Some further thoughts on the definition of learning

Learning is often defined as a change in behavior that is due to experience. It has, however, been argued that this definition is too broad in that it includes changes in behavior that are due to one stimulus. This was the core reason why my colleagues and I (De Houwer et al., 2013) chose to redefine learning as a change in behavior that is due to an environmental regularity, whereby a regularity is defined as any event that is more than one stimulus at one point in time (e.g., one stimulus presented multiple times, two stimuli presented together once or multiple times, a behavior and a stimulus presented together once or multiple times). I still believe that this argument is valid (see below) but in De Houwer et al. (2013) we illustrated it with an invalid example. More specifically, in De Houwer et al. (2013), it was stated that a single loud bang can produce a change in behavior, which – intuitively - does not qualify as an instance of learning. However, we failed to realize that this example refers to behavior (i.e., responding; e.g., transitioning from being calm to being startled) rather than a change in behavior (i.e., a change in responding; e.g., strong responding to the loud bang by transitioning from being calm to being highly startled vs. weak responding to that same loud bang by transitioning from being calm to being mildly startled; see De Houwer & Hughes, 2023). Hence, it is not a good example of a change in behavior due to one stimulus.

There are, however, valid examples of changes in behavior that are due to a single stimulus and that – intuitively - do not qualify as instances of learning. In dishabituation, for instance, a single intense stimulus X can reinstate a habituated response to another stimulus Y. Likewise, in semantic priming studies, a single presentation of the word DOCTOR can facilitate responding to the word NURSE (see De Houwer & Hughes, 2020, p. 259, Footnote 3). Also the administration of a drug can change how organisms respond to a stimulus. These are changes in behavior (i.e., stimulus Y evokes a weak response before the dishabituation stimulus X but a strong response after the presentation of stimulus X; NURSE is responded to more quickly when preceded by DOCTOR then when preceded by an unrelated word; a stimulus is responded to differently after the intake of a drug than without the drug) that are due to a single presentation of one stimulus (i.e., stimulus X; the word DOCTOR; a drug) but that – intuitively – do not qualify as instances of learning. Admittedly, it is difficult to make explicit why such changes in behavior do not qualify as instances of learning. Ultimately, the most important criterion for the quality of definitions is not intuition but utility. Time will have to tell whether it is useful for researchers to exclude, from the definition of learning, changes in behavior that are due to one stimulus.

Defining learning in terms of regularities in the environment (and thereby excluding changes in behavior that are due to one stimulus) has at least some advantages. First, it allows researchers to distinguish different types of learning by referring to different types of regularities. For instance, whereas classical conditioning can be defined as changes in behavior that are due to regularities in the presence of two stimuli, operant conditioning refers to changes in behavior that are due to regularities in the presence of behavior and stimuli. The concept of regularities also allowed us (De Houwer & Hughes, 2020, Chapter 4) to define complex learning as changes in behavior that are the joint effect of multiple regularities and to introduce the concept of meta-regularities as regularities that involve one or more regularities as elements. Second, by identifying regularities as a class of events in the environment, the functions of regularities can be examined. For instance, in De Houwer and Hughes (2020, Chapter 4), we argued that regularities can function as CSs or Sds, and

might in fact often function as contextual cues for relational responding (e.g., pairing stimuli in space and time signals that they are equivalent in some respects).

Excluding from learning changes in behavior that are due to a single stimulus might, however, be too restrictive. Consider one-trial habituation. A single presentation of a stimulus could in principle result in a weakened response to the second presentation of that stimulus, yet this would not qualify as an instance of learning when learning is defined a change in behavior due to a regularity. It seems odd to exclude one-trial habituation (but not two-trial or three-trial … habituation) from learning. Upon further reflection, however, excluding one-trial habituation from learning could be justified because it involves a situation in which it is impossible to establish experimentally whether the change in behavior is due to the single presentation of a stimulus or to the repeated presentation of that stimulus. Any test of a change in behavior requires a measurement of behavior, either within subjects (in which case an organism needs to be probed twice) or between subjects (in which case each organism needs to be probed only once). Importantly, each behavioral test requires the presentation of a stimulus. Hence, when testing whether a single presentation of a stimulus produces a change in behavior, at least two stimuli need to be presented: one stimulus presentation for which it is examined that it will produce a change in behavior and a second stimulus to verify whether a change in behavior has occurred. If the response to the second presentation of the stimulus is different than the response to the first presentation of that stimulus, it is unclear whether this change in behavior is due to the first presentation of the stimulus (in which case it would not qualify as learning) or whether is it due to the fact that it is already the second presentation of the stimulus (in which case it would qualify as learning). The question of whether a change in behavior is due to a single stimulus or to the repeated presentation of a stimulus cannot be answered experimentally because it is impossible to verify a change in behavior without presenting a stimulus. The two potential causes of the change in behavior (the presentation of one stimulus + a test stimulus vs. the repeated presentation of the stimulus) are inherently confounded. It could well be that one-trial habituation qualifies as learning, but it is impossible to establish this. Note that this problem exists regardless of one's definition of learning: even when defining learning as the effect of experience on behavior, it will still be impossible to determine experimentally whether a change in behavior toward a particular stimulus is due to a single presentation of that stimulus or the repeated presentation of that stimulus. Because the question does not go away when excluding "regularities" from the definition of learning whereas there are advantages to including "regularities" in the definition of learning, I opt to define learning in terms of regularities.

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This text was written in response to a question of Melissa Bateson (University of Newcastle) after a talk I gave. She asked why I insisted on including the concept "regularities" in the definition of behavior given that the definition of learning as a change in behavior due experience is so widespread (and generally adopted by biologists).