Relativity in Hearing and Stimulus Discrimination

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Abstract What does it mean to hear a sound? What does it mean to perceive anything? Sound has no objective reality, such as “vibration.” Of two people together, one may hear a sound and one may not. We know only that their actions—their judgments—differ. Such comparison underlies all discriminations. In experiments on concept learning, for example, pigeons peck when they are shown a slide containing human beings and do not peck when the slide contains no humans. The experimenters judge beforehand whether the slides contain human beings or not, and the pigeons’ concept of human being is determined by the comparison between the experimenters’ judgments and the pigeons’ pecking or not. Similarly, to tell which of two people is hearing or deaf, an observer that can hear must judge whether their behavior corresponds with the observer’s judgments. In an experiment by Lubinski and Thompson (*Behavioral and Brain Sciences*, 16, 627–680, 1993), in which pigeons pecked at different keys depending on which of two different drugs they had received beforehand, the experimenters judged which drug had been injected, and the pigeons’ pecking corresponded to the experimenters’ judgments. If two persons’ judgments differ, they can only resolve the difference by deciding that one of them is mistaken. If no one is there to hear a tree fall in the forest, from the point of view of a science of behavior, it made no sound.

Keywords Stimulus discrimination · Hearing · Sound · Private events · Dualism · Perception · Mentalism

If a tree falls in the forest, and no one is there to hear it, does it make a sound?
(Traditional Zen koan)

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Does the tree falling make a sound? Can sound exist apart from hearing? What does it mean to hear a sound? What does it mean to perceive anything? The standard behavior-analytic answer is that an auditory discrimination or any other discrimination consists only of a change in behavior concomitant with a change in stimulation. We find this account in textbooks and the writings of behavior analysts. How adequate is this definition? This paper aims to show that the statement omits something rarely made explicit and often omitted altogether: the relativity in stimulus discrimination.

Appealing to common sense or the culturally received view of the world, the layperson says, “If a tree falls in the forest, of course it makes a sound. Trees falling always make a sound.” If, however, no one is there to hear it (including animals and recording devices), how could anyone know the tree falling made a sound? Inductive reasoning is always logically flawed, because no matter how many times an event occurs, you never know if it will happen again. On one hand, a layperson says that the tree falling makes a sound even if no one is there to hear it, but, on the other hand, someone must be there to hear the sound to know for sure. The conundrum comes down to the question, “Does sound exist apart from its being perceived, or does sound exist only in our perceiving it?” Put another way, “Is sound an objective reality—‘vibration,’ according to Ghiselin (2018)—and our perception of it subjective, or is sound only a perception?” The *koan* aims to question the existence of any such thing as objective reality.

To advance our understanding, we may ask, “What does it mean to hear a sound?” If you hear a sound, the way anyone knows of it is that your behavior changes. For example, Ted and Sue are together, and Ted says, “Did you hear that?” Ted discriminates in the sense that his behavior before hearing the sound differs from his behavior after hearing it. Sue might make no such discrimination and say, “No, I heard nothing,” only hearing what Ted said. If Ted heard it, and Sue did not, how can we know if the sound is real? If sound is vibration, did it not vibrate in Sue’s ear too? It may be real for Ted, but it is not real for Sue.

How is it possible for Ted to hear a sound and Sue not to hear it? The layperson might respond that Ted must have been attending to the sound, whereas Sue wasn’t. This “explanation,” however, is an example of mentalism. It does no more than restate the original observation that Ted’s behavior differs from Sue’s, because the only evidence for attention is Ted’s behavior.

A valid alternative relies directly on the difference in their behavior. Ted says, “It sounded like a crash, like a tree falling in the forest,” and he may go into the forest to see if any trees may have fallen lately. His questioning, describing, and investigating *is* his hearing the tree falling. More technically, Ted’s behavior induces an observer to say that Ted heard a sound. Thus, to hear a sound means to behave in ways that an observer will recognize as hearing a sound.

The layperson might challenge such relativity and ask, “What is the sound itself?” The question itself is misguided. Just as one cannot speak without saying something or walk without walking somewhere, one cannot hear without hearing a sound. The sound is not something separate—e.g., vibration—but is intrinsic to the hearing. No essence defines sound apart from hearing. Stimuli and the actions they induce have no ontological status apart from one another. To hear a tree falling differs from hearing a bell ring; the behavior—what the hearer might say or do—differs. Even if sometimes

instruments measure vibrations that may or may not accompany hearing, on many occasions—e.g., dreaming and hallucinating—no vibration is present. Ted heard the sound, and Sue did not. All we know is that Ted's behavior changed from one time to the next, whereas Sue's behavior did not change.

In a report on concept learning in pigeons, Herrnstein and Loveland (1964; see also Herrnstein, Loveland, & Cable, 1976) made a general point about perception that applies also to hearing. The experiment entailed showing pigeons slides from *National Geographic* magazine and requiring a (hungry) pigeon to peck at a key next to the slide in order to produce a bit of food. Some slides contained one or more human beings, and other slides contained no humans, but both types of slide included the same sorts of settings: scenes from jungles, deserts, farms, and cities. Pecking the key only produced food when a slide contained a human, and the pigeons came to peck almost exclusively when the slide contained a human. Moreover, they did this even with slides they had never seen before. Thus, the pigeons exhibited the concept "human being." Among the questions that may arise is, "Is the pigeons' concept of human the same as a human's concept of human?"

In explaining their procedure, Herrnstein and Loveland said, "For any one session, approximately half the photographs contained at least one human being: the remainder contained no human beings—in the experimenter's best judgment" (p. 549–550; emphasis added). The statement reveals that the experiment was, in fact, comparing two sets of judgments: those of a human being and those of a pigeon. If the pigeons classified the slides in the same way as the human, the pigeons had the concept "human being." Herrnstein et al. (1976) followed up with experiments on the concepts tree, water, and a specific person and obtained similar results to the experiment with human being. They conducted exhaustive tests comparing pigeons' difficulties and errors with humans' (the experimenters') and found no notable differences. They concluded, "In summary, from aggregate measures of performance and from an inspection of the pictures themselves, it is clear that the pigeons used principles of classification that approximate those we use ourselves, at least in complexity" p. 290). They considered their results to indicate that, for at least some pigeons, "...the pigeons' stimulus classes were essentially isomorphic with ours" (p. 296).

These experiments drive home a basic point about stimulus discrimination. In each experiment, the human researchers selected slides: with human beings or without, with trees or without, with water or without, and with the specific person or without. The evidence for the concept arose from comparing the humans' judgments with the pigeons' judgments. This observation, however, holds for any discrimination, no matter whether complex, as in the concept experiments and everyday life, or simple, as in typical experiments on stimulus control.

As a classroom demonstration, I used to bring in a pigeon in an apparatus with a response key and feeder. The key could be transilluminated red or green for a minute or two at a time. The pigeon was trained to peck at the red key and not peck when the key was green. For me and most students, the change of behavior with the change of color was clear, but suppose one student was color blind. The color blind student would be at a loss to explain why the pigeon sometimes pecked and sometimes did not, because that student could not compare the pigeon's changing behavior with judgments of color. Even in such simple discriminations, the experimenter's perceptions, perhaps inadvertently, lay down the standard by which performance is assessed. If a pigeon pecks when

the experimenter thinks it should not, the experimenter might call it an “error,” but calling it so would depend on the experimenter’s comparing his own perception with the pigeon’s performance. The relativity of performance to perception never goes away.

Concept learning and color discrimination entail judgments by the researcher and the pigeon in the same sense modality—vision—but nothing requires that the two judgments be based on the same sensory input. Researchers on bird song or echolocation in bats and dolphins compare visual displays with the animals’ changing behavior, which discriminates among auditory signals. A researcher studying behavioral thermoregulation in a lizard compares (visual) temperature readings with the lizard’s moving in and out of the sun and shade; at that point, how the lizard discriminates temperature remains to be determined.

An experiment by Lubinski and Thompson (1993) offers an instructive example. These researchers trained pigeons to peck at two response keys. Before each session, a pigeon received an injection of one of two different drugs. Pecks at the left key produced food if the injection was Drug A, and pecks at the right key produced food if the injection was Drug B. After a number of sessions, the discrimination formed: pecks went to the left key following injection of Drug A, and pecks went to the right key following injection of Drug B. When they administered a third drug, Drug C, before the session, pecks went to the left key; Drug C produced an effect on behavior similar to Drug A.

Lubinski and Thompson explained their results by asserting that the pigeons were discriminating on the basis of private stimuli produced by the drugs. They supposed that the private stimuli produced by Drug A differed from those produced by Drug B, and that the pigeons’ pecking was directed to the left key or the right key by the different private stimuli. To explain the pecking going to the left key with Drug C, they supposed that Drug C must produce private stimuli more like those produced by Drug A than by Drug B, and that the pecking was directed by those similar private stimuli.

Relying as it does on unobserved stimuli within the pigeon, the explanation seems misguided, at least in the context of a science. Speculation about unobserved stimuli adds nothing to the account, because the basis of the discrimination remains unknown. To explain observations, one must not invoke invisible causes. The analogy with a color discrimination would say that the pigeon discriminates red from green on the basis of private stimuli generated inside it by the different colors. Instead, we say that the discrimination is between the red key and the green key, with no appeal to private stimuli necessary. What was the observable basis for the discrimination between the drugs?

Just as the experimenters in the concept experiments sorted the slides, the experimenters in this experiment sorted the drugs. They must have looked at the label on the bottle and judged it to be Drug A, Drug B, or Drug C before injecting it. As in the concept experiments, they compared their judgments with the pigeons’ pecking. The similarity between Drug C and Drug A, lay solely in the similarity of the pecking. One need not infer similar private stimuli to conclude that Drug C has effects similar to Drug A, because the effect is the pecking. We may conclude only that the experimenters’ discrimination between the drugs corresponded to the pigeons’ discrimination between the keys.

The situation of Lubinski and Thompson (1993) resembles that of the researcher studying thermoregulation. The researchers compare changes in their visual signals

with changes in the subject's behavior and, finding a match, report a discrimination. The physiology underlying both discriminations remains to be understood.

This is not to say that private stimuli never become public when means are discovered to measure them or that speculation about physiology can never be fruitful. Postulating unobserved private stimuli as causes of observed behavior, however, is little different from postulating mental states that could never be observed; the only difference is the faith that private stimuli, with the right instrumentation, might become public. If, for example, measurement of a pigeon's heart rate indicated that Drug A increased heart rate, whereas Drug B did not, one would begin to have some evidence for the basis of the discrimination.

To return to hearing, Rachlin (2014) discussed the following situation. Two people, Adam and Eve are sitting still in a room while a recording of a Mozart string quartet is playing. Adam can hear, but Eve is deaf. How can one tell the difference? A layperson might say that one of them is hearing the music privately, but private hearing is no answer, because it appeals to an unobservable essence, and, besides, it does not tell which one is deaf. The answer is that in this narrow time frame, no one can tell which person is deaf, one can only tell in a wider time frame. Afterwards, Adam may say that he enjoyed the music, whereas Eve may say, "What music?" To tell that Adam can hear and Eve cannot, we need to see adequate samples of their behavior over a period of time. The patterns of their behavior will differ. Rachlin (2014) concluded, "The crucial difference between Adam and Eve is that Adam may do different things when sounds are present than when they are absent, while Eve generally does not do different things in the presence and absence of sounds" (p. 20).

Rachlin omitted from his account one important element: A third person (by implicit assumption, hearing) must be observing Adam and Eve to judge whether they can hear or not. Let us call this observer Mary. Mary witnesses occasions like those shown schematically in Fig. 1. On one occasion, she hears no sound and observes that Adam and Eve behave the same (X). On another occasion, Mary hears a sound and observes that Adam and Eve behave differently: Adam's behavior changes to Y, but Eve's behavior remains X. After enough such different occasions, Mary will conclude, based on comparing her hearing with Adam's and Eve's across several such occasions, that Adam can hear and Eve is deaf. As in the concept experiments and the experiment by Lubinski and Thompson, the observer's (Mary's) observations are the judging standard.

Taking this line a bit further, we may now suppose that the observer is not Mary, but Jane, who is deaf. What does Jane witness in Adam's and Eve's behavior? As observer, Jane hears no difference between the columns in Fig. 1; both occasions are equivalent. She, like the color blind student with the pigeon pecking at the red and green key, can only be puzzled by the changes in Adam's behavior from X to Y; they would appear inexplicable.

	Judged: Silence	Judged: Sound
Adam's Behavior	X	Y
Eve's Behavior	X	X

Fig. 1 The difference between Adam's hearing and Eve's deafness. When the situation is judged by a third-party observer to be silence, Adam's actions and Eve's actions are similar (X), but when the observer judges that sound is present, Adam's actions change (Y) while Eve's do not

Now let us suppose we give Jane a microphone attached to an oscilloscope. Even though she cannot hear the sounds on the different occasions, she can now see them. Now she can discriminate silence from sound, but visually. Now she has a judging standard and can, like Mary, conclude that Adam can hear and Eve is deaf. Although Jane's standard now is visual instead of auditory, she can compare her judgments with Adam's and Eve's behavior on multiple occasions.

Jane's situation with the visual sounds resembles the situation of Lubinski and Thompson (1993) with their pigeons' discrimination of the drugs. Instead of visual sounds, Lubinski and Thompson had visual cues in the form of the labels on the different bottles of the different drugs. Just as Jane could not hear whatever events accompanied changes in Adam's behavior, Lubinski and Thompson could not feel the pigeons' private feelings, but they did have visual cues that allowed them to compare their judgments to the pigeons' key pecking.

To return to our first example with Ted and Sue, we see that their behavior differs, because Ted behaves in ways that induce Sue or another observer to say that Ted hears the sound but Sue does not. They can resolve the difference in their judgments in one of two ways. Either Ted was mistaken or Sue was mistaken. The resolution depends on their relationship and the different consequences of the different resolutions. Sue may decide that she must have been mistaken because Ted is usually right about such matters, and they may go together into the forest to investigate. Ted may decide that he must have been mistaken, because he does not want to bother going into the forest, and whether a tree fell or not does not matter. The first resolution is like Ted claiming to have a pain and Sue responding sympathetically (Baum, 2011; Rachlin, 1985). The second resolution is Ted retracting his claim to have heard a sound and saying he did not hear anything after all.

Why does this relativity of judgments matter? The short answer is that dualism renders a science of behavior incoherent, because dualism leads to positing unobservable causes (Baum, 2016). Explicitly acknowledging the comparison of judgments steers us clear of dualism, which is the basis for mentalism. The differences between the judgments of Ted and Sue, Adam and Eve, Mary and Jane, or of a researcher and a pigeon all occur in the same (one) world. No need arises to distinguish material from nonmaterial or objective from subjective. Whether Herrnstein and Loveland (1964) or Lubinski and Thompson (1993), the researchers' judgments were not objective and the pigeons' judgments subjective or the other way around. The judgments exist in the one world, neither subjective nor objective.

Conclusion

The Zen *koan* with which we began is a didactic device; it is not intended to have a yes or no answer. In the larger context of Zen teaching, the *koan* is meant to take the student beyond dualistic thinking. Science, too, seeks to go beyond the dualistic thinking of common sense built into a language like English (Baum, 2016, 2017a, 2017b). It focuses on the one world, the world of our experience. Whereas Zen seeks to go beyond our worldly experience, science seeks to make sense of our worldly experience. Thus a science of behavior seeks to make sense of our experience of behavior—i.e., our observations of organisms' behavior. To understand what it means to hear a sound, we

focus on the behavior that we describe as “hearing a sound.” To the behavior analyst, the answer to the *koan* has to be “no,” because no one was there to hear the tree fall and no one could behave in the way that we would call “hearing a tree fall.” That is the account of “hearing a sound.” It leaves out nothing necessary. In particular, it leaves out the misleading duality of sound and hearing that common sense offers, but that is a good thing.

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