

Supplemental Material of the Manuscript “The Keyword Effect: A Conceptual Replication, Effects on Bias, and an Optimization”

Introductory Example Text

Operant conditioning: learning through the consequences of behavior. Through operant conditioning, a person learns the association between a certain behavior and a reaction to that behavior. This reaction is also called consequence. The consequence following a certain behavior influences how often this behavior is going to be displayed in the future. A consequence can be a pleasant or an unpleasant event. The pleasant event is what we also call a pleasant stimulus and the unpleasant event is also referred to as an unpleasant stimulus.

The following example is supposed to make this clear: After playing, Max helps his mother clean up while his brother Tom leaves. Now the consequence is that the mother praises Max and yells at Tom. Because of the pleasant stimulus *praise*, Max learns that it is right to help cleaning up after playing. Thus, he will show the behavior *cleaning up after playing* more frequently in the future. Because of the unpleasant stimulus *being yelled at*, Tom learns that it is not right to just leave after playing. Therefore, his behavior *leaving after playing* will appear more seldomly in the future.

Operant conditioning plays an essential role in the development of good and bad types of behavior in humans and animals. Thus, it is important to know the basic terms and processes which will be explained in the following.

Reinforcement of behavior means that a certain behavior will be rewarded by a consequence. A reinforcement makes the behavior appear more often in the future. There are two different types of reinforcement: positive reinforcement and negative reinforcement. The term *positive* indicates that something will be given as a consequence while the term *negative* indicates that something will be reduced or taken away as a consequence to a certain behavior.

With positive reinforcement, a behavior is rewarded by a pleasant stimulus as a consequence. For example, people get the pleasant stimulus *money* for bringing back bottles with a deposit on them, which will make them bring back their bottles more often in the future.

Behavior is rewarded with negative reinforcement when an unpleasant stimulus is taken away or is avoided as a consequence. For example, when you take a painkiller, the unpleasant stimulus *pain* is taken away. Therefore, in the future you are going to take painkillers more often when you are in pain.

Punishment of behavior means that a specific behavior is punished by a negative consequence. Punishment makes a behavior appear less frequently in the future. There are two types of punishment: positive punishment and negative punishment. The term *positive* indicates that as a consequence something additional is given, while the term *negative* means that as a consequence something is going to be reduced, avoided, or taken away.

With positive punishment a behavior is punished by an unpleasant stimulus as a consequence. For example, if you park your car in a place you are not allowed to, you get the unpleasant stimulus *monetary penalty*. Therefore, in the future you are less likely to park your car in a place you are not allowed to.

With negative punishment, a behavior is punished by the removal of a pleasant stimulus as a consequence. For example, some children are forbidden to watch television when they disobey their parents. Therefore, in the future they will disobey their parents' rules less often.

When talking about the reinforcement of behavior, you can differentiate between primary and secondary reinforcers. Primary reinforcers satisfy innate needs and are therefore naturally pleasant stimuli. They can reinforce behavior in both humans and animals from birth. For example, the innate need *hunger* can be satisfied by the primary reinforcer *food*. Hence, food can reinforce behavior in all humans and animals.

Secondary reinforcers do not satisfy innate needs and therefore do not work from birth. They develop from neutral stimuli, so they are neither pleasant nor unpleasant at first. For a neutral stimulus to become a secondary stimulus one has to learn that it helps to receive the primary reinforcer. Therefore, the behavior has to be reinforced several times. After the behavior, the neutral stimulus follows and after that the primary reinforcer has to appear. The experience that the neutral stimulus is helpful to get the primary reinforcer will turn it into a pleasant stimulus and hence into a secondary reinforcer which can now reinforce the behavior all by itself. For example, *money* is a neutral stimulus in the beginning. Since you always get money after work and you are then able to get the primary reinforcer *food*, you learn that money is helpful. In that way, money becomes a secondary reinforcer and is enough on its own to reinforce *work*.

A schedule of reinforcement determines how often a behavior gets reinforced. With a continuous schedule of reinforcement, a behavior will be reinforced every single time it is shown. Therefore, the association between the behavior and the reinforcer is learned quickly and the behavior will already appear after a short time of training. However, reinforcement is expected every time the behavior is shown. Hence, the behavior is not going to appear if it is not reinforced anymore and the expectation of reinforcement is not fulfilled.

With a ratio schedule, not every single behavior gets rewarded. Instead, it is pre-determined how often the behavior has to be displayed to be reinforced. For example, it is determined that a behavior is always going to get reinforced when it is shown three times in a row. Therefore, the association between the behavior and the reinforcer is learned more slowly. However, reinforcement is not expected after every single display of the behavior. Instead, it is expected that at some point in the future there will be a reinforcement if the behavior is shown continuously. Hence, the behavior will still appear, even if it has not been reinforced for a longer period of time.

Sample Questions

1. Martin is driving on a highway on which he is allowed to drive up to 100 km/h. He pays attention to the speed limit. As he drives past a speed camera he is not flashed. Which statement applies to the reinforcement of behavior in this context?
 - a) Martin's behavior is reinforced negatively because the pleasant stimulus occurs.
 - b) Martin's behavior is reinforced positively because the positive punishment occurs.
 - c) Martin's behavior is reinforced negatively because the negative stimulus does not occur.
 - d) Martin's behavior is reinforced positively because the negative punishment does not occur.
2. Which type of schedule of reinforcement is best if a behavior is supposed to be maintained permanently?
 - a) Schedules of reinforcement are not proper for this matter.
 - b) Continuous schedules of reinforcement intended to reinforce the behavior every time it is shown.
 - c) Individual schedules of reinforcement which match the particular behavior.
 - d) Ratio-schedules which reinforce behavior in pre-determined intervals.

Test Questions and Corresponding Keywords

Stress: The biomedical perspective

1. Which state is most likely to reflect the term of **homeostasis**?
 - a) A fish that swims against the tide.
 - b) A heater that keeps a room's temperature constant by means of a temperature sensor. *
 - c) A nation that closes its borders to other nations.
 - d) A building that is steadily expanded by new floors.
2. Under which circumstances are environmental disturbances most likely to become **stressors**?

- a) When disturbances show up unexpectedly.
 - b) When disturbances are present over a longer time period.
 - c) When disturbances cannot be compensated easily. *
 - d) When disturbances are new.
3. In which competition should the **physical stress response** have the most negative effect on the performance?
- a) In a competition of holding breath.
 - b) In a 100-meter sprint.
 - c) Playing memory. *
 - d) Finding a figure in a picture puzzle.
4. How does a stress response run according to the **organization of neuronal responses**?
- a) From the amygdala to the thalamus to the cortex.
 - b) From the thalamus to the cortex to the amygdala.
 - c) From the cortex to the thalamus to the amygdala. *
 - d) From the thalamus to the amygdala to the cortex.
5. Under which circumstances are both neuronal **stress axes** activated?
- a) When a stress response occurs reflexively.
 - b) When danger is imminent but has not occurred yet.
 - c) When threats should be handled immediately.
 - d) When threats cannot be handled immediately. *
- Homeostasis
 - Stressors
 - Physical stress response
 - Organization of neuronal responses
 - Stress axes

The development of thunderstorms

1. **Lightning** is the longer, the ...
 - a) ... higher the air temperature is.
 - b) ... more clouds there are.
 - c) ... higher the humidity is. *
 - d) ... higher the tree it strikes.
2. Which statement is most likely to apply to the connection between thunderstorms and **electric fields**?
 - a) When there is no thunderstorm, there is no electrical field between clouds and earth's surface.
 - b) Current between the clouds and earth's surface only flows during thunderstorms.
 - c) When there is no thunderstorm, the voltage between the clouds and the earth's surface continues to increase.
 - d) After a thunderstorm, the voltage in the electrical field between clouds and earth's surface has increased significantly. *
3. What is not relevant for **cloud formation** that can lead to thunderstorms?
 - a) There have to be temperatures below freezing point in the upper part of the clouds.
 - b) There have to be rising and falling air currents in the cloud.
 - c) The mass of the ice crystals has to be higher than the mass of the water droplets. *
 - d) Ice crystals and water droplets have to rub against each other.
4. Which statement relating to **pre-discharge and main discharge** is wrong?
 - a) Pre-discharge and main discharge collide near the clouds. *
 - b) The main discharge has its origin in the ground and the pre-discharge in the cloud.
 - c) The main discharge is straighter than the pre-discharge.
 - d) The main discharge is brighter than the pre-discharge.
5. Which statement about the development of **thunder** is true?

- a) The more spikes a lightning has, the quieter the thunder.
 - b) Thunder emerges when negatively charged particles from the cloud hit the ground.
 - c) Thunder already emerges before formation of the lightning.
 - d) The hotter the lightning, the louder the thunder. *
- Lightning
 - Electric fields
 - Cloud (formation)
 - Pre-discharge and main discharge
 - Thunder

Crusades – Reasons for the clash of two cultures

1. The call to the crusade by the Pope created...
 - a) ...turmoil and anger among the people.
 - b) ...fear and terror among the people.
 - c) ...euphoria and enthusiasm among the people. *
 - d) ...belligerence and combativeness among the people.
2. What was the original intention of **Christianity** for the crusades?
 - a) Defense. *
 - b) Imperialism.
 - c) Forced conversion (to Christianity).
 - d) Colonialism.
3. Which tension was to be solved by the further development from “**holy**” to “**just**” **war**?
 - a) Christians versus Seljuks.
 - b) Combat as a profession versus gospel peace offer. *
 - c) Muslims versus infidels.
 - d) Gospel versus sinner.

4. Which one was the decisive **motive of the crusade** for wealthy people who originally had not been trained for fighting?
- a) Forgiveness of sins.
 - b) Threat of poverty. *
 - c) Reputation of Christianity.
 - d) Joy of fighting.
5. Which of the following examples is most likely to describe the self-image of the **crusaders**?
- a) They saw themselves as followers of God who went to war out of fear of punishment.
 - b) They saw themselves as slaves of God who went to war at his command.
 - c) They saw themselves as martyrs of God who went to war out of political intention.
 - d) They saw themselves as fighters of God who went to war in his holy mission. *
- Papal call
 - Christianity
 - Holy/just war
 - Motives of crusades
 - Knight (crusader)

The academic self-concept and its role for school

1. Which statement relating to the **facets** of academic self-concept is true?
- a) The mathematical academic self-concept is superior to the verbal academic self-concept.
 - b) The verbal academic self-concept is usually higher than the mathematical academic self-concept.
 - c) The form of the mathematical academic self-concept can differ significantly from the verbal academic self-concept. *

- d) There is only one general academic self-concept.
2. Which statement regarding the **differentiation** of the academic self-concept is wrong?
- a) Differentiation increases with age.
- b) The connections between the different facets of the academic self-concept increase with increasing differentiation. *
- c) The exchange with the social environment is an essential driving force for differentiation.
- d) In principle, differentiation can progress lifelong.
3. Anna got a 2¹ on her mathematic test and thus improves her previous performance by one grade. If Anna applies the individual **reference standard**, then...
- a) ...her academic self-concept in mathematics improves. *
- b) ...her academic self-concept in mathematics remains unchanged.
- c) ...her academic self-concept in mathematics deteriorates.
- d) ...the mathematical and the verbal academic self-concept are compared.
4. What is not a consequence of the **big-fish-little-pond effect**?
- a) Sinking academic self-concept when changing to the Gymnasium (grammar school).
- b) Higher level of interest in the subject in low-performance classes.
- c) Increasing academic self-concept when changing to the Hauptschule (secondary modern school).
- d) Higher academic self-concept at the Gymnasium (grammar school) in general. *
5. Boys usually have a higher mathematical academic self-concept than girls. What is the reason for this **gender difference**?
- a) Boys usually are more industrious in mathematics.

¹ Note that a 2 is a German grade that is equivalent to a B.

- b) In boys, good performance in mathematics is rather attributed to talent. *
 - c) Boys usually are more interested in mathematics.
 - d) Boys are more likely to choose mathematics as a main subject.
- Facets of self-concept
 - Differentiation
 - Reference standards
 - Big-fish-little-pond effect
 - Gender differences

Table Supp1

Correlation between Bias and Relative Accuracy at Both Measurement Time Points for all Groups.

	Keyword+comparison group				Keyword group				Control group			
	Bias T1	Bias T2	Relative accuracy T1	Relative accuracy T2	Bias T1	Bias T2	Relative accuracy T1	Relative accuracy T2	Bias T1	Bias T2	Relative accuracy T1	Relative accuracy T2
Bias T1	1.00	0.92**	0.04	0.08	1.00	0.96**	0.34'	0.34'	1.00	0.96**	-0.12	-0.11
Bias T2	-	1.00	0.09	0.14	-	1.00	0.30'	0.30'	-	1.00	-0.23	-0.16
Relative accuracy T1	-	-	1.00	0.94**	-	-	1.00	1.00**	-	-	1.00	0.98**
Relative accuracy T2	-	-	-	1.00	-	-	-	1.00	-	-	-	1.00

Note. ** $p < .001$, ' $p < .10$.