**Participant Instruction**

Version 3, 17 June 2013

**Study Title: Neural Mechanisms of Decision Making and Cognitive Control**

First of all, thank you very much for participating in our experiment.

We are interested in how people learn and make decisions. Usually people make decisions in order to achieve positive outcomes or rewards and to avoid less positive ones. However, often it is not straightforward to figure out which options yield the best outcomes.

In this experiment, you will collect rewards in different (virtual) environments. We ask you to **compare** the environments and make decisions about which environment is better, i.e. gives you more rewards. On top of that, we are interested in how people **predict** how many rewards they will get in an environment in the future.

In this session, you will experience three short trainings to prepare you for the main experiment in the MRI. The first training is a Comparison Training, the second one is a Drift Training and the third one is a Prediction Training.

**What should you do in this experiment?** Perhaps, what we ask you to do in this experiment is best explained by an analogy. Imagine you are a treasure hunter who searches for gold and who aims to collect as much gold as possible in different environments. Now, the treasure hunter may search for these rewards in different environments: in a cave, in a jungle, in a desert, etc. He may develop a sense of how frequent and how large treasures are in each environment. And based on this he may prefer to stay in one environment or to leave to go to another environment. What we ask you to do in this experiment is something similar.

In this experiment, the process of searching through an environment is (simplistically) represented by pressing a button when you see a fixation cross. With every search step / button press, you search through an environment a bit more. Each search step is followed by one of two consequences. Either your efforts pay off and you find a treasure chest with gold in it; or you find nothing (represented by an empty treasure chest). The figure on the next page should illustrate this:



Note that the rewards you receive vary in magnitude. When you earn the smallest reward magnitude, only the bottom of the chest is covered (left pic), whereas the chest is almost completely filled when you earn the biggest reward magnitude (bottom right).

Examples:

Note that the frequency of rewards varies. The highest frequency is when every second button press yields some gold. The lowest frequency is when only every 6th button press leads to a reward.

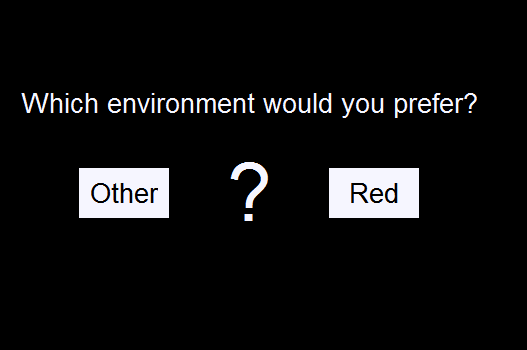
Examples:



Note that the overall amount of gold you collect in an environment depends on the **frequency and on the magnitudes** of the rewards.

**1. Comparison training.** In this first training as well as in the actual experiment, we ask you to search for rewards in a *stable red environment* and in a *changing environment*. The red environment is essentially the same every time. This means that it gives you the same amount of gold every time you search through it. However, the changing environment is different every time you enter it. Ideally, you want to be in the changing environment if it gives you more gold than the red environment, and you want to be in the red environment if the changing one gives you less.

In this training, we ask you to “press your way” through the red environment. After that, we ask you to do the same for a changing environment. You should pay attention to how much gold you receive in both environments (no need to count, just try to get a feel for it). So in the end, we will ask you which environment yielded more gold. You will see a screen like this:



Please use the buttons marked on the keyboard for your response. You can respond as soon as the question mark disappears (after 2-3 seconds).

After that we will show you how well you did. If you choose the better environment, you will earn **Bonus Points**, which equal the sum of gold that you earn MORE in this environment compared to the one you did not chose. Alternatively, if you choose the lesser of the two environments, we will show you how many Bonus points you missed.

The training will comprise several such Red-Other-Comparison sequences. You should use these to learn to **compare** the environments. Note that both environments are always equally “long” in terms of button presses.

In the actual experiment, we will use the stable red environment as a reference. To this end, please pay particular attention to:

* How much reward you earn in the red environment overall.
* How long the red environment is in terms of number of button presses (you do not need to count the presses, just try to get a rough idea; although it is not necessary to know this to solve this training, it will become relevant in the main experiment!)

Importantly, the Comparison Training has the main purpose that you learn the red environment. Later in the experiment, we will ask you to make decisions about the red environment without (!) showing it to you again. So please use this opportunity to learn about how much you earn in the red environment and how long it takes to get through it.

Any questions? Should we start the Comparison Training?

**<Comparison Training taking place>**

**2. Drift Training.** Well done! When you read this, you have successfully completed the Comparison Training and know now about the rewards you find in the red environment. This knowledge is important for the experiment. However, for this second training, we will put this aside for a moment and focus on the changing environment solely, because it has a few properties that you should be aware of.

As mentioned above, the changing environment is different every time you enter it and to illustrate this, the changing environment has a different colour every time you are in it (since we had only a limited number of colours, you will encounter similarly coloured changing environments – however, the environment is *always* new, any similarity in colour is purely random!). But, the changing environment does also change while you press your way through it. In that sense, the changing environment **drifts**. Some changing environments drift a lot, some are almost stable, some change rapidly and some change in a very slow fashion. However, all drift in a systematic way!

Maybe, to make it more intuitive, let us explain using the treasure hunter analogy: Caves or deserts or mountains are very different places to go and search for gold. While hunting for rewards in one of these environments, a good treasure hunter constantly asks himself how well his time is spent there. He observes carefully how the value of an environment changes while he finds more (or less) gold. Essentially, we would ask you to do exactly these things in the drift training.

So your task is to make your way through different changing environments and to observe how they drift, i.e. how they get better or worse. Some will drift a lot, some others only a bit. Remember that the amount of gold you collect depends on the **frequency and on the magnitudes** of the rewards. This means how often you receive rewards changes over time, but also how much reward you receive every time you receive one. However, both do not change in a straightforward way. For instance, the magnitudes may be low at first, then a bit higher, then again lower, then very high, etc. You have to take into account both the change in magnitude and the change in frequency at the same time to understand the drift in one changing environment. The drifts are always only in one direction. Either an environment gets better overall, or it gets worse. However, this can happen in a quick or in a slow way, it can change a lot or it can change only very subtly.

To illustrate this, we will ask you in this training to explore three changing environments, one that is relatively stable, one that gets better and one that gets worse. We will show you these environments three times and each time we will ask you to focus on different aspects. First, please focus on changes of **how much** gold you get each time you get some (ignoring how often you get it), then focus on changes of **how often** you receive gold (ignoring how much you get each time). And finally, please pay attention to changes of both **how much and how often** you receive gold. During the training, there will be a screen telling you which feature to attend.

Any questions left? Should we start?

**<Drift Training taking place>**

**3. Prediction Training.** Now you should have an idea how it is to compare red and changing environments. You should have an idea how long the red environment is and how much gold you approximately earn there. Also, you should have an idea in what sense the changing environment drifts.

However, what we ask you to do in the actual experiment is a bit more difficult than just comparing the environments or observing their change. It is to **predict** how good an environment will be at a later point in time. Note that this Prediction Training now is almost exactly what you will do in the main experiment.

Perhaps one way to explain what you should do is, again, to expand on the treasure hunter analogy. Imagine, when the treasure hunter searches through, for instance, a cave. He initially finds only very little gold treasures, but then more and more. He might feel that he is “on the right track”. Suddenly, he finds a sideway leading out of the cave and into the jungle. Imagine the treasure hunter has extensive experience with how much gold he finds in the jungle (= red environment). Should he stay in the cave or leave for the jungle? Well, that should depend on his expectations about how much money he earns if he stays. In this case, he might feel that the treasures he had found were only the “tip of the iceberg” and that there might be many more. So he might stay. In other cases he might feel that there is nothing more to gain from an environment. So he might leave. The main thing we ask you to do in this training as well as in the actual experiment is to make this kind of decision.

In the Prediction Training, you will always start in a changing environment. After some time (sometimes very early, sometimes late), we will ask you to make a decision that is very similar to the one of the treasure hunter. We call this decision “stay/leave decision”. You can choose between staying and leaving. If you decide to stay, you will keep on searching gold treasures in that changing environment. If you choose to leave you will instead search for rewards in the red environment. In other words, we ask you to predict how good the changing environment will be and to compare that with how good you know that the red environment is. The question is: Will you gain more rewards overall if you spend the time period after the stay/leave decision in the changing, or in the red environment?

This is also why it is important that you remember the red environment and the approximate time you spend there. If you decide to leave you will experience a red environment just like in the Comparison Training. If you decide to stay you will further experience the changing environment (for the same number of button presses you would otherwise spend in the red environment). These stay/leave decisions are the most important part of the experiment. Please try to predict the changing environment as well as possible and to decide as accurately as you can.

In the end, we will tell you if your decision to stay or to leave was good. Like in the Comparison training, you will get **Bonus Points** for good decisions. These are equal to the sum of gold you earn *additional* to the points in the alternative environment that you did not choose. If you make a less good decision, we show you how many points you missed. In other words, these Bonus Points reflect the difference of overall gold you can collect in both environments. Note that this refers only to the phase *after* the stay/leave decision. So the Bonus Points are entirely determined by the decision you make there.

Note that you will not get feedback whether your choice was right in the actual experiment. So please use this training to learn how to make correct decision. Also, please use the instances you decide to leave for the red environment to “refresh” your knowledge how good it is there, as you will not be able to do that so often in the main experiment. This is because in the actual experiment, we will sometimes not show you what is happening after the stay/leave decision.

<**Prediction Training taking place>**

**Two last things.** Well done, we are almost there! You learned about how good and how long the red environment is and you experienced how it is to make a decision if it is worth leaving the changing environment for it. Also, you saw that sometimes you do not experience the phase after your stay/leave decision. This was on purpose in order to save some time. In quite a few blocks of the actual experiment, the phase after the stay/leave decision will also be cut off. Your payoff in the end will be as if these periods would have taken place. So please take the stay/leave decision very seriously in every block! Please note that it is entirely random which post- stay/leave -periods are missing. This is not at all related to your decisions.

And remember, you will not get feedback whether your decisions were good. However, if your decisions were good is essential for how much you earn in this experiment. Of course, you get a fixed amount of money for sure for participating. This reflects all the gold that you will inevitably collect during the experiment. However, you get a flexible payoff extra that reflects how good of a treasure hunter you were during the experiment. This payoff equals the number of **Bonus Points** you collect (unfortunately, the Bonus Points from the trainings do not count). Bonus Points are calculated in the same way as in the trainings. So they reflect how much more gold you collect by making good decisions. From time to time, we will show you how much Bonus Points you have collected so far.

Note that this study does NOT involve deception of any kind! There is no “hidden” thing about your behaviour that we are interested in. We are interested in the decisions about stay/leave you make and there is no simple “trick” what you should choose. What you should do is to always pay as much attention to the changing environments as you can and try to make the decision that is best for the situation!

**Any questions left?** Now that you know how everything works, you can experience a few trials of the experiment and then this training session is over. If you have any questions left, please ask!