The Effect of Language on Economic Behavior:

Replication and Extension on Examining the Causal Link between Future Tense and Time Preference in the Lab

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Abstract

This paper is a replication and extension from Chen, He et al. (2019). They provided a strong-form examination on the linguistic-savings hypothesis (LSH) in the lab, but did not find empirical support between future tense and time preference. Although they took advantage of Chinese and subtly embedded the word 'will' in the sentences, we doubt this treatment is too weak to be seen by subjects. Therefore, we redesign the visual manipulation and introduce eye-tracking in our studies. In contrast to the results of original study, we show that future tense makes people more impatient in some extent. Moreover, eye-tracking data further suggest the hot spot in multiple-price-list and the actual fixations on the word 'will'. These are all necessary materials for future dicussion.

Key words

Replication

Eye tracking

Future tense

Time preference

Linguistic-savings hypothesis

Introduction

This paper is a replication paper from Chen, He et al. (2019): The effect of language on economic behavior: Examining the causal link between future tense and time preference in the lab. The issue of whether language can influence time-perception or decision-making has been discussed in several fields for quite a long time, including linguistics, anthropology and neuroscience, but remains little attention until recently. Chen (2013) hypothesized that the heterogeneous degree of future tense in different language would lead the users to different actions. Specifically, the linguistic-savings hypothesis (LSH) interpreted that the languages do not require speakers to use future tense to describe future events would tend to enforce the future-oriented behavior. Since then, many empirical studies have investigated the correlation between future-time reference (FTR) and future-oriented actions.

More recently, Chen, He et al. (2019) conducted the experiment in two Chinese-speaking countries to examine the causation between the use of FTR and the future-oriented behaviors, controlling the effect of language from culture factors in order to test LSH. They also took advantage of unique linguistic characteristic of Chinese language: Chinese allows its speakers to omit the use of future-reference word without violating the grammatical rules, hence lending power to speaker to manipulate whether to use the future tense or not. For instance, when saying "明天我將有考試" (míng tian ¯ woˇ jiang ¯ youˇ kaoˇ shì; I have a test tomorrow), the speakers can choose to omit the future-tense word "will" by saying "明天我有考試"(míng tian ¯ woˇ youˇ kaoˇ shì; I will have a test tomorrow). The advantage comes to the aid by overcoming the demand or confusion effect. The study concluded that repetitive exposure to the use of future-reference word didn't bring the subjects to behave impatiently in time preference task. Chen et al. noted that there could be other factors mitigating the treatment effect, or it needs a more intense control of the design to observe the effect.

In this paper, we first re-examine LSH using Chinese language by adopting a stronger manipulation on the time-perception framing to observe the causation between the use of FTR and the future-oriented behavior more clearly. To be specific, we remove the confusing words in the original experiment and add the future tense in the heading of our descriptions, all for the visual enhancement of the treatment in a subtle way.

In addition, we also introduce eye-tracking to further understand people's cognitive reaction in this kind of economic decision-making. Eye-tracking is a technology used for recording subjects' eyes movement, which is relatively new for economists. With its assistance, we are able to tell (1) which parts of the screen did subjects tend to pay more attention; (2) how much 'will' is actually seen by subjects. These visual data do provide further understanding and become the base of our extension.

We adopt the multiple-price-list method (Coller and Williams 1999) used in Chen et al.(2019) to examine intertemporal preferences. There are eight rounds in this experiment and nine rows in each round. Subjects make decisions between a smaller-sooner versus a larger-later monetary reward in each row, and choose a unique switch point in each round. If a subject chooses the switch point, which means that above the switch point, they are willing to wait more weeks for a bigger reward.

The linguistic manipulation are put into the sentences. In our studies, we noticed that the questions are fixating as much as the options. Therefore, we thought the word 'will' should be embedded into the upper half in each rounds. Also, to prevent the unnecessary effect, the pronoun "I" are removed in both control and experimental groups. All the sentences are adjusted to make sure that the description are sounds natural to chinese speakers.

Our results show that the average switch point chosen by the subjects are higher for treatment group than for in control group under intermediate time frame, but the effect seems to be insignificant in the delayed time frame. As the primary variable we interest in, the average switching point implies subjects' time preference. If a subject selects the higher choices, presenting that he or she is a less patient person, vice versa.

The regression presents that the treatment effect is only significant while considering the individual characteristics and the manipulations. The significant positive effect provides evidence that the treatment successfully increases the switch points chosen by the subjects, which means make them to be more impatient. It lends support to the initial supposition that the future- tense word enhance the distance between present and future.

We also explore the parameters captured by the eye-tracker to further interpret subjects' characteristics. It lends support that the exposure of the future-tense words provide strong manipulation to make the subjects perceive the future tense. In Chen, He et al. (2019), the exposure of the future tense appears 72 times in the whole treatment. In our experiment, the exposure is further strengthen due to the manipulation, leading subjects to receive more future-tense words in the whole process.

Literature Review

We adopt eye-tracker as the main key of our extension, strengthening the FTR manipulation and discovering the perceptual pattern behind decision making. Eye-tracking technology is used for observing eye activity, generating data such as fixation (a short eye stay, related to subject's attention), saccade (the movement between two fixations, related to subject's scan-path), pupil dilation (how much the pupil expand, related to subject's emotion), and so on. These are useful for researchers to acquire abundant data in psychological and biological aspects, which might be consistent to the choice data or not.

By the summary of Lahey et al.(2016), Eye-tracking has a long history since late 19th century, applied in psychology, marketing, education, surgery, and even software engineering. However, in the field of Economics, eye-tracking is a whole new world. It was not until early 21th century that few neuroeconomisists started eye-tracking in their research.

Knoepfle, Wang, and Camerer (2009) are one of the forerunner, applying eye-tracker in their research to observe the learning behaviors in games. They discovered that subjects do focus on the payoff of their counterpart (in precise, averagely 46.1% fixation), in order to acquire information for developing their next strategy. Wang, Spezio, and Camerer (2010) introduced eye-tracker in sender-receiver games to detect the truth-telling behavior. Similarly, they noted that subjects would pay more attention on important parameter (in detail, state and bias in this kind of game). Also, pupil dilation could be a useful observable variable associated with deception from those senders.

Related to decision making over multiple choices, we found a bunch of studies on attribute attendance in discrete choice experiments (DCE) using eye-tracking. Meißner, Martin, Andres Musalem, and Joel Huber. (2016) suggested high-valued alternatives in conjoint choice tasks receive increased attention. Balcombe, K., Fraser, I., Williams, L., & McSorley, E. (2017) agreed with them that higher levels of visual attendance related to specific attributes, but suggested that the strength of this relationship is relatively weak and thus discourage experimenters applying eye-tracker. However, Chavez, D., Palma, M., & Collart, A. (2018) revealed that choices are a function of visual attention by a new method called weighted total visit duration (WTVD). These studies interest us to look deep further.

To conclude those findings by eye-tracking, we could figure out which is much important information to subjects and thus piece together with the choice data. Just as Bernheim (2009) suggested, the nature of decision processes could be successful in testing the models in economics and solving problems behind traditional standard choice data. These features are especially critical in our extension stemmed from Chen, He et al. (2019), which allowed us to analyze the visual pattern of subjects and examine how much FTR treatment they really receive in the multiple-price-list method.

Following the advantage of eye-tracking, we find that there is still a room to improve in the visual manipulation due to the concern of not emphasizing the word “will”. In the original setting of Chen, He et al. (2019), they conducted a multiple-price-list method and subtly embedded the future tense word “will” in the middle of those sentences. This strategic design did successfully implement the treatment and eliminate the demand effect at the same time. However, we do worry about this method is so quiet that subjects might not pay sufficient attention on the word “will”, leading the treatment group behaved as the control group. That is, we could not tell the ‘no result’ from Chen, He et al. (2019) was because of the failure of the LSH hypothesis or the failure of the treatment manipulation.

As Knoepfle et al. (2009) and Wang et al. (2010) have shown, subjects mostly focus on the key of decision making (e.g. the payoff). We do make a prediction that this feature will be consistent in our studies, driving subjects’ attention to the two numbers associated with the delayed weeks and the payment. To be more specific, in the sentence “After X weeks, I will receive Y dollars.”, only the two numbers “X” and “Y” will be seen, and the critical word “will” might be missed. Moreover, in the total 8 scenarios, the contexts are almost the same except the slight differences between the time frame. That is, subjects might get used of it and thus do not pay attention words by words. These are vital issues to be concerned because the future tense might not be considered in the cognitive process of a subject. Although they emphasized the exposure of the future tense ‘will’ between the treatment group (FT condition) and the control group (NFT condition) is 72 vs 0, we are eager to see how much future tense are actually received by subjects.

Therefore, we have three missions in our studies: (1) Did subjects tend to pay more attention on delayed weeks and payment, which are the key parameter in decision making; (2) How much FTR treatment 'will' is actually seen by subjects, interpreted by the fixation duration and numbers; (3) Whether we could enforce stronger manipulation based on eye-tracking data to provide a clearer examination of LSH prediction.

Experimental Design

We inherit the multiple-price-list method (Coller and Williams 1999) used in Chen et al.(2019) to test intertemporal preferences. There are eight rounds in this experiment and nine rows in each round. Subjects make decisions between a smaller-sooner versus a larger-later monetary reward in each row, and choose a unique switch point in each rounds. The smaller rewards are 100 in all rounds, and the larger rewards are 110 in the first row and increase by 10 for each row. It means the largest reward that subjects can get is 190. The timings of the later rewards are 1, 2, 4, and 8 weeks from the present when the timing of the sooner reward is the present, while the timings of the later rewards are 5, 6, 8, and 12 weeks from present when the sooner one is four weeks delay from present. In order to prevent the order effect, the eight rounds are in a random order.

In each rounds, subjects can choose a switch point from 1 to 9. It means that above the switch point, they are willing to wait more weeks for a bigger reward. If they don't want to switch to a larger-later one, they can choose 0 as their switch point. After eight rounds, the computer will select one round and one row randomly. According to the switch point which subjects chose in that round, the system will show when and how much of the monetary reward. For example, if the third rounds and the fourth row are selected, and the switch point in that round is the third row, it means that the subject is willing to switch to a larger-later reward in the fourth row. That is, they can get a bigger reward but waiting more weeks.

In our experiment, we change the description of the sentences and control the gender of each groups. The first pronoun "I" in the description of lottery choices will change the degree of risk-aversion (He, 2017). We think the pronoun may influence personal decision-making behavior. In order to prevent the unnecessary effect, the pronoun "I" are removed in both control and experimental groups. And the sentences are adjusted to make sure that the description are sounds natural to chinese speakers. Women tend to be more patient than men (Dittrich and Leipold, 2014). To avoid gender influence the result, both groups are set the similar sex ratio because we only have 13 subjects. Two pages which show the result that the subjects chose in the previous round and one black dot in the middle are put between each round. These can not only remind the subjects which switch point they are willing to chose but also calibrate the eye tracking again.

The linguistic manipulation are put into the sentences. In our studies, we noticed that the questions are fixating as much as the options. Therefore, we thought the manipulation should be embedded into the upper half in each rounds. In the FT condition, the upper-half description of larger-later reward are "於ｘ星期後，將收到超過100枚法幣" (After X weeks, will receive more than 100.), and the choice menu are described as "於ｘ星期後，將收到ｙ" (After X weeks, will receive Y.). On the other hand, in the NFT condition, the rows are "於ｘ星期後，收到超過100枚法幣。" (Receive more than Y after X weeks.) and "於ｘ星期後，收到ｙ。" (Receive Y after X weeks.). Both conditions are natural to Chinese speakers. The manipulation is not embedded into the smaller-sooner reward in both conditions.

Figure 1: Control Group (NFT condition)

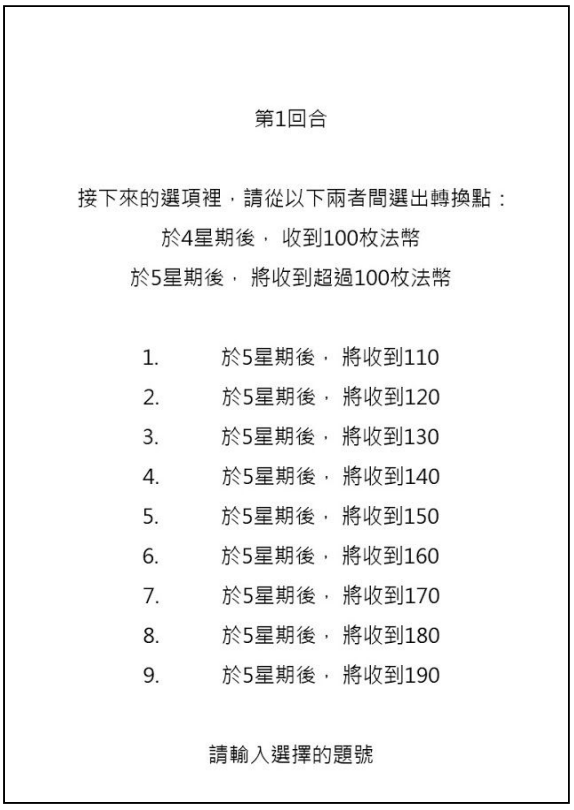

Figure 2: Treatment Group (FT condition)

(‘將’ is the word ‘will’,placed after the comma)

Results

We conduct our experiment in Taiwan, where was one of the experimental location in Chen, He et al. (2019) and the majority of the populations speak Chinese. This study recruits 13 undergraduate students at National Taiwan University, and the experiment is programmed and conducted using MATLAB and eye-tracker. The subjects are asked to participate in the time preference task, which deciding their payment after the end of the process.

We provide a general scenario of the selection from our subjects. Our variable of interest here is the average switch point. As subjects are required to select between a series of binary choice in the whole process, the average switching point implies subjects' time preference. If a subject selects the higher choices, presenting that he or she is a less patient person, vice versa.

Figure 3 summaries the switch points chosen by the all subjects between the two treatment conditions. The average switch point chosen by the subjects are higher for treatment group than for in control group under immediate time frame, but the effect seems to be insignificant in the delayed time frame. When using the Mann–Whitney U test, the p-values is 0.058 and is significant in 10% level.

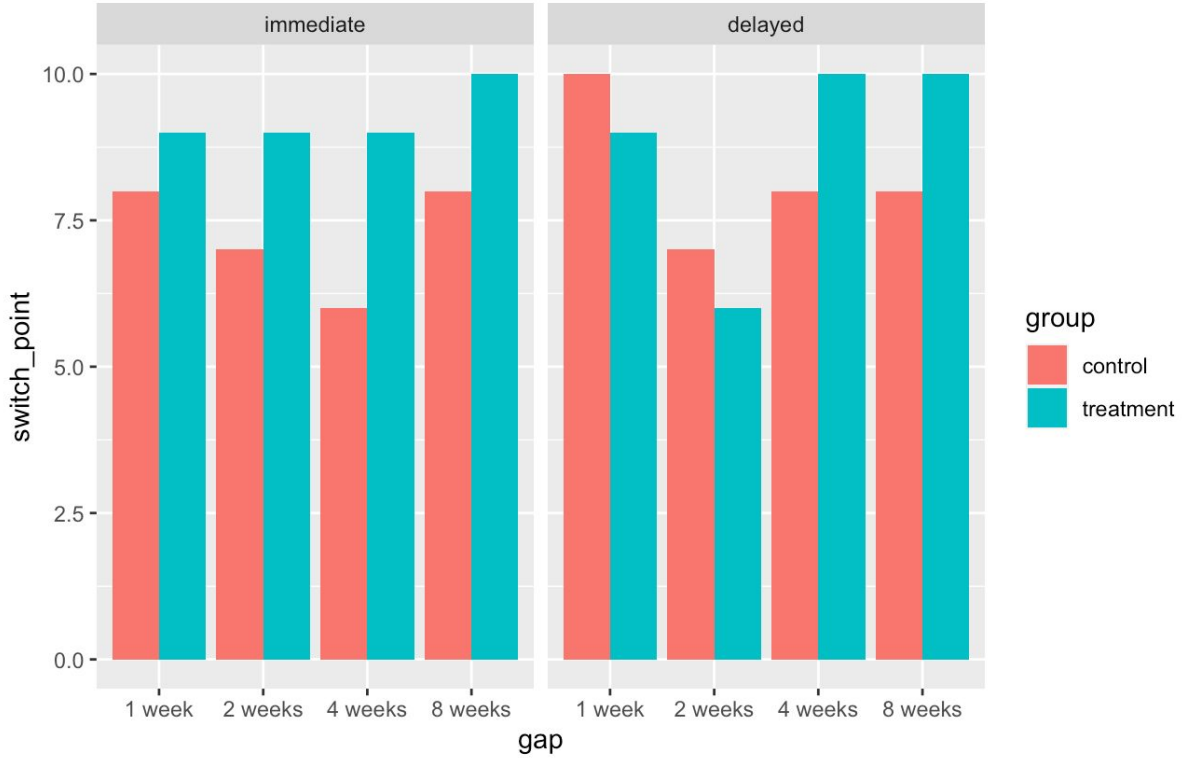

Figure 3: Comparison of the average switching point

VARIABLES	switch_point	switch_point	switch_point
Treatment_will	1.818	1.807	2.870**
	-1.208	-1.217	-0.940
Time interval		0.215*	0.209*
		-0.104	-0.107
Delayed		0.359	0.358
		-0.465	-0.470
Female			-1.797*
			-0.896
Econ_major			-3.026***
			-0.894
Constant	3.411***	2.437**	4.012***
	-0.849	-0.890	-0.887
Observations	104	104	104
R-squared	0.100	0.144	0.393

Table 1: Regressions

Table 1 presents the regression result from considering different conditions under the treatments. We utilize the interval regression since we can only observe the interval of interest rates from subjects' selections. In column (1), we examine the treatment effect of using future-tense word "will", investigating this effect is strong or not. Moreover, in column (2), we consider different factors under the treatments. *Time Interval* presents the duration of delay in weeks. *Immediate Time Frame* indicates the immediate and delay frame appearing in the both groups. Column (3) further consider the personal characteristics such as individual's gender and major, seeking for the better control over the different factors.

The results show that the treatment effect is only significant in the third model, which considering the individual characteristics and the manipulations. The significant positive effect provides evidence that the treatment successfully increases the switch points chosen by the subjects, which means make them to be more impatient. It lends support to the initial supposition that the future- tense word enhance the distance between present and future.

For eye-tracking data, we apply heat map to visualize our findings. Heat map analysis is constructed and colored by the aggregation of fixations. Red represents the most favorite parts that subjects pay the most attention, yellow refers the parts with average attention, green stands for the parts get less attention, and white means the parts with no fixation or too little to show. Here, for brief, we just provide Figure 4 as a representative example and keep others in the appendix.

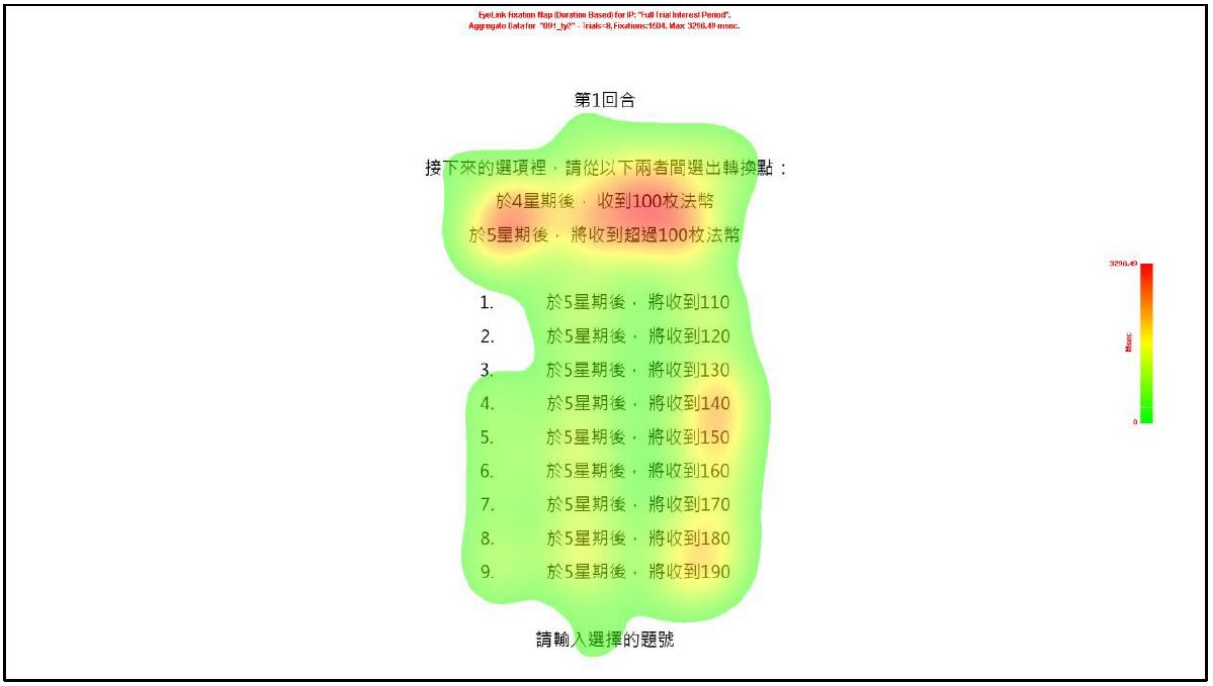

Figure 4: heat map analysis for eyetracking data (‘將’ is the word ‘will’)

Similar with Figure 4, we could conclude subjects’ visual patterns for 4 features. First, consistent with the previous literature and our prediction, almost every subject values the weeks delayed and the payment will be received. Interestingly, though the numbers of payment are fixed to 100 in the questions, subjects tend to check it again and again. Second, compared to the week, payments’ amounts get at least as much or even more attention and are usually valued more. That is, money (incentive) matters. Third, comparing between the heading questions above and the choices list below, questions get a higher valuation most of the time, since it is first-showing and full of necessary information while the list of choices are relatively predictable. Here comes our contribution. Chen, He et al. (2019) did not put the future tense ‘will’ in the heading, where the subjects valued the most, generating concerns in weak treatment. Lastly, for the other facts we have in the choices list, we find subjects only pay their attention on the choices they would like to pick. Take figure 4 for example, the subject are considering 140 vs 150 and 180 vs 190 in different trial. These findings are useful to piece up the thinking process under decision-making and improve the experimental design in similar settings.

Variable	mean	Sd	Range
IA_DWELL_TIME	3263.333 (ms)	1200.505	[1436, 5238]
IA_DWELL_TIME_%	6.847 (%)	3.397	[2.59,13.37]
IA_FIXATION_COUNTS	12 (#)	3.301	[7, 17]
IA_FIXATION_COUNTS_%	8.142 (%)	3.212	[4.55, 14.33]

Table 2: Summary statistic of fixation on the word 'will'

We also investigate the parameters captured by the eye-tracker to further interpret subjects' characteristics. Table 2 shows the summary statistic of these features. *IA_DWELL_TIME* (in milliseconds) presents the total duration of fixations on the word 'will' in 8 trials , and *IA_DWELL_TIME_%* implies the percentage of time taken to fixations on the word 'will' in 8 trials to the time taken to all fixations in the 8 trials. *IA_FIXATION_COUNTS* illustrates how many fixations on the word 'will' in all trials, and *IA_FIXATION_COUNTS_%* presents the percentage of the numbers of fixations on the word 'will' in all trials to the numbers of total fixations in the all trials.

From Table 2, we get the concrete visual exposure of the future-tense words: averagely for a person, 3263 ms (6.847%) in the measurement of duration and 12 times (8.142%) in the measurement of counts. In Chen, He et al. (2019), they claimed the exposure of the future tense appears 72 times in the whole treatment. However, even though we expand this number to 80 by adding the word 'will' in the heading questions (the most favorable part in the experiment) in 8 trial, we are not confident enough to say the future tense are seen by subjects that much.

Necessary to remark, fixation could be a useful index to stand for attention, but insufficient fixation is not equal to insufficient attention. Saccades (the scan-path) should also be considered as a whole, since subjects might look through the word but don't stay for a long time. Moreover, the effect of language could be acquired by either a reading process or a listening process as language itself. With the earphones we used, subjects are able to hear the word 'will' clearly just after the comma, reducing the flaw of the visual issues.

To conclude, we still provide a strong manipulation to make the subjects perceive the future tense. In our experiment, the exposure is further strengthen due to the manipulation, leading subjects to receive more future-tense words in the whole process.

Conclusion and Discussion

In this paper, we design a replication and extension from Chen, He et al. (2019). Replication is due to the issues of accountability for a research in science, which is gradually being valued in economics. Extension is for the purpose of expanding the questions we ask. We try to achieve both goals in the same time, and we did it. After redesigning the experimental manipulation, we find that there is a negative relation between future-time reference (FTR) and future-oriented actions, which is consistent with LSH hypothesis and different from Chen, He et al. (2019). Furthermore, after introducing eye-tracking, we retained the visual pattern of a subject and thus figure out the actual input in visual process.

However, we do not finish some of the issues yet. For the replication, the sample size we have is only 13, which is one - seventh of the numbers in the original setting in Taiwan. With this tiny simple size, despite we find the present result is significant, it relies on the keep-going process to determine the validity of our findings. For the extension, despite we strengthen the visual manipulation, the concrete fixations are still relatively small. Future studies could develop other index to see how much treatment is actually implemented (e.g. self-representation survey) and thus provide a stronger examination on the causal link between future tense and time preference.

Lastly, we find that the technology of eye-tracking is not only able to discover the parameter subjects care more, but also to revise the experimental design. This two-way use should be considered harder in the future studies, especially in the field of language experiment.

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Appendix I: Instructions

實驗說明

感謝您的參與。本場實驗包括主實驗項目以及實驗後問卷，總共所需時間約為 30 分鐘。除了保證的 100 元出席費之外，根據您所做的決定以及運氣，您的實驗報酬還包括了您在實驗中所賺取的報酬。

如果您在過程中有任何問題，請詢問實驗者。

在本實驗中，您的報酬將會以法幣計算。您兌換報酬的根據將由以下匯率來計算：

10 枚法幣＝新台幣 16.7 元

為確保無記名原則，您在實驗過程中的抉擇將只會連結至您的參與者代碼。雖然在實驗完成後，因會計作業需求我們會需要您提供姓名，但後續研究者無法連結您的姓名與參與者代碼，也就是說您在實驗中的抉擇仍是保密的。

Appendix II: Exit survey

實驗後問卷

1. 你的性别是？(Are you)

女 (Female)

男 (Male)

2. 你是否為台灣本地生 (Are you a native Taiwanese?)

是 (yes)

否 (no)

3. 你是否是經濟系或管理學院的學生？(Are you an Econmics or Management major?)

是 (yes)

否 (no)

4. 您的年級是？ (are you in year?)

大學一年級 (1)

大學二年級 (2)

大學三年級 (3)

大學四年級 (4)

大學五年級以上 (5 and above)

5. 請問您能流利地使用哪些語言 (Which language would best express yourself (are you most comfortable in using?)

中文 (Mandarin)

英文 (English)

台語 (Hokkien)

客家語 (Hakka)

其他 (other language)

6. 請您猜測一下本次實驗的目的：(Please guess the purpose of this experiment)

7. 對於實驗過程您是否有任何建議想給實驗者參考？(Any advice)