1. **Hypothesis**

H1: The common sequence effect and mere token effect can be reversed when the difference in time delay between LL and SS is large.

1. Reverse common sequence effect

First, suppose you are indifferent between A and each variant of B:

A. $100 tomorrow or B1. $102 in 1 month

A. $100 tomorrow or B2. $112 in 6 months

A. $100 tomorrow or B3. $220 in 40 months

Then, we insert a common sequence “$10 in 6 months” in each option. Let us think in intertemporal trade-off. When inserting the common sequence in B1, the average delay is extended; when inserting in B2, the average delay is unchanged; when inserting in B3, the average delay is shortened. Regardless of the potential difference in changes of the accumulated utility of money (which depends on how to specify it), we should observe that most people shift from A to B3; fewer people shift from A to B2; and even fewer people shift from A to B1 (even negative number).

Third, let us think in attention. When inserting the common sequence in B1, more attention will be paid to a later period with a smaller reward, which decreases the value of overall sequence. This is consistent with the trade-off model. However, inserting in B2 and B3 may have different impacts. When inserting in B2, the attention weight allocated to the period where you get money (“6 months”) is also increased. This always increases the value of overall sequence. When inserting in B3, more weight is allocated to an earlier period, but the weight allocated to the original period where you get money (“40 months”) is decreased. When the amount of money ($220) is large, the decrease in weight for this certain period should also be large. Thus, there could be either an increase in overall value, or a decrease in overall value; and when the original amount of money is larger, we are more likely to observe a decrease. Note that in the last paragraph, I do not consider the convexity of the utility function of money; in this paragraph, I do not either. In this case, we may observe more people shift from A to B2 than from A to B3 (at least more than what is predicted by the trade-off model).

Given that the magnitude of reward plays a role in this, along with the three choices above, I set another three choices, in which each amount of money is halved. So, we have (3+3)\*2 = 12 questions for this part.

1. Reverse mere token effect

The design is similar to the above. The only difference is that I insert “$10 today” in each option. So, we have 6 questions for this part as well.

Let me illustrate the mere token effect, and how it may be reversed by the attentional mechanism. Suppose you are indifferent between

A. $100 tomorrow or B1. $102 in 1 month

The mere token effect says, when comparing

A’. $10 today and $100 tomorrow or B1’. $10 today and $102 in 1 month

You would prefer B1’ to A’. However, if we think in attention, when the original delay in the variants of B is long enough, we may observe the opposite. For example, suppose you are indifferent between

A. $100 tomorrow or B1. $220 in 40 months

When comparing

A’. $10 today and $100 tomorrow or B3’. $10 today and $220 in 40 months

You may be more likely to choose B3’ rather than A’. The reason is, if you spread the attention weights across time periods, spreading across “40 months” means that, on average, the attention weight you can allocated to “today” is very limited (compared to the case of “1 month”). In intuition, you just want to get the all the money tomorrow and go, and cannot wait over three years that long.

H2: (Magnitude-increasing temporal sensitivity) Increasing the reward for a specific future period enhances people’s sensitivity to changes in its reward.

In this part, I expect to observe that, when making comparisons between

A. $20 today and $10 in 3 months or B. $10 today and $20 in 3 months

C. $20 today and $120 in 3 months or D. $10 today and $130 in 3 months

You may prefer A to B, but D to C. The reason is that, when increasing the magnitude of reward in a certain period (in this case, we increase the reward you can get in 3 months by $70), the attention weight allocated to that period is also increased. Thus, people should be more sensitive to the difference of rewards in that period. I’m not sure about the previous two propositions, but I’m sure that this proposition is not predicted by the trade-off model. I expect to have 10 questions for this part.

1. **Sample**

For the current experiment, I hope to run a pilot with 25~30 subjects. Then recruit 150 subjects for a formal test. The total budget is £500. I am waiting for the fund, hopefully it will arrive next week. The survey consists of 35 questions and I expect to give each participant £2. Each participants will answer the same questions (so it’s a within-subject design). However, if you can help edit the number and content of the questions, that should be fantastic.

1. **Model Comparison**
2. Attentional Discounted Utility

Let denote a sequence of rewards. In the attentional discounted utility model (ADU), the decision process is divided into two stages. The first stage is to decide the attention weight for each period through a costly learning process. Under certain assumptions, the attention weight (denoted by ) is decided through and , where is the initial weight, is the instantaneous utility of period , and is the unit cost of learning. One can also put into the utility function, thus

It shows that the attention weight for each period is “anchored” in the initial weight , because the attention adjustment process is costly; and it is increasing with , indicating that the decision maker is motivated to pay more attention to the periods with larger rewards. The sum of weights is fixed at 1, indicating the decision maker’s capacity of information processing is limited.

The second stage is to choose the reward sequence that can maximize the weighted sum of utilities:

1. Intertemporal Trade-off

In the trade-off model, the overall utility of a reward sequence can be written as , where is the accumulated utility of rewards, is the (weighted) average duration of utility accumulation, and is the trade-off parameter. The latest version I know about this model is from Scholten, Read, and Sanborn (2016), which says can be calculated by

where the weight is calculated by

We can perform the following arithmetic transformation on . Note that in the denominator of , is added for times, is added for times, and so on. Thus, we can rewrite the denominator as . Then, rearrange into

Therefore, the overall utility of the reward sequence can be written as

where

and

The above formula is closely related to the ADU. To be exact, ADU can be transformed into this formula in three steps: First, when deciding the attention weight , replace by . By doing so, will be proportional to instead of . Second, take the rank-dependent discounting as the initial status, i.e. . Discounting functions of this type have been suggested by the decision-by-sampling theory (note that in previous documents I use the exponential discounting as the initial status). Third, when summing up the utilities in the second stage, replace the instantaneous utility function of period by .

In summary, I think attentional mechanism provides a theoretical account for why it is reasonable to use the average duration of utility accumulation in intertemporal tradeoff model. It could be viewed as the result of some costly sampling process implemented by the decision maker to learn the sequence value. Therefore, the most evidence that was applied to justify the trade-off model can also help justify the attention-adjusted discounted utility.

1. Differences

There are two main differences between ADU and the trade-off model.

First, in the trade-off model, what is summed up to calculate the value of a sequence is , which consistently declines with time. Imagine a decision maker allocating a consumption budget over two periods, then this type of function implies that the instantaneous utility of the second period is always lower than that of the first period. The decision maker has no reason to allocate more consumption in the second period than the first period (as this only shifts attention to the second period, which has a lower level of utility). By contrast, what is summed up in ADU is . Increasing the consumption in the second period can both shift attention to the second period and increase the level of utility for that period. So, it is possible to have people preferring improving sequences.

Second, in the trade-off model, the time weight is proportional to ; while in ADU, the time weight is proportional to . For a period with no reward, the trade-off model allocates no weight to it, but ADU will allocate some weigh. Imagine that a sequence originally has a positive reward in period and no reward in the previous periods, then we increase the reward in period 0. The trade-off model predicts that when is larger, the average duration can be reduced by a larger amount, thus the increase in sequence value should also be larger. By contrast, ADU predicts that the periods with no reward will occupy some attention. When increasing the immediate reward, those periods will inhibit the decision maker shifting attention to period 0. Thus, when is larger, the increase in sequence could be smaller.