

Relative monetary saving as a modulator of the temporal framing effect

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Abstract. This study challenges the conventional approach to intertemporal decision making, namely the notion of the singular time line along which one models value discounting. The study examines the assumption about the mind's ability to generate a few mental representations of time flow and so the thesis about complex nature of time dimension. It presents two experiments on the impact of the relative amount of monetary saving proposition on the manifestation of the temporal framing effect. The aim was to examine the impact of different types of time representation on the attractiveness of monetary saving proposition and so to specify the properties of the different cognitive representations of time flow. The between-subjects design was applied in both studies. The decision making tasks were randomly assigned in each experimental condition for assessing the impact of temporal frames and time distances on decision-making. The *first* experiment examines the attractiveness of monetary saving formulated in a situational vs. a propositional time flow in both, past and future time mode. The results describe the discrepancies in manifestation of the framing effect similar to the classical "Jacket and Calculator" problem but depending on the applied representation of time flow and within the past and future time mode. The *second* experiment examines both of those representations of time flow only in the future time mode, but with longer time distances. Whereas the propositional time flow causes a strong loss of proposition acceptance, the attractiveness of the monetary saving in the situational time flow slowly discounts. The discrepancy between the properties of the situational and the propositional time flow determines the differences in decision outcomes and in manifestation of the temporal framing effect. The higher the relative saving in the past time mode, the stronger the time framing effect. The opposite was found for the future time mode. Here, an increasing relative saving results in a decreasing effect of temporal framing. In general, the results confirm an essential discrepancy between two mental representations of time flow, thus they support the thesis about the complex nature of time dimension.

Keywords: time, time representation, decision making, framing, temporal framing effect, monetary saving

Відносна величина грошового заощадження як модулятор темпорального фреймінг-ефекту.

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Анотація. Це дослідження ставить під сумнів традиційний підхід до моделювання прийняття інтертемпоральних рішень, а саме пропонується відійти від сингулярної часової лінії, вздовж якої

завичай моделюється дисконтування цінності. У дослідженні розглядається припущення про здатність розуму генерувати кілька ментальних репрезентацій плину часу, а отже, теза про складну природу часового виміру досвіду особи. Представлено два експерименти щодо впливу відносної величини грошового заощадження на маніфестацію ефекту часового фреймінгу. В них вивчається вплив різних типів когнітивної репрезентації часу на привабливість пропозиції щодо грошового заощадження. Таким чином специфікуються властивості різних когнітивних репрезентацій часу. В обох дослідженнях як основний було застосовано метод міжгрупового порівняння. Завдання для випробуваних стосувались прийняття рішення й були випадковим чином розподілені між експериментальними умовами та випробуваними. Вони спрямовувались на оцінювання впливу репрезентації плину часу та впливу часової відстані на прийняття рішення щодо грошового заощадження. Перший експеримент розкриває привабливість пропозиції грошового заощадження, сформульованої в ситуаційному та пропозиційному плинні часу в двох модусах - в минулому та майбутньому часі. Результати описують розбіжності у прояві фреймінг-ефекту, подібного до класичної задачі «Піджак та калькулятор», але залежно від застосованої репрезентації плину часу та в означених модусах часу. Другий експеримент досліджує обидві репрезентації плину часу лише в модусі майбутнього, але з довшими часовими відстанями. Тоді як пропозиційна репрезентція плину часу спричиняє сильну втрату привабливості пропозиції, привабливість грошового заощадження при ситуаційній репрезентації плину часу зменшується істотно повільніше. Розбіжність між властивостями ситуаційної та пропозиційної репрезентацій часу детермінує відмінності в прийнятих рішеннях та у особливостях маніфестації часового фреймінг-ефекту. Чим вище відносно заощадження запропоноване в минулому часі, тим сильніший ефект часового фреймінгу. Протилежне було виявлено для майбутнього часу. Тут зростання відносного заощадження призводить до зменшення ефекту часового фреймінгу. Загалом, результати підтверджують суттєву розбіжність між двома когнітивними репрезентаціями плину часу та підтримують тезу про складну природу часового виміру досвіду особи.

Ключові слова: час, репрезентація часу, прийняття рішення, часовий фреймінг, грошове заощадження

INTRODUCTION

Human existence extends across such domains as space and time. Different aspects of being in time are extensively modeled in various sciences, including economics, psychology, biology, sociology and physics. Time provides a dimension along which events, processes, and transformations of different objects can be described. In psychology and behavioral economics, considerable attention is devoted to modeling of intertemporal judgment and decision-making processes. These processes are of not only theoretical importance but also of great practical relevance, for instance for modeling of goods exchange and investments.

Intertemporal judgment and decision making require the ability to broaden one's time horizon and move beyond the present moment. Conventionally, this is achieved through reliance on the notion of a timeline. At the same time, intertemporal economic behavior exhibits various deviations and inconsistencies. Such variations are often described as anomalies in decision making. In contrast to the mainstream approach we proposed the psychological concept of multiple cognitive representations of time flow (Polunin, 2015, 2021, 2025). We assume that the human mind is capable of producing multiple mental representations of the flow of time and that, depending on contextual conditions, individuals apply different representations in intertemporal decision making. As result many anomalies in intertemporal decision making may arise because individuals evaluate delays differently depending on how time is cognitively represented, rather than because they possess unstable or inconsistent discount functions.

For manipulation of decision making one effectively applies task framing which consists in variation of verbal task formulation but without changing the essence of the task. In 1981, Tversky and Kahneman suggested that alternative wordings of the same decision problem could have different effects on individuals' preferences (*framing effect*). One example of such a framing effect was illustrated by their *Jacket and Calculator* problem and later complemented by a number of other framing effects (e.g., Kühbinger, 1998; Levin et al., 1998).

For the purpose of this study, we will focus on the *Jacket and Calculator* problem (Tversky & Kahneman, 1981) which demonstrates the existence of topical mental accounting. The topicality of the accounting is essential in our case, because we investigate how a representation of a certain object (an amount of money) varies over time. Further, the extent of such a framing effect depends on the level of relative saving (Moon et al., 1999). The decision outcomes in the *Jacket and Calculator* problem point to a high preference of a relative high saving proposition. Despite the equality of the absolute level of saving proposition, the low level relative savings are less preferred. Discrepancies in preferences between high and low relative savings not only define the size of the framing effect, but also have practical implications for modelling consumer behaviour (e.g., Darke et al., 1995; Heath et al., 1995; Svenson, 2008). In this study, this will be used as a measure specifying the differences between certain representations of time flow – the situational and the propositional time flow (Polunin, 2015).

Literature Review

As it was already stated the most of the recent but also earlier fundamental studies in the field of intertemporal decision making are base upon the notion of singular time line. Dai et al. (2025) analyse five competing discounting models applied to intertemporal decision-making. All of these five models are based on the notion of singular time line. Similarly, Sun, C., & Potters, J. (2022) examining the effect of magnitude in intertemporal allocation tasks evidently apply the notion of singular linear time flow. In the study by Kulati, Myck & Pasini (2023) the singular time line was taken as foundation for the study on heterogeneity in time preferences among older adults.

So, in general the decision-making problem is usually formulated in a time dimension, so that the time-markers point to certain temporal conditions of the problem. Loewenstein (1988) described three types of the temporal framing effect that are based on the different manipulations with temporal description of a proposition. This list of temporal framing effects does however not include a novel temporal framing effect, which is based on the discrepancy of the situational and propositional time flows (Polunin, 2015). In this temporal framing effect, a subject makes different decisions on mathematically equal saving propositions that are given at the exact same time point as well as on the exact same time distance, and the propositions are processed in the same time order. By means of this temporal framing effect we could show that the human mind develops more than one cognitive representation of time flow at the same time interval, namely the situational and the propositional time flow. Thus, one and the same proposition, given in the situational vs. the propositional time flow, is evaluated differently over the same time distance, even if the evaluation is made from the same reference point, e.g., the present time moment.

The propositional time flow refers to a case where the time flow is considered for an object only (a proposition). In the propositional time flow the task is formulated in such a way that only the object changes its position in the time dimension. On the other hand, the situational time flow describes the general replacement of a situation as a whole in the time dimension. Mathematically, there is no difference between these two kinds of time flows as long as the time distance between the two moments is the same. Naturally, the direction of transition in the time dimension must also be kept the same. However, due to the special task wording, these two representations of time flow may be activated separately, resulting in different attractiveness of the exact same proposition, e.g. the proposition to save money. In the current study we vary the relative amount of a monetary saving proposition to examine the situational and propositional time flows in terms of their impact on the proposition acceptance.

One may formulate the *Jacket and Calculator* problem (Tversky & Kahneman, 1981) for a sell-out which has begun in the past, is beginning now, or will begin in the future (Polunin, 2009, 2011). Usually, this problem is formulated in the propositional time flow. It can however also be formulated in the situational time flow. This may cause the corresponding variations in the mental accounting and may further lead to the specific manifestation of the framing effect. The topical mental account under the past time mode must be defined mainly by an aging process of a possible monetary saving. A future monetary saving opportunity announced at the present time moment is mostly under the

impact of simple waiting as a temporal process¹. Therefore, a substantial difference in the influence of time mode (past vs. future) is to expect, which was already suggested by prior research (e.g., Polunin, 2009; Weber et al. 2007), however, restricted to the propositional time flow only. The *question* is whether the aging and waiting as temporal processes have the same impact on the proposition value, which is given in the situational vs. the propositional time flow. In other words, do the situational and propositional time flows show the same impact on the proposition acceptance when it is given in the past and future time mode? Since the framing effect in the *Jacket and Calculator* problem is sensitive to the relative amount of monetary saving, the second *question* is whether the situational and propositional time flows show a different sensitivity to the level of relative monetary saving. The *general hypothesis* can be formulated as follows: the temporal distortions of a proposition translate into distortions of a decision outcome. Moreover, the cognitive representations of situational and propositional time flows may differently contribute to the temporal distortions of proposition, despite the equality of its other parameters.

Before describing the single assumptions, one must stress that conventionally, processes are modelled in the singular propositional time flow. In general, analytical world modelling, does not incorporate more than one time flow with different features (e.g., the physical description of an object over time). Therefore, it is not unchallenging to make assumptions embedded into the situational time flow. Studies on intertemporal decision-making (e.g., Frederick et al., 2002; Loewenstein & Elster, 1992) describe how the proposition attractiveness changes over time when it is processed within the propositional time flow. However, the variation of proposition attractiveness has not been studied within the situational time flow. Thus, the current study may be considered exploratory up to a certain point. The high relative saving may be the highly attractive option in both the situational and the propositional time flow. Based on the essence of the situational and propositional time flow representations (Polunin, 2015) we can assume that the higher the relative saving, the lower the discrepancy between the situational and propositional time flows should be. Consequently, the temporal framing effect for a high relative saving should be weaker than that for a low one. For a very high level of a relative saving, the effect may even disappear. In sum, we expect that a high relative level of monetary saving will weaken the difference between the situational and propositional time flow, leading to the corresponding weakening of the temporal framing effect.

The specification of features of situational and propositional time flow in regard to the level of relative saving can be made by examining the manifestation of the classical framing effect demonstrated by Tversky and Kahneman (1981). Given in the propositional time flow, the classical framing effect remains in the *future* time mode (Polunin, 2009). This is also what we expect in the current study. For the situational time flow however, this expectation is rather doubtful. From an earlier study we know that the acceptance of a proposition with a low relative saving remains the same, or even slightly increases in the situational future. How a subject reacts to the proposition with the high relative saving is challenging to predict, but it might remain high. However, when the preference for a high relative saving in the situational future declines, then one should expect a corresponding decrease of the classical framing effect.

According to the earlier study (Polunin, 2009) one may expect the effect of the *past openness* for the propositional time flow. The past openness as a special kind of time flow representation describes a higher preference for the monetary saving proposition that has began in the past compared to that for the same proposition beginning at the same distance in the future. Despite the lower probability to appreciate the past proposition, the subjects prefers it over the future one. Usually this effect can be found for a low relative saving, but not for a high relative saving. If and how this effect is manifested in the situational timeflow is not yet known. A certain conceptual similarity between the situational time flow and the present time mode suggests that the past openness can also be expected for the the situational time flow.

¹ We have shown that in the future time mode, other temporal processes are possible as well, for instance ageing. Here, however, only the simple waiting or the zero probability barrier (Polunin, 2011) will be studied.

For a specification of the discrepancy between the situational and the propositional time flow representations, the time distance also has to be taken into account. Because of the high discounting in the propositional time flow and the low discounting in the situational time flow (Polunin, 2015), the growing time distance may contribute to the more pronounced manifestation of all effects that are based on these two kinds of time representation. To examine the hypotheses, we conducted two experiments. Their goal is to investigate whether the situational and the propositional time flow show the same features when one varies (a) the amount of relative saving, (b) the time mode and (c) the time distance.

EXPERIMENT 1

Methods and materials

Design

The experiment was carried out at the National Technical University of Kyiv, Ukraine. The level of monthly student’s income at this university is quite homogeneous in comparison with other universities in Kyiv, which may be important for the experiment outcome. Subjects were randomly assigned to each version of the task. Besides their task decisions, people were asked to indicate their age and sex. The experimental task was adapted from the “*Jacket and Calculator*” problem described by Tversky and Kahneman (1981). Instead of a jacket and a calculator, a microphone and a headphone were chosen, since it is likely that both would be available at the same store. The amount of money to be saved was 35 UAH and it was applied to all experimental conditions. At the time of data collection the exchange rate was about 1 USD=8.06-8.16 UAH and 1 EUR=10.28-10.45 UAH. Thus, 35 UAH were equal to ca. 4.3 USD or 3.37 EUR. In one wording, the monetary saving was 33.3% of the initial headphone price, in the other case it was 5.26%. In total, there were ten versions of the same basic scenario incorporated in the research design: time mode (past vs. now vs. future), two temporal distances (0 days, which means “now” vs.5 days), two versions of time flow (situational vs. propositional), and two versions of task wording (high vs. low relative savings). The experimental conditions are shown in *Table 1*. A between-subjects design was applied, which is the traditional approach for studying framing effects (Kühbinger, 1998; Levin et al., 1998; Tversky & Kahneman, 1981).

----- **Table 1 approximately here** -----

Table 1. The experimental conditions of the first experiment.

Relative price reduction	Now	Future		Past	
		Propositional future	Situational future	Propositional past	Situational past
33.3%	105-35=70 UAH	105-35=70 UAH	105-35=70 UAH	105-35=70 UAH	105-35=70 UAH
5.26%	665-35=630 UAH	665-35=630 UAH	665-35=630 UAH	665-35=630 UAH	665-35=630 UAH

Source: developed by the author

Materials

Written versions of the task were prepared in Ukrainian. A similar wording was used in each case except for the time flow representation variable and the relative amount of monetary saving. For the *propositional* time flow the tasks were formulated similarly to the tasks used in our early study (Polunin, 2009). For the *situational* time flow in the future time mode the tasks were given as illustrated below. For the past time mode the task wording was similar and only the time mode was changed.

Future time mode.

Imagine the following situation and decide how you will act.

Please, imagine that in 5 days you will go to the electronics supermarket to purchase a headphone for 105 UAH and a microphone for 665 UAH.

A shop assistant informs you that the headphone you wish to buy is on sale at the other branch of the store, a 20-minutes drive away, for 70 UAH.

Would you make the trip to the other store? (tick one box)

YES NO

Participants

For this experiment, 690 students (69 for each experimental condition; 78% male, 22% female; age 17-22; average age 18.9 years) were recruited. Participation was voluntary and unpaid. The number per session ranged from 16 to 30 subjects. Each participant was randomly assigned to one of the experimental conditions.

Results

In all problem wordings the subjects were given the possibility to save the same absolute amount of money, while the relative amount of saving, time mode, and time flow representation were varied. This leads to a variation of the proposition acceptance. The decision outcomes for each single experimental condition are displayed in the *Table 2*. In the present time mode, a classical framing effect similar to the one reported by Tversky and Kahneman (1981) for the *Jacket and calculator* problem was found ($\Delta=24.7\%$, $\chi^2=8.44$, $df=1$, $p=.004$). In the other experimental conditions however, its manifestation was essentially modulated by the impact of time mode, and by the cognitive representation of time flow.

Within the propositional time flow in the past time mode, an elimination of the classical framing effect was found ($\Delta=5.8\%$, $\chi^2=0.46$, $df=1$, $p=.49$), in line with results from previous studies (Polunin, 2009, 2013). This elimination is due to the strong aging of a proposition with high relative saving and the slow aging of a proposition with low relative saving. Consequently, because of the discrepancy in the aging rate, both propositions become equally accepted at a certain distance in the past time mode. For the propositional time flow in the future time mode, despite the general decline of proposition attractiveness, there was a remaining framing effect ($\Delta=21.8\%$, $\chi^2=6.61$, $df=1$, $p=.01$) which is again in line with previous findings (Polunin, 2009, 2013). The latter finding points to an essential discrepancy in time flow representation for the past and future time mode. In the past time mode, an aging of proposition was dominant, while in the future time mode the impact of simple waiting is decisive. So, both, aging and simple waiting, lead to decline of proposition attractiveness, but they essentially differ how this decline is manifested.

The earlier described quite minor phenomenon of past openness also appears in the results. Past openness was shown by comparing the “yes” responses to the wording with a 5.26% reduction under the past (44.9%), present (42%), and future (33.3%) time conditions. Due to the past openness, the amount of “yes” responses under the past time condition was higher than that under the future time condition, however not significantly ($\Delta=11.6\%$, $\chi^2=1.9$, $df=1$, $p=.16$). Despite the past openness appearing in the results, the effect is small. The past openness for the propositions was found only with the low relative saving, because of their slow aging. Hence, as suggested earlier (Polunin, 2009), two temporal processes predefine the topical account in the past time mode: an aging of the saving proposition and a past openness. They differ in the sense that an aging of a sale proposition shows in declining proposition-attractiveness with a growing time distance. Past openness, on the other hand,

describes a mental extension of an event, such as the beginning of a sell-out up to the present time moment, and so it keeps its actuality for decision-making in the present.

----- **Table 2 approximately here** -----

Table 2. The percentage of positive responses on the saving proposition in each experimental condition. The *classical framing effect* is given as the difference between the ‘yes’ responses for the 33.3% and 5.26% saving propositions (bottom row). The *temporal framing effect* is given as the difference of the ‘yes’ responses between the situational and propositional task wordings, see two columns: $\Delta(\text{Sit.Future-Prop.Future})$ and $\Delta(\text{Sit.Past-Prop.Past})$.

Relative price reduction	Now	Future			Past		
		Proposit. Future 5 days	Situat. Future 5 days	$\Delta(\text{Sit.Future-Prop.Future})$	Proposit. Past 5 days	Situat. Past 5 days	$\Delta(\text{Sit.Past-Prop.Past})$
33.3%	66.7%	55.1%	56.5%	$\Delta=1.4\%$ $\chi^2=0.03$ df=1 p=.86	50.7%	69.6%	$\Delta=18.9\%$ $\chi^2=5.1$ df=1 p=.024
5.26%	42%	33.3%	56.5%	$\Delta=23.2\%$ $\chi^2=7.5$ df=1 p=.006	44.9%	49.3%	$\Delta=4.4\%$ $\chi^2=0.26$ df=1 p=.6
Difference of ‘yes’ “33.3% - 5.26%”	$\Delta=24.7\%$ $\chi^2=8.44$ df=1 p=.004	$\Delta=21.8\%$ $\chi^2=6.61$ df=1 p=.01	$\Delta=0\%$ $\chi^2=0$ df=1 p=1	-	$\Delta=5.8\%$ $\chi^2=0.46$ df=1 p=.49	$\Delta=20.3\%$ $\chi^2=5.9$ df=1 p=.015	-

Source: developed by the author

For the situational time flow the findings were rather different (*Table 2*). In the past time mode the classical framing effect known from the *Jacket and Calculator problem* (Tversky, Kahneman 1981) was not eliminated, but remained ($\Delta=20.3\%$, $\chi^2=5.9$, df=1, p=.015). The percentage of positive responses even rose slightly compared to the present time mode. Hence, for the situational time flow, there is no indicator to argue for an essential aging process as a cause for declining proposition attractiveness. On the contrary, in the future time mode the classical framing effect did not remain, but disappeared ($\Delta=0\%$, $\chi^2=0$). These discrepancies in manifestation of the classical framing effect point to an essential difference between the propositional and the situational time flow in past and future time mode. The findings further suggest an essential difference between features of past and future at the level of cognitive representation.

The earlier described temporal framing effect (Polunin, 2015) was reproduced as well. In the future time mode the effect was significant for the *low* level relative saving ($\Delta=23.2\%$, $\chi^2=7.5$, $df=1$, $p=.006$), but not for the *high* level relative saving ($\Delta=1.4\%$, $\chi^2=0.03$, $df=1$, $p=.86$). Thus, the propositions made in the future time mode point to a decline of the temporal framing effect up to its total disappearance, which is accompanied by the raise of the relative amount of monetary saving. In the past time mode the picture was exactly the opposite. The temporal framing effect reached significance for the *high* level relative saving ($\Delta=18.9\%$, $\chi^2=5.1$, $df=1$, $p=.024$), but not for the *low* level relative saving ($\Delta=4.4\%$, $\chi^2=0.26$, $df=1$, $p=.6$). Initially, it was assumed, that the temporal framing effect for a high relative saving should be weaker than that for a low one. The results show that this assumption is true only for the future time mode. Thus, the dependence of the temporal framing effect from the relative monetary saving seems to be modulated by the time mode.

The findings suggest that the classical framing effect described by Tversky and Kahneman (1981) and the temporal framing effect appear independently. These two kinds of framing are based on different assumptions; the first one on the topical accounting of proposition and its sensitivity to the relative level of saving, and the second one on the difference between the representations of the situational time flow and the propositional time flow.

The other phenomenon, past openness, defined as a preference for the past proposition over the equally distant and equally large but future proposition (Polunin, 2009), also manifested quite differently in the situational compared to the propositional time flow. Here, the absence of past openness for the situational time flow is assumed. The results do not indicate any sign of past openness for the *low* relative saving proposition given in the situational time flow, on the contrary, a rather opposite picture regarding the past openness emerges ($\Delta=-7.2\%$, $\chi^2<1$). There seems to be a tendency of past openness manifestation for the high relative saving ($\Delta=13.1\%$, $\chi^2=2.5$, $df=1$, $p=.11$), however, at the current stage, a strong appearance of the past openness along the situational time flow is missing.

Comparing the impact of the two representations of time flow on a proposition attractiveness indicates that a propositional time flow may cause a stronger loss of attractiveness of a saving proposition than a situational time flow does. For the latter, the impact of relative saving is the opposite in the past and in the future time mode.

EXPERIMENT 2

Since the value showed quite strong discounting in the propositional time flow, but a small decline in the situational time flow, one could assume that this discrepancy may be better manifested at longer time distances. In studies from both 1987 and 1992, Freyd demonstrated that each stimuli has its own temporal dimension. Thus, in the second experiment we applied a long time distance for one commodity (headphone) in the problem wording. The problem wording with only one commodity is intended to control whether the second commodity impacts the variation in time of the goal commodity.

Design

The data were collected at the National Technical University of Kyiv. All participants were presented with the same problem situation in which they can save money purchasing a headphone. The absolute amount of monetary saving was always constant (40 UAH). At the time of the data collection, the exchange rate was: 1EUR=18.10UAH (sell), 1EUR=19.20UAH (buy); 1USD=13.40UAH (sell), 1USD=13.50UAH (buy). The relative amount of saving was once set to 33.3%, and the other time to 5.5%. The temporal distance between the present time moment and the saving possibility had two stages: 6 and 12 days. In total there were ten versions of the same basic scenario with the following variables: time mode (now vs. future), time stages (0 days vs. 6 days vs. 12 days), and two levels of the relative saving (high (33.3%) vs. low (5.5%)). All variables were applied once in the propositional, and the other time in the situational time flow (table 3).

----- Table 3 approximately here -----

Table 3. The design of the second experiment.

Relative monetary saving	Now, 0 days distance	Future 6 days distance		Future 12 days distance	
		Situational	Propositional	Situational	Propositional
		High saving, 33%	120-40=80 UAH	120-40=80 UAH	120-40=80 UAH
Low saving, 5.5%	720-40=680 UAH	720-40=680 UAH	720-40=680 UAH	720-40=680 UAH	720-40=680 UAH

Source: developed by the author

Materials

The tasks were simplified and only one commodity was used in the problem wording. The wording of the task was similar to a previous study (Polunin, 2015). Below are the examples of the problem wording given in the situational and propositional time flows in future time mode.

Task for activation of the situational time flow representation.

Imagine the following situation and decide how you will act.

Please, imagine that in 6 days you will go to the electronics supermarket to purchase a headphone for 120 UAH. When you choose a headphone and go to the checkout, a shop assistant will inform you that the headphone you wish to buy is on sale at another branch of the store, a 20-minutes drive away, for 80 UAH.

Would you make the trip to the other store? (tick one box)

YES NO

Task for activation of the propositional time flow.

Imagine the following situation and decide how you will act.

Please, imagine that you went to the shop to purchase a headphone for 120 UAH. When you choose the headphone and goto the checkout, a shop assistant informs you, that the headphone you wish to buy will be on sale in 6 days at another branch of the store, a 20-minutes drives away, for 80 UAH.

Would you make the trip to the other store? (tick one box)

YES NO

Participants

Seven hundred and twenty students (72 for each experimental condition; 80.5% male, 19.5% female; age 17-27; average age 19.06 years) participated in the experiment. Participation was voluntary and unpaid. The number per session ranged from 14 to 36 subjects. Each participant was randomly assigned to one of the experimental conditions.

Results

The percentage of positive responses to the monetary saving proposition across all conditions is displayed in the *Table 4*. The framing effect similar to the one described by Tversky and Kahneman (1981) is given in the bottom row. The *temporal framing* effect is given in the columns marked with 'Δ(Sit.-Propos)'. The effect of the relative saving in the present time mode was significant, $\Delta=13.9\%$, $\chi^2=4.7$, $df=1$, $p=0.03$. Thus, despite the change of the task wording (i.e., eliminating the second commodity in the problem) we got an effect similar to the *classical* framing

effect described by Tversky and Kahneman (1981) when they applied the *Jacket and Calculator problem*. For the propositional time flow, the classical framing effect remains in both cases of the delated saving proposition; for the 6 days distance it equals to $\Delta=20.8\%$ ($\chi^2=6.25$, $df=1$, $p=.012$) and for the 12 days distance it equals to $\Delta=16.7\%$ ($\chi^2=4.01$, $df=1$, $p=.045$). For the situational time flow however, the classical framing effect was eliminated again: for the 6 days distance it was equal to $\Delta=4.2\%$ ($\chi^2<1$) and for the 12 days distance it was equal to $\Delta=3.2\%$ ($\chi^2<1$). Hence, the second experiment further supports the finding that the *classical* framing effect is eliminated for the monetary saving proposition formulated in the future time mode of the *situational* time flow. One may argue for the essential discrepancy in modulation of the classical framing effect by the kind of cognitive representation of time flow. This stresses the inequality between the representations of the situational and propositional time flows. Over all future time conditions the situational time flow causes smaller losses of the proposition acceptance than it does the propositional time flow.

In the first and the second experiments the discrepancy in manifestation of the classical framing effect in the present time mode and in the situational future should be noted. The present time mode enables the classical framing effect, while the situational future eliminates it. This finding highlights the difference between the present time mode and the situational future, even if the latter seems to be similar to the former in some conceptual aspects.

----- **Table 4 approximately here** -----

Table 4. The percentage of positive responses to a monetary saving proposition. The total number of participants was 720, with 72 subjects for each condition.

Relative saving	Now, 0 days distance	Future 6 days distance			Future 12 days distance		
		Situat.	Propos.	Δ (Sit.- Propos.)	Situat.	Propos.	Δ (Sit.- Propos.)
		High saving, 33%	88.9 %	80.6%	59.7%	$\Delta=20.9\%$ $\chi^2=7.46$ $df=1$ $p=.006$	77.8%
Low saving, 5.5%	75%	76.4%	38.9%	$\Delta=37.5\%$ $\chi^2=20.7$ $df=1$ $p<.001$	74.6%	44.4%	$\Delta=30.2\%$ $\chi^2=13.53$ $df=1$ $p<.001$
Difference between 33% and 5.5% savings	$\Delta=13.9\%$ $\chi^2=4.7$ $df=1$ $p=.03$	$\Delta=4.2\%$ $\chi^2=.37$ $df=1$ $p=.54$	$\Delta=20.8$ % $\chi^2=6.25$ $df=1$	-	$\Delta=3.2\%$ $\chi^2=.19$ $df=1$ $p=.66$	$\Delta=16.7\%$ $\chi^2=4.01$ $df=1$ $p=0.045$	-

		p=.012	
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Source: developed by the author

Across all conditions in the future time mode, the percentage of positive responses for the proposition made in the situational time flow was higher than that made in the propositional time flow. In all four cases and for both levels of the relative monetary saving, a significant temporal framing effect was found (*Table 4*, columns with the title ‘ $\Delta(\text{Sit.-Propos.})$ ’). The size of the temporal framing effect was modulated by the level of relative monetary saving. While in the first experiment the high relative saving lead to an elimination of the temporal framing effect, here it resulted in a smaller size of the temporal framing effect: for 6 days this was $20.9\% < 37.5\%$, and for 12 days this was $16.7\% < 30.2\%$. Thus, for the low relative savings, the temporal framing effect is bigger. Summarizing both experiments it can be suggested that the *temporal* framing effect in the future time mode is the higher, the lower is the relative monetary saving is.

The impact of the time distance can be shown through the change of proposition attractiveness over time, compared to the present time mode. We assumed that the situational time flow should be less sensitive to the time distance, and proposition discounting should essentially be weaker than when the propositional time flow is activated. The results support this assumption; all propositions given in the situational time flow showed a smaller decrease of the proposition-acceptance compared to the initial acceptance in the present time mode. Interpreting the results it should be noted that the range of distances might be somewhat unsuccessful in that both distances are quite long (6 and 12 days) so that the subjects practically showed the same readiness to wait for the future saving. Overall, however, the results suggest that the situational time flow has the lower sensitivity to the growing time distance. On the other hand, the monetary saving proposition made in the propositional time strongly loses its attractiveness along the growing time distance (*Table 4*).

DISCUSSION

The results argue for a different sensitivity of the situational and propositional time flow to the relative level of monetary saving proposition. Consequently, the manifestation of the temporal framing effect varies. The classical framing effect, similar to the one demonstrated by Tversky and Kahneman (1981) in the *Jacket and Calculator problem*, also varies depending on whether the decision problem is given within the situational vs. the propositional time flow. Both types of framing effect, the classical and the temporal, run quite independently of each other, because they are different in nature – the first is based on the topical mental accounting, and the second on the discrepancy between the situational and the propositional representation of time flow.

We can thus speak of an essential difference between the situational and propositional time flows. The situational time flow may be thought of as a kind of quasi-present time. Such a time flow “moves” the entire situation along the conventional time line, but the movement takes the form of a mental “jump”. One jumps from one situation to the next one without paying much attention to what lies in between. This may explain the weak discounting of a proposition within the situational time flow. A generally strong discounting, as known from the DU-model (Frederick et al., 2002), is to be expected for the propositional time flow. Within the propositional time flow every additional time unit contributes to loss of proposition value.

The situational and propositional time flows also show different properties in relation to the past and future time mode. The *situational* past is processed almost like the present time mode, with a very similar size of the classical framing effect. The *propositional* past can be described by an essential discounting of the high relative level of saving proposition, and with the consequent elimination of the classical framing effect. The described discrepancy in manifestation of the framing effect is a strong argument for discrepancy between the situational and propositional time flow in the past time mode.

When explaining the situational time flow as quasi-present, one has to consider the discrepancy between the situational time flow outside the present moment of time, and the present time. They

differ in sensitivity to the relative level of the monetary saving proposition. The elimination of the classical framing effect when the proposition is given in the situational future speaks for this difference. This finding points to the noticeable inhomogeneity of time dimension. The relevant properties are summarised in the *Table 5*.

----- **Table 5 approximately here** -----

Table 5. The specification of the properties of situational and propositional time flow in regard to the level of relative saving. Here, a classical framing effect is defined as that described by Tversky and Kahneman (1981) using the *Jacket and Calculator problem* or the other but similarly formulated problems.

Time flow	Present time mode	Future time mode	Past time mode
Situational	The baseline condition. The zero distance to any point in the past or in future time mode eliminates any other representation of the time flow and makes all of the possible representations of the time flow equal. This can be modelled as: $(time\ distance) \times (time\ representation) = 0 \times (any\ time\ representation) = Present\ time\ mode.$	The situational time flow is not very sensitive to the level of relative saving; therefore, the <i>classical</i> framing effect disappears.	The propositions with the low and high relative savings have almost the same attractiveness in the situational past time mode and thus the classical framing effect remains almost as if the problems are formulated in the present time mode.
Propositional		Both propositions with high and low relative savings show almost the same general trend of declining attractiveness. The <i>classical</i> framing effect remains for a certain distance in the future.	The proposition with the high relative saving ages quicker than that with the lower one, so that the classical framing effect declines or is eliminated altogether at a certain time distance in the past.

Source: developed by the author

One may notice that the description of the present time mode by the formula: $(time\ distance) \times (time\ representation) = 0 \times (any\ time\ representation) = Present\ time\ mode$ points to the unique property of the now moment, which unites the properties of all other possible representations of a time flow. Thus, all possible cognitive representations of the time flow converge into the present time mode, independently of the discrepancies in their properties. This corresponds to immediate presence of an object or a proposition at the moment. Outside of the present time moment however, the mind's ability to develop several cognitive representations of a time flow results in the problem of a subjective time-momentum modelling.

CONCLUSION.

In the recent systematic review on temporal discounting by Seaman et al. (2022) point to the dominant use of conventional linear time for modelling discounting. Lipman & Attema (2024) reviewed the methods for measuring discount rates and one notices the clear prevalence of the singular time line as conventional concept in this field of studies. Sarmiento et al. (2023) review the studies on pharmacological modulation of temporal discounting. They list the neurochemical mechanisms of impatience and delay discounting. The mechanism and their functions are also described relying on the singular time line. Keidel et al. (2021), Keidel et al. (2025) examine the cognitive factors behind delay discounting relying on the singular time line. Jiang, Y., Jiang, C., et al Hu, T., & Sun, H. (2022) examine effects of emotion on intertemporal decision-making. Their model

also is based on the single-dimension of time flow. Huang & Xu (2024), relying on the conventional notion of time line, in their meta-analysis disentangle the effects of temporal framing on risk perception, attitude, behavioural intention, and behaviour. Thus, one concludes that the concept of singular time line dominates in the main stream studies on intertemporal decision making and judgment.

The standard models of intertemporal decision making originating with Paul Samuelson assume that (a) time is a single linear dimension and (b) people discount future outcomes according to a stable function. However, empirical research shows many systematic anomalies, such as: 1) magnitude effect, 2) delay vs date framing effect, 3) preference reversals, 4) subadditive discounting, 5) hyperbolic discounting. Researchers often treat these as different psychological phenomena. Our findings suggest that these anomalies may appear because different tasks activate different representations of time flow. Thus, the intertemporal discounting depends on how time flow is mentally represented.

In this sense the existence of many cognitive representations of time flow (Polunin, 2021, 2025) challenges the conventional singularity of time flow. One and the same physical momentum may belong to different representations of the time flow. Moreover, one and the same time interval may be experienced individually through one of the many representations of time flow. As previous studies (Polunin, 2011, 2015) suggest, in some cases there may even be two representations of time flow at play in the same time interval. This results in essentially different variations of an object (e.g., the value of money) over time. In order to achieve predictability, e.g., in stock returns, one needs to know how the human mind models a time flow in relation to the actual given task with its specific wording. This then helps to model the possible under- or over-valuation of a proposition over time. The heterogeneity of time flow representations makes this task rather complicated. For instance, an impact of time flow on proposition along the time interval consisting of a few sequential non-overlapping sections (marked by index j , $j=1,n$) with an involvement of different representations of time flow (marked by index i , $i=1,m$) may be described as: $\Delta = \sum_j d_j k(i) R t(i)$, where d_j – is the distance in the time units of the j -th segment in which the i -th representation of time flow is in play, $R t(i)$ is the i -th time representation influencing the proposition on the j -th time segment, and $k(i)$ is a discounting coefficient for the i -th representation of time flow. Concluding we insist on the following. While the mainstream studies on intertemporal decision making and in behavioral economics assume: *value = reward × discount function of delay*, we suggest the following function: *value = reward × discount function (specified for cognitive representation of time)*. And this function is to apply separately for each cognitive representation of time flow. This stresses the notion that the cognitive representation of time may itself be a hidden variable in intertemporal choice.

An interesting implication of proposed approach is that many famous anomalies in intertemporal choice may not be separate phenomena at all. They might all arise from changes in how time is mentally represented. In other words, instead of explaining each anomaly with a different psychological mechanism, our approach suggests that a single hidden variable – representation of time flow - may generate several well-known effects.

The empirical and theoretical arguments (Polunin, 2021) for the multiplicity of cognitive representations of time flow can open a new dimension in the discussion of the role of time representation in human decision-making, in human evolution, and economic behaviour. Rosati and colleagues (2007), Beran and Evans (2006, 2007), and Beran et al. (2014) point to the waiting behaviour of apes and discuss the origin of human patience and its relevance for the development of economic and social relationships. Boyer (2008) raises the question of the relevance of mental time travel for evolutionary economics. He argues that mental time travel nudges us towards more restrained choices, which are beneficial in the long run, especially given human dependence on cooperation and coordination. Conventionally, all these discussions are about the singular time flow representation. The mind's ability to develop more than one representation of time flow has not yet been considered. The multitude of time flow representations may allow for the multiplicity of behavioural reactions to one and the same stimuli. Such variability in reactions may be essential for evolutionary and historical selection of the most efficient way of to model the world. For instance,

current and the earlier results (Polunin, 2015), suggest that the situational and propositional time flow modulate the proposition attractiveness differently over time. Consequently, their activation leads to a different readiness to wait for one and the same proposition. The situational time flow is responsible for a low discounting rate, whereas the propositional representation of time flow leads to a strong discounting. So, they essentially impact on mental proximity of an object or event which is given in flow of individual experience. It is also necessary to address the earlier described discrepancy in time representation from the first- and the third-person perspectives (Krishnamurthy & Kumar, 2002; Polunin, 2013, 2014). Such a discrepancy may contribute to social interactions, e.g., modulating disagreements about past and future propositions among a group of people.

In general, the study supports the psychological concept of multiple cognitive representations of time flow we presented in the set of earlier studies (Polunin, 2009, 2011, 2015, 2025). The concept argues that time is not a single unified cognitive construct, but it consists of separate heterogeneous representations of time. The variability of the cognitive representation of time flow may thus be a factor in the evolutionary and historical development of humans. This opens up new perspective for investigating how the different representations of time flow have contributed to evolutionary development, e.g. to the conceptualization of causality, to recognition of causality among life events, to patience, or to the modulation of other time sensitive behaviours. If one assumes such effects, then subsequent studies should examine, for instance, how the preferences for certain representation of time flow are distributed in today's human population, and whether this coincides with the variations in economic behaviour. In that sense, new perspectives emerge for research on the relevance of cognitive time representation for the different aspects of human behaviour, the epistemological activity, but also for economic, legal, and managerial tasks.

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CONFLICT OF INTEREST STATEMENT

The author declares no competing interests.

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