGY 206, its equivalent at another university, or two semesters of college-level biology as a prerequisite for entrance. The AM students had just completed a 2 mo elementary didactic lecture course in basic human physiology, which was roughly equivalent to PGY 206, and were preparing for a more in-depth study of medical physiology using the problem-based method (2).

Considering the scope of classes tested, there was a gradation of prior exposure of biology or physiology ranging from no prior exposure (HS students) to biology as a prerequisite (PGY 206 and AHE students), to prior exposure to physiology (PGY 412 and AM students). Therefore, comparison of results among these various classes enabled testing the degree to which prior exposure to biology or physiology influenced teleologic vs. mechanistic thinking, objective 2 of this study.

The purpose of including the African students was to provide some indication as to whether students from different cultural backgrounds had similar or different teleologic vs. mechanistic attitudes toward body functions. However, it is recognized that because of the small number of African students involved the present study will not be able to make a definitive statement in this regard.

Test instrument. The test instrument for this study was a questionnaire consisting of 10 statements, each of which was an incomplete sentence. Three of the 10 statements are given in Table 1. Each statement, or incomplete sentence, concerned a certain body function. For each statement, a given student was to select one of two possible choices that he or she felt best completed the sentence. It was strongly emphasized to the students that each choice for completing a sentence was correct and that there were no wrong answers. They were told that this was not an examination but simply a questionnaire to determine how students thought about certain physiological functions. To emphasize this point and to assure confidentiality, the students were asked not to identify themselves on the test instrument. What the students were not told about the test instrument was that one of the completing phrases (choices) was slanted toward teleology whereas the other choice emphasized physiological mechanisms.

Testing procedure. To address objectives 1 and 2, the test instrument was administered on the first day of instruction to all of the various classes with the exception of the 1988 PGY 412 class. This group was administered the instrument on the second day of class, the first day being used by the instructor to present a lecture on the difference between mechanistic and teleologic thinking, so as to satisfy objective 3 of this study. The instructor for both the 1987 and 1988 PGY 412 classes was the same individual.

Data analysis. Each test instrument was analyzed for its percent of teleological responses. To analyze for statistically significant differences among the student groups, the data from the various classes were subjected to a one-way analysis of variance with the F ratio being used to determine significance. Probability levels for significance are given in the text.

RESULTS

Figure 1 presents the mean responses of the various classes for which the test instrument was administered on the first day of instruction. Overall, there was a 61% teleological response among the classes and there were no significant differences between the various groups.

TABLE 1. First 3 of 10 statements in test instrument

<table>
<thead>
<tr>
<th>Statement</th>
<th>Choice 1</th>
<th>Choice 2</th>
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<tbody>
<tr>
<td>1. During physical activity, oxygen enters muscle tissue from the blood because: a) oxygen content inside muscle tissue decreases as the oxygen is used. b) muscles require oxygen to produce energy.</td>
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<tr>
<td>2. Delivery of a baby at the end of a normal pregnancy occurs because: a) baby is developed and ready to leave the womb (uterus). b) muscles surrounding the womb begin to contract.</td>
<td></td>
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</tr>
<tr>
<td>3. Sweating occurs whenever: a) body needs to eliminate excess heat. b) muscles surrounding sweat glands contract.</td>
<td></td>
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</table>

Respective teleologic responses to the above 3 statements are: b, a, and a.
Note that the two PGY 206 average scores were extremely close. This indicates that the test is reproducible.

To determine whether the relative degrees of teleology vs. mechanistic thinking can be modified by didactic instruction, the test instrument was given to the 1988 PGY 412 students on the second day of class; the first day was used for a presentation, by the instructor, on teleology vs. mechanistic thinking. The average teleological response of this PGY 412 class was 12%, a value that was significantly lower in comparison to any of the other student groups ($P < 0.0001$).

**DISCUSSION**

The results of this study showed a definite bias toward teleological thinking prior to any didactic instruction in the life sciences, as indicated by the HS class scores presented in Fig. 1. This observation supports Piaget's studies (6), which suggest that during normal development a child's explanations of natural phenomena pass through what he termed a "precausal" phase in which ideas of nature are teleological rather than causal, and the studies by Laurendeau and Pinard (5), indicating that precausal thinking persists into early adolescence.

The observation that exposure to either biology (PGY 206 and AHE students) or elementary physiology (PGY 412 and AM students) does not significantly alter the tendency of students to consider body function in teleologic terms can be interpreted in at least two ways. First, it is possible that the precausal, or teleologic, notions about nature that are developed during childhood (6) are very strong and persist not only into adolescence (5) but into adulthood as well. Second, the previous biology or elementary physiology courses taken by the students participating in this study may have been taught from a teleologic point or view, and/or teleology and mechanistic approaches may not have been differentiated. The latter explanation is supported by the results showing a reduction in teleologic responses of a second PGY 412 class to only 12% when the test instrument was given after a lecture on teleologic vs. mechanistic thinking. These results indicate that the tendency of students to think in teleologic or mechanistic terms can be modified on a short-term basis. It remains to be determined whether this modification persists for a prolonged period of time.

However, since it is unlikely that a strong persistence of the teleologic notions developed during childhood could be so markedly modified even in the short term by only one lecture, the high tendency toward teleologic thinking demonstrated in the advanced students may have been, at least in part, related to the nature of previous biological instruction.

In summary, this study indicated a definite basis of students to think of body functions in a teleologic as opposed to a mechanistic manner. This tendency occurred among students of widely differing cultural backgrounds (native African and American) and was not significantly modified by prior course work in biology and/or physiology. However, students' attitudes toward body function could be shifted on a short-term basis (one class period) from predominantly teleologic to predominantly mechanistic by a direct discussion of the difference between these two modes of thinking.

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Portions of this study appeared in abstract form (7).

REFERENCES