About *Inferred Functions*

I think that *Theory of Instruction*, by Carnine and me, presents the basic principles that a good instructional designer would use to create instruction that is effective and efficient. The book has been almost completely ignored by mainstream education (even the branch that deals with theories of instruction).

Another book that I believe presents the basic principles of learning (not instruction) has also been pretty thoroughly ignored. That book is *Inferred Functions of Performance and Learning*, by Don Steely and me.

The approach the book spells out does not try to infer what goes on in the brain from studies that show correlations between brain activities (a la fMRI data) and performance. Rather, the inferred-function approach goes straight from behavior to the identification of logically necessary functions that would have to occur inside the organism for the behavior to occur.

The final step may be the most difficult-to accept the fact that this approach tells what actually occurs in the organism. If a function is logically necessary for a behavior to occur, the organism that performs the behavior must perform the function. It doesn't really matter how foreign or contra-intuitive the conclusion is. A guy I worked with for years, Wes Becker, lived by this motto. If the conclusion is inescapable, don't try to weasel around it.

The inferred-function analysis does not indicate where, how, or through what sort of neurological mechanisms the organism performs the logically required steps, merely that the organism must have some mechanisms and processes that carry them out. A simple game, right? Go from behavior to what is logically needed for that behavior to occur. Apparently not obvious at all. People who are into correlations that center around neurological structures seem to think that theirs is the only game in town. In fact it is a weak game because you have to be very cautious about using correlations to infer how something is caused. An MRI may provide some very general information about what is going on, but it provides no information about the *specific content* that the system is processing (what's going on in the kid's mind when he's trying to read). It yields information only about broad categories of content or broad emotional states. It tells you if something is going on in a language center, but it doesn't tell you a great deal more, like what specific thoughts or operations are going on in the kid's head.

This doesn't mean that you can't play the correlation game with brain activity; however, the fact that an MRI provides "empirical documentation" doesn't rigorously account for much. You don't train the brain to have a different pattern; you work on content and performance. If the training works, it may result in changes in brain activity that are correlated with the learner's performance.

Anyhow, inferring necessary functions based on performance takes you to places you would not believe. If you start with a simple organism that performs an apparently simple behavior and observe the behavior carefully, you discover that the simple organism is not that at all. Labeling the behavior as "inherited" or as a product of its genes does not tell us anything about the nuts and bolts of what has to go on inside its performance system for that behavior to be possible.

For example, you have a single-celled organism that finds food through olfaction only. How does it do that? We can figure out what is needed by starting with a concrete example and identifying what provisions the mental system needs. Let's say the organism is swimming around and receives olfactory information that food is present somewhere in the surroundings. What good is this reception if all it tells is only that food is present? Not much. If the olfaction is discriminable within a 1-square foot area around the food, our little organism could spend a lifetime cruising around in this area without ever locating the source of the stimulus. It could go over some of the same routes a thousand times and have no information that it took these routes before and they didn't bring the organism in contact with the food. The organism could come within a whisker of the food hundreds of times and never realize it.

We know that information about the presence of the food molecules is inadequate because the organism doesn't perform aimless behavior. It actually locates the food. So the performance system must have additional information and processes.

Although it's not immediately apparent, *the organism needs information about both the absolute levels and relative or comparative levels of the reception*. That information has to come from the same molecules that indicate the presence of food. But that information has nothing to do with the qualitative features that make these molecules discriminable from others. It has to do with their number or density. The organism's system must be designed to discriminate whether there are more or fewer of these molecules.

So from the beginning, we categorically assert that the organism is able to abstract and use *multiple features* of the stimulus, those that are unique (that distinguish the molecule from all others), and those that indicate the level of the stimulus.

Let's say the system has the capacity to identify not only olfaction that food is present, but also ten levels of a reception's strength. (This number is arbitrary and unimportant, just illustrative.) Level 1 is the lowest perceptible level; 10 is the highest and occurs only when the organism is in contact with the food.

With the ability to discriminate these gradations of reception, the organism would be able to determine whether it was relatively close to the food or farther from it.

But, there's a problem because the system still does not have enough information to locate food. Let's say the initial reception is 7. Okay, which direction do you go if it's level 7? You don't know which direction because you don't have enough information. So pick a direction. Go north. Is that the right direction? There's only one possible way to find out. Take another reading after you go north.

Let's say the reading to the north is 5. Will that help? Only if the system has more information. If you know only that the level is now 5, you don't have information any more useful than you did when the reception was 7. The reason is that 5, by itself, doesn't imply a direction.

The smallest unit of information that implies a direction is that the level started at 7 and changed to 5. The only way the organism could have that related information is for the organism to store information about the initial level and compare it with current level, 5.

So now the system is pretty complicated. It has 7 in memory; information about the current level, 5, and a procedure that provides a temporal comparison of the two and draws a conclusion that the level has decreased. Does the system have enough information to do something about this information? Almost, but not quite. If you don't have information about the direction you went, the rest of the information is useless. The level was 7 and now it’s 5. If you have no knowledge of the direction you went, you don't have any information about the direction you should go now. (If the organism went in a long straight line, it wouldn't really need to record the direction it went. It would know that the direction it is now facing is wrong. So face a different direction and go.)

If your system records information that you were going north, your performance system could conclude the equivalent of this verbal argument: "Going north led to a lower level; therefore north is the wrong direction. Pick another one and see what happens with that direction."

An important point is that the system must be designed to treat the levels both as *absolutes*, or they couldn't be compared, and as *relative values* to conclude that the latest value is less than the earlier value). The relative nature is illustrated by a different example: You start at level 3, go in a direction and terminate at level 5. This is the same 5 used in the other example, but now it has completely different implications for the behavior of the organism.

If the idea that a single-celled organism would have such a sophisticated information-processing system is unacceptable, that's just prejudice. The only way to discredit the case for this function is to show how the behavior could be performed with a system that had less information or carried out less sophisticated logical operations. Try it. Bet you can't come up with anything simpler.

Sure it's a mind-blower that the system would abstract multiple features of the food molecule. But it's also a mind-blower that this organism is able to sense the presence of food through a form of olfaction, and even more mind-blowing that the organism is governed by incredible DNA blueprints that tell how to construct the organism.

The book also deals with learning and shows that it is an extension of what the system needs to perform behaviors that are not learned. This tour reveals lots of other mind-blowers, like the two different kinds of thoughts you have, the voluntary ones and the involuntary ones. The involuntary ones are necessary for learning, and you have lots of these thoughts. These are not the kind you direct but the uninvited kind. You see somebody and recognize the person. That recognition is involuntary. You don't say, "Well, let's see. That person has features a, b, c; therefore, that person must be my friend Liz." You even get these epiphanies when you see somebody that "reminds you of somebody else." Again, the thought pops into your mind. You didn't create it. The implications for the design of the storage and retrieval system of the brain are intimidating. It means you have things classified as the sum of their features and classified by individual features.

You could name people who talk a lot. That shows you have people classified by individual features (talks a lot). You distinguish between your uncle and the man that looks something like your uncle. Therefore, you have your uncle classified as the sum of thousands of features.

It took Don and me eight years to sort the whole thing out. It may not be perfect, but it's pretty good.